D8.1 Plan for collaboration with I4MS projects and DIHs

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Abbreviations and Acronyms

Table 1 - Abbreviations and Acronyms

APPS	Advance Production Planning and Scheduling
BP	Blocking Point
CJ	Customer Journey
CSA	Coordination and Support Action
CPS	Cyber Physical System
DEP	Digital Europe Programme
DIH	Digital Innovation Hub
DMP	Digital Manufacturing Platform
DOA	Description of Action
DTA	Digital Transformation Accelerator
EC	European Commission
EDIH	European Digital Innovation Hub
EIT	European Institute of Innovation & Technology
ESM	Efficient and Sustainable Manufacturing
FoF	Factory of the Future
FSTP	Financial Support to Third Parties
HEP	Horizon Europe Programme
HPC	High Performance Computing
IA	Innovation Action
ICT	Information and Communication Technology
IDSA	International Data Spaces Association
MaaS	Manufacturing as a Service
MFF	Multiannual Financial Framework
OSS	Open Source Software
PdM	Predictive Maintenance
RAF	Reference Architecture Framework
R&I	Research and Innovation
SAE	Smart Anything Everywhere
SMI	Smart Manufacturing Industry
TEF	Test Experimentation Facilities
TF	Task Force
XaaS	Everything as a Service
ZDMP	Zero Defect Manufacturing Platform

Executive summary

Deliverable D8.1 "Plan for collaboration with I4MS projects and DIHs" is the first deliverable of WP8 "Beyond DISSEMINATION: AI DIH ecosystems from awareness to adoption" which aims at creating awareness and visibility around AI REGIO, its assets and activities. In particular, D8.1 belongs to WP8.6 Collaboration with **I4MS** projects and **DIHs** (POLIMI).

According to the DOA *this task addresses the liaison and co-operation activities with other projects that will contribute to the I4MS and Digital Innovation Hubs initiatives through seven complementary and interactive actions: (a) Participate to common dissemination events; (b) Exploit synergies between projects; (c) Link to innovation networks; (d) Contribute to a common web portal and a corporate identity; (e) Organize regular meetings to assess the co-operation activities; (f) Participate to mentoring activities for widening purposes; (g) Participate to the development and maintenance of the Digital Innovation Hub Catalogue.*

The present deliverable D8.1 describes the initial AI REGIO collaboration plan with 8 main communities relevant for our mission and objectives:

i. In the **I4MS program**, AI REGIO is one of the Phase IV Innovation Action. The Phase III MIDIH project represents the ancestor of AI REGIO under three main viewpoints: the methods and tools for DIH management; the ICT Platform (DIHIWARE) for Innovation and Collaboration inside and between DIHs; the CPS/IoT Open Source Platform and its two implementation lanes (FIWARE and APACHE). In the I4MS Phase IV, AI REGIO expects to set-up close collaborations with KITT4SME and DIH-WORLD Innovation Actions. The I4MS4Ts CSA will support collaboration opportunities form other Phase IV projects as well.

ii. In the **Support to Hub priority**, AI REGIO has identified strong opportunities of collaboration with those DIHs focussing on Manufacturing industry: some in Smart Anything Everywhere, some in the Robotics domains. The relevant S4E and RODIN CSAs will facilitate this task, while the DIH4INDUSTRY platform will be the Innovation and Collaboration place for all DIHs focussing on Manufacturing. The DIHNET.eu CSA will support collaboration opportunities form other DIH projects as well, also in other but related domains, such as energy, agri-food and healthcare.

iii. Other **DIH communities in the AI and Manufacturing** domains will be sought for collaboration. In particular, the Vanguard Initiative and its Efficient and Sustainable Manufacturing pilot is a community at the basis of AI REGIO; the AI DIH Network project and its mentoring and coaching program paved the way for DIH-DIH collaboration; the DIH4AI platform (based on DIHIWARE) will support an interoperability framework with AI4EU and its services.

iv. In the context of the next **EC MFF Multiannual Financial Framework**, AI REGIO will seek collaboration opportunities both in the Digital Europe and Horizon Europe programmes, by leveraging on its exploitable assets and unique value proposition. In the DEP, AI REGIO will contribute to the EDIH, Data Spaces for Manufacturing and AI TEF for Manufacturing topics. In the HEP, privileged dissemination channels will be open to "AI for sustainable manufacturing" and I4MS second generation for manufacturing sustainability in SMEs.

v. In the **Digital Manufacturing Platform** cluster, AI REGIO will participate to the working groups extended meetings (especially WG1 standardisation and WG3 impact) related to the "AI for Manufacturing" domain: reference architectures, open source implementations and standards. Collaboration with CF CSA will be sought regarding the mapping of AI REGIO cases to the three CF1 pathways and the new CF2 ones, especially the one about Data Spaces. Cross-domain interactions with agrifood, health & care, energy sectors will be implemented in the OPEN DEI CSA environment and through the activities of its TF1 about Design Principles of Data Spaces.

vi. In the **AI for Manufacturing** ICT-38 projects, AI REGIO will look for new innovative tools and solutions to potentiate and extend its AI4Manufacturing toolkit of WP4. In particular, XMANAI (coordinated by TXT) will support explainability of AI decisions, while COALA will provide advanced human-machine interaction and chatbots capabilities.

vii. In **Manufacturing and AI Partnerships and Associations**, AI REGIO will look for interesting collaborations regarding AI solutions entangled with other advanced manufacturing technologies (such as Additive Manufacturing, new Materials and Nanotechnologies) supporting different industrial sectors (such as Process and Mining industries) through liaisons with EFFRA, EIT MAN and A.SPIRE. In the domain of other Digital Technologies, AI REGIO will be the AI4EU, BDVA, AIOTI and IDSA communities as well.

For each and every community indicated above, AI REGIO D8.1 has depicted a collaboration table to be implemented along WP8 and reported in its following deliverables D8.x about communication and dissemination actions (High, Medium, Low relevance and AI REGIO potential impact).

Table 2- Collaboration Table for WP8

Collaboration Item	I4MS	Hub	DIH	MFF	DMP	AI4M	PPP
Joint Dissemination	H	M	M	L	M	M	L
Synergies with Projects	H	H	M	L	M	M	L
Link to innovation networks	H	M	M	M	L	L	M
Common Marketplace	H	H	M	M	L	L	M
Cluster Meetings	H	M	M	L	H	M	L
Mentoring Activities	H	H	M	M	L	L	M
Digital Innovation Hub Catalogue	H	H	H	M	L	L	L

1 Introduction to WP8 and Task 8.6

Inside WP8 "*Beyond DISSEMINATION: AI DIH ecosystems from awareness to adoption*", the ***Task8.6 Collaboration with I4MS projects and DIHs*** addresses the liaison and co-operation activities with other projects that will contribute to the I4MS and Digital Innovation Hubs initiatives.

It entails contributions to the following activities: (a) Participate to common dissemination events; (b) Exploit synergies between projects (e.g. brokering, access to facilities offered by the other projects, guiding SMEs to the appropriate project, skills development and contribution to Digital Skills and Jobs Coalition, investors network, smart specialisation regional investments); (c) Link to innovation networks (e.g. Enterprise Europe networks, National Contact Point networks) in order to multiply innovation beyond projects; (d) Contribute to a common web portal and a corporate identity without detriment of the individual identity and web site of each project; (e) Organise regular meetings to assess the co-operation activities, in particular a monthly phone call with group of advisors and a regular phone call about skills development; (f) Participation to mentoring activities organised for widening purposes; (g) Participation to the development and maintenance of the Digital Innovation Hub Catalogue. This first deliverable D8.1 at M3 includes the collaboration plan with the following communities:

- **Chapter 2: I4MS** (ICT Innovation for Manufacturing SMEs) program inside H2020. In particular, AI REGIO is naturally linked to the Phase III project MIDIH[1], successfully completed at the end of September 2020. From MIDIH, AI REGIO is inheriting the methodology for DIH analysis and management, the DIHIWARE Innovation and Collaboration platform and the Open Platform for Industrial IoT and Industrial Analytics. The continuity between the two projects is based on some common partners and through the DIH4Industry marketplace[2] which is the exploitation vehicle for MIDIH and many other DIH projects active for the benefit of Manufacturing Industry. Privileged liaison with Phase IV projects will materialize through the common I4MS CSA, especially with KITT4SME (see below) which is addressing the same DT-ICT-03 bullet on AI Innovation.
- **Chapter 3: Support to Hub** Focus Area in DT-ICT-18/19 work programme. Deeper relationship is envisaged with industry-oriented actions, as those in the Smart Anything Everywhere SAE[3] (DT-ICT-01), and ROBOTICS[4] (DT-ICT-02) actions. Collaboration with the DIHNET.eu CSA[5] will assure the cross-fertilization with other adjacent domains and sectors, such as Agriculture, Energy and Healthcare. Methods, tools and platforms of AI REGIO will be proposed to the other domains also in the view of the EDIH initiative in the coming Digital Europe Program 2021-2027. The so-called precursor EDIH network has been approached and common methods and tools exchanged.
- **Chapter 4: Other DIH initiatives in AI and Manufacturing.** This is a miscellaneous set of initiatives which span from the DIH Catalogue[6], the Efficient and Sustainable pilot in the Vanguard Initiative[7], the AI DIH Network study[8] (tender) and the future DIH4AI Innovation

[1] https://www.midih.eu/

[2] https://dih4industry.eu/welcome/index.html

[3] https://smartanythingeverywhere.eu/

[4] https://rodin-robotics.eu/

[5] https://dihnet.eu/

[6] https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool

[7] https://s3platform.jrc.ec.europa.eu/efficient-and-sustainable-manufacturing

[8] https://ai-dih-network.eu/

Action about "AI on-demand platforms" in H2020 ICT-49-2020 call[9]. It is indeed very important for AI REGIO to look outside H2020 initiatives and discuss common Research & Innovation as well as dissemination topics and to indirectly address the AI-on demand platform AI4EU[10]. In this last respect a community "AI for Manufacturing", in collaboration with ICT-38 RIAs[11], could be also involved in AI REGIO ecosystem and its network of DIHs.

- **Chapter 5: AI and DIH in next Multiannual Financial Framework**. This is a look into the future about the DIH priority in DEP crossed with the AI technology and instantiated in the Manufacturing sector. The EDIH and its Digital Transformation Accelerator is of course our major target (of WP3 in particular) where to address AI REGIO methods, tools and platforms especially in the Manufacturing domain. The "Data Spaces for Manufacturing" topic is addressed in AI REGIO WP5 and it is for sure the most relevant pre-condition to finally have an "AI TEF for Manufacturing" network.
- **Chapter 6: Digital Manufacturing Platforms and Pilots.** The AI REGIO main technological objective is to develop a bridge between DIH for Manufacturing and DMP projects (DT-ICT-07)[12]. Built on top of the MIDIH Open Platform, the AI REGIO AI4Manufacturing toolkit (WP4) will set up fruitful relations with the DMP specialists in platforms e.g. for hyper-connected, smart autonomous and collaborative product-service scenarios. Special liaison will be sought with the CF2 CSA (Connected Factories)[13] and its 2025 pathways, as well as with OPEN DEI CSA[14] for cross-domain fertilization and adoption in other domains.
- **Chapter 7: Manufacturing and AI Partnerships and Associations.** Specific relationships will be established with the current and new initiatives in both the Manufacturing and the AI domains. In the former case, EFFRA[15] and EIT MANUFACTURING[16] need to be addressed particularly in the view of implementing their SRIA and 2023 roadmap. In the AI domain, the BDV Partnership[17] and its evolution to DAIRO[18] will be duly considered in the view of coming Horizon Europe multi annual programme. The International Data Spaces Association[19] is also very precious to provide reference architectures and guidelines for successful B2B Data Exchange in the Manufacturing sector.
- **Chapter 8 Future Outlook and Conclusions.** This conclusive chapter will anticipate the content of next WP8 deliverables and action plans for what relationships and liaisons with I4MS and other relevant initiatives is concerned.

[9] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/ict-49-2020

[10] https://www.ai4eu.eu/

[11] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/ict-38-2020

[12] Digital Manufacturing Platform European Commission : CORDIS : Search : Results page (europa.eu)

[13] https://www.connectedfactories.eu/

[14] https://www.opendei.eu/

[15] European Factories of the Future Research Association https://www.effra.eu/

[16] https://eitmanufacturing.eu/

[17] Big Data Value Association https://www.bdva.eu/

[18] Data, AI and Robotics Partnership https://ai-data-robotics-partnership.eu/

[19] https://www.internationaldataspaces.org/

2 The I4MS Program in Digital Transformation focus area

I4MS (ICT Innovation for Manufacturing SMEs)[20] is *a program promoted by the European Commission to expand the digital innovation of manufacturing SMEs in Europe. As an SME or a mid-cap you can apply for technological and financial support to experiment with different technologies and services to improve the innovation skills of your staff and the technologies and services your company provides. I4MS is one of the key initiatives of the European Commission to shape the pan-European network of Digital Innovation Hubs*.

I4MS has been organized in four interlinked phases since the beginning of H2020 (see Figure 1)

Figure 1 - The four Phases of I4MS

I4MS Phase III has invested 34 MEUR to fund four innovation actions in four strategic domains in "ICT for Manufacturing": HPC / Cloud based Simulation (Cloudifacturing Innovation Action[21]), Robotics (L4MS Innovation Action[22]), Laser and Additive Manufacturing (AMable Innovation Action[23]) and Cyber Physical Systems and Industrial Internet of Things (MIDIH Innovation Action[24]). AI REGIO is in line of continuity especially with MIDIH, its methods and tools for DIH management and its Open Source Digital Manufacturing Platform.

[20] https://i4ms.eu/

[21] https://www.cloudifacturing.eu/

[22] Logistics for Manufacturing SMEs http://www.l4ms.eu/content/l4ms-project-home

[23] https://www.amable.eu/

[24] https://www.midih.eu/

The **I4MS Phase IV** is implemented by the call "**DT-ICT-03-2020**: I4MS (phase 4) - uptake of digital game changers"[25]. The challenge is to accelerate the design, development and uptake of advanced digital technologies by European industry – especially SMEs and mid-caps –, notably in sectors where digital technologies are underexploited. SMEs and mid-caps in the manufacturing sector need support in the use of secure digital technologies in their production processes, products and business models to enable personalised products and to facilitate cost-effective small-scale production.

The following five topics are called:

a) ***Smart modelling, simulation, and optimisation for digital twins***. *Experimentation of novel modelling, simulation, and optimisation techniques, possibly combined with high-performance computing and data analytics, for digital twins covering the full lifecycle of products and systems.*

b) ***Laser based equipment in advanced and additive manufacturing***. *Actions will focus on assessment of technologies, systems, and processes and on digitisation opportunities, including the link between design tools and production and quality assurance. Actions should include the identification of high-potential business cases and support for the development of business models.*

c) ***Innovative Artificial Intelligence in manufacturing***. *Experimentation of innovative Artificial Intelligence techniques in manufacturing, aggregating and analysing data from multiple sources, including e.g. MES (manufacturing execution systems) data, real-time process analytical data, in-line quality control, sound, video and olfactory input. Proposals are encouraged to build on the results of topic ICT-26-2018-2020.*

d) ***Cognitive autonomous systems and human-robot interaction***. *Experimentation with cyber-physical systems in production environments, with special focus on reduction of waste, energy and resource consumption and efficient logistic processes. Adoption of robots safely cooperating with humans to support their work, improving both the efficiency and the working conditions and taking into account gender issues. In this topic, proposals should include partners that facilitate creation and experimentation with and by the arts to ensure human acceptance of digital technologies in manufacturing and to stimulate new products and services.*

e) ***Widening Digital Innovation Hubs***. *Experimentation through Digital Innovation Hubs in regions which are so far underrepresented in Smart Anything Everywhere and I4MS, building on the work by projects "Smart Factories in new EU Member States" and "DIHELP". The objective addresses all technology areas mentioned above and the technologies addressed in Smart Anything Everywhere and related areas. The hubs should strongly collaborate with other Innovation Actions funded under the Hubs part of the Focus Area, e.g. through joint highly innovative cross-border experiments.*

The **DT-ICT-03** winning projects, as AI REGIO, had their KOM in July-October 2020:

a) **Smart modelling, simulation, and optimisation for digital twins**.
- Create and Harvest Offerings to support Manufacturing SMEs to become Digital Twin Champions, **Change2Twin**, 951956
- Digital twins bringing agility and innovation to manufacturing SMEs, by empowering a network of DIHs with an integrated digital platform that enables Manufacturing as a Service (MaaS), **DIGITbrain**, 952071

[25] https://cordis.europa.eu/programme/id/H2020_DT-ICT-03-2020

b) **Laser based equipment in advanced and additive manufacturing**.
   - Fostering the PAN-European infrastructure for empowering SMEs digital competences in laser-based advance and additive manufacturing, **PULSATE**, 951998

c) **Innovative Artificial Intelligence in manufacturing**.
   - Platform-enabled KITs of arTificial intelligence FOR an easy uptake by SMEs, **KITT4SME**, 952119
   - Regions and DIHs alliance for AI-driven digital transformation of European Manufacturing SMEs, **AI REGIO**, 952003

d) **Cognitive autonomous systems and human-robot interaction**.
   - Value Of Joint EXperimentation in digital Technologies for manufacturing and construction, **VOJEXT**, 952197
   - Grow your manufacturing business, **Better Factory**, 951813

e) **Widening Digital Innovation Hubs**.
   - DIH-World - Accelerating deployment and matureness of DIHs for the benefit of Digitisation of European SMEs, **DIH-World**, 952176

Finally, a **CSA** has been funded to coordinate all the DT-ICT-03 Innovation Actions.

- I4MS Tools and Technologies for Transformation, **I4MS4Ts**, 951848

2.1 I4MS Phase III, the CPS / IOT domain

As already highlighted, AI REGIO is inheriting several outcomes from the MIDIH project and can leverage on the presence in both initiatives of some key beneficiaries (such as POLIMI, ENG and NISSATECH).

Three main MIDIH assets are now exploited and extended in AI REGIO:

1. **Methods and Tools for DIH Management**. MIDIH has elaborated a methodology to support DIHs in extending and improving their service proposition both to their constituency and to other DIH in the network (e.g. the DIH4INDUSTRY network). The following main achievements are inherited by AI REGIO:
   a. **Service Portfolio Analysis**. A structured approach is proposed to DIHs in order to define their as-is and to-be service portfolio. Services are classified in 5 main top-level categories (ETBSD Ecosystem, Technology, Business, Skills, Data), while a 3-levels taxonomy with examples is provided in order to support DIHs in the definition and description of their as-is and to-be services. In particular, for the to-be services, three main categories have been depicted: Project-funded, Project-inspired, Project-collaborative services with an increased degree of co-operation with the projects and its beneficiaries. *AI REGIO is adopting the same approach with a smart specialization on the AI technologies (while MIDIH was focusing on CPS/IoT).*

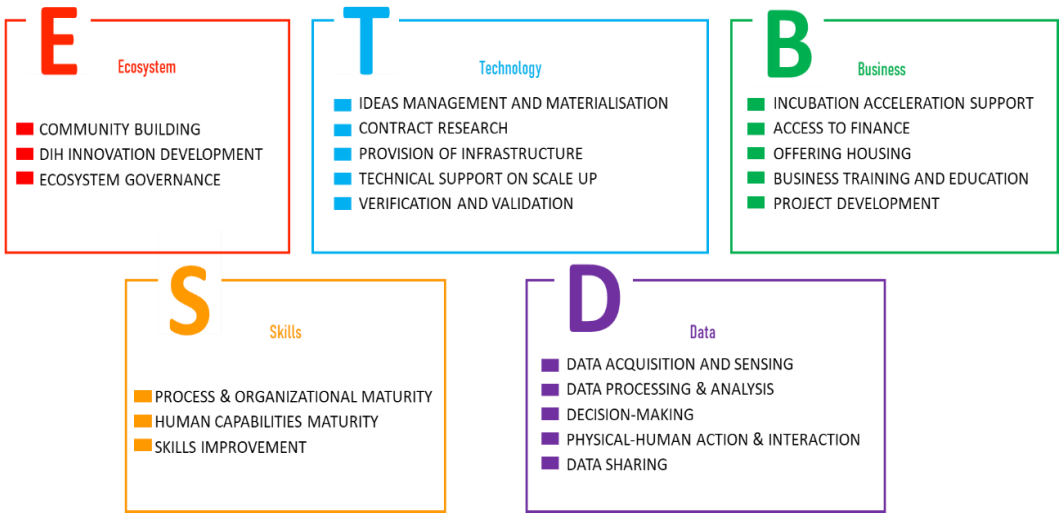

Figure 2 - The ETBSD methodology

b. **Customer Journeys (CJ) and Blocking Points (BP)**. A Customer analysis is proposed in order to understand typical needs, expectations and interaction workflows by the various ecosystem stakeholders. Customizable templates for Technology Providers, Technology Users, Students, Start-ups, Public Bodies and other DIH customers are provided, in order to ease the identification of customers and the definition of typical interaction workflows. Customer Journeys (CJs) are then defined as level-by-level Digital Transformation (DT) evolutionary pathways that typically model the customer interaction with a DIH. A third step in this analysis is the identification of Blocking Points, i.e. of factors preventing customers to evolve their Digital Transformation from one level to the subsequent one. *AI REGIO is extending the method for different categories of DIHs and to the AI Technologies. For instance, AI-based technology providers in the 13 AI REGIO DIHs will be identified and involved in order to understand their expectations form the interaction with a network of AI DIHs for Manufacturing. As Blocking Points, the complexity of AI technologies, the need for high quality datasets and the requirements related to human skills and competencies will be considered.*

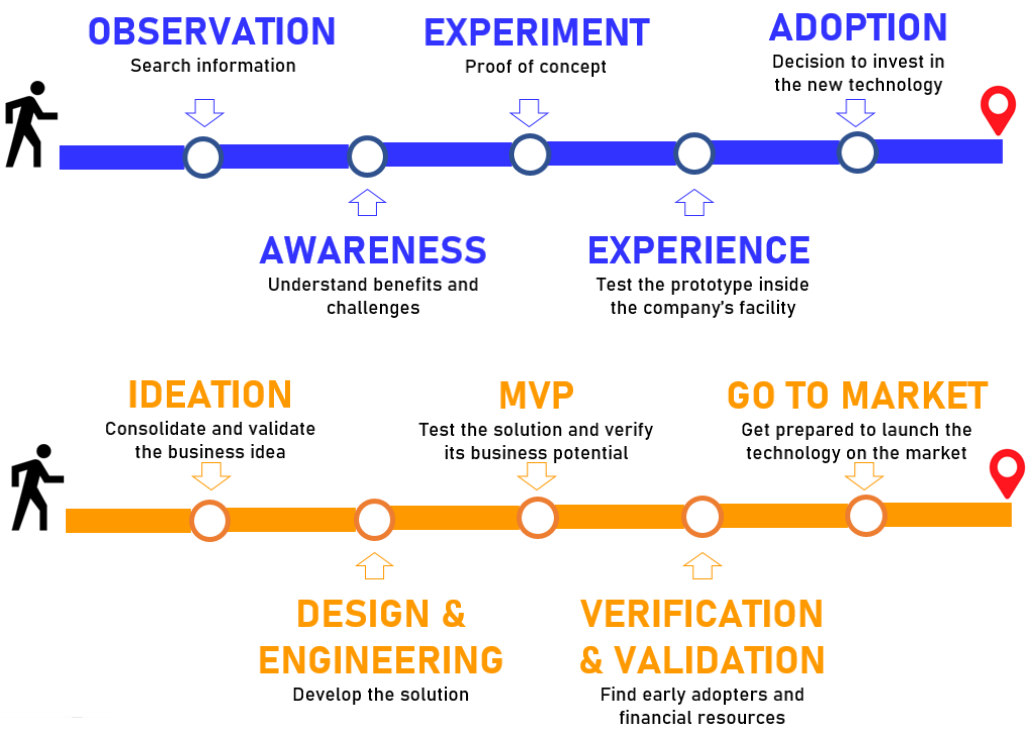

Figure 3 - Customer Journeys for Technology Users and Technology Providers

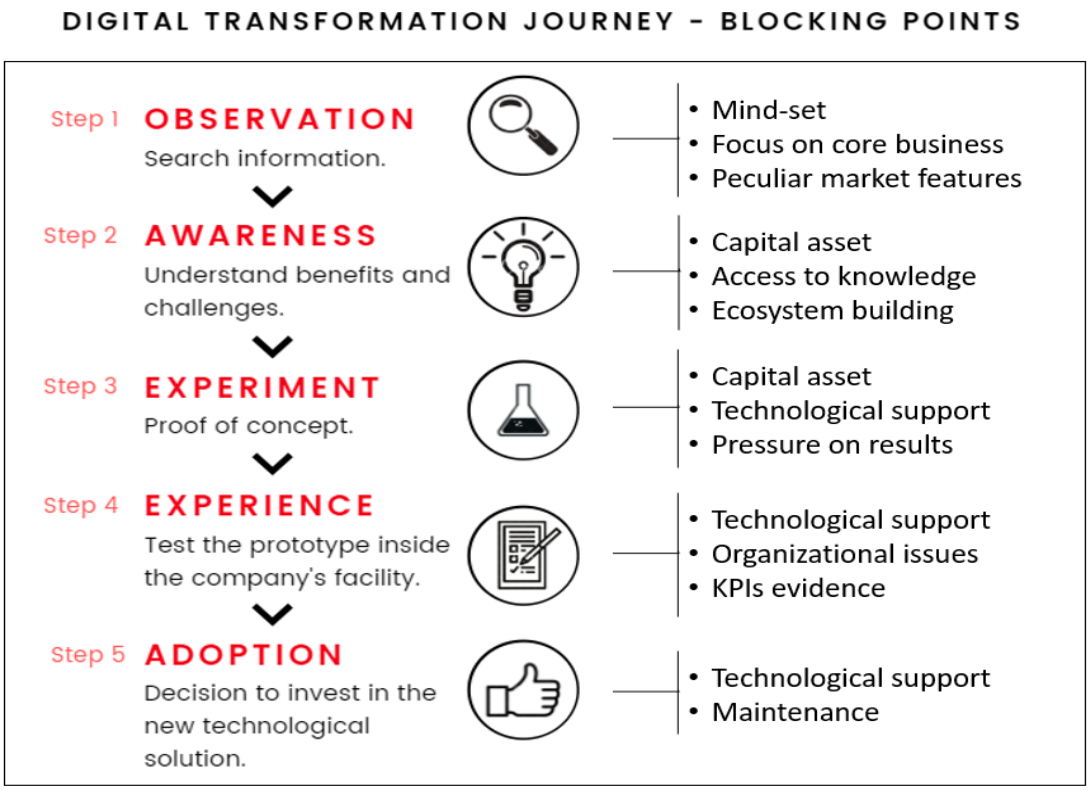

Figure 4 - Blocking Points in Digital Transformation

c. **Service-oriented Digital Transformation Matrix**. The third step of the methodology consists of populating the Customer Journeys with as-is and to-be Services in order to overcome the Blocking Points identified. The result is a bi-dimensional matrix

where the different steps of the CJ are implemented by services, supporting the evolutionary pathways from one level to the subsequent one. Generic DT Matrices can be generated by the DIHs for each of their Customers' typologies as reference sequences of services for DT (pathways): new to-be services are aimed to fill gaps in the pathway and to overcome blocking points limitations. Such generic pathways are then to be instantiated for the specific Customer and, in the case of Manufacturing SMEs, accompanied by a DT plan along the six dimensions of the pathway (6Ps migration model). For each milestone achieved by the customer in its DT journey, a success story can be generated and substantiated by evidence of the progress made. *AI REGIO will consider different customers (e.g. public bodies like regional agencies) and customize the services (especially the Technology, Skills and Data ones) for the AI for Manufacturing domain.*

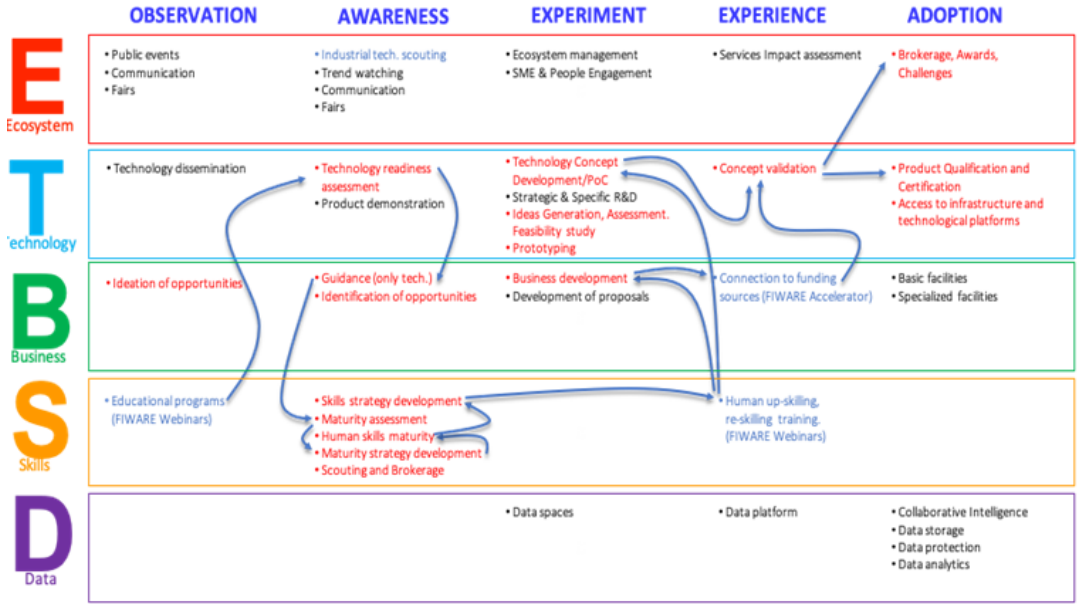

Figure 5 - Generic Digital Transformation Matrix with Service workflows

2. **DIH Innovation and Collaboration Platform DIHIWARE**. DIHIWARE platform[26] aims at supporting the collaboration among DIHs networks with a wide range of services, information and tools that will help them communicate, align, collaborate and synchronize activities. Every DIH places high values on innovation. This value is delivered both in the offered services, as well as how collaborative business processes can be supported by a specific IT Platform.
   The DIHIWARE knowledge management capabilities, integrated in a collaborative oriented platform can build a new environment capable of giving rise to a Network of DIHs fostering the interaction among hubs, information exchange and peer-learning. The DIHIWARE Platform brings together DIHs networks, allowing them to become trusted advisors in their relationship with services consumers. Consequently, DIHs can represent a vibrant link between consumers and providers, in the exploration of new opportunities and in the observation of new trends within the industry and beyond. The platform also enables the identification of patterns between multiple sectors and across different industries. Through the DIHIWARE, it will be possible to a) connect DIHs to get work done through structured, actionable discussions on the DIHIWARE Platform;

[26] www.dihiware.eng.it and https://midih.eu/documents/news_train/presentacion8.pdf

b) align the network with strategic goals: and gather feedback and information to build a common strategy and make better strategic decisions;
c) align and focus the network on these strategic priorities to achieve specific goals; d) make the network more productive: to find the right knowledge, expertise and best practices from across the network;
e) capture and share knowledge and ideas to improve quality and spur innovation.

The following main functions are provided by DIHIWARE:

a. **Knowledge Management**: The DIHIWARE Knowledge Management System offers tools for knowledge management, social activity next to collaboration and innovation capabilities. It links users, processes and resources acting as a powerful knowledge hub where it is easy publish, organize, and access community information in one central location.

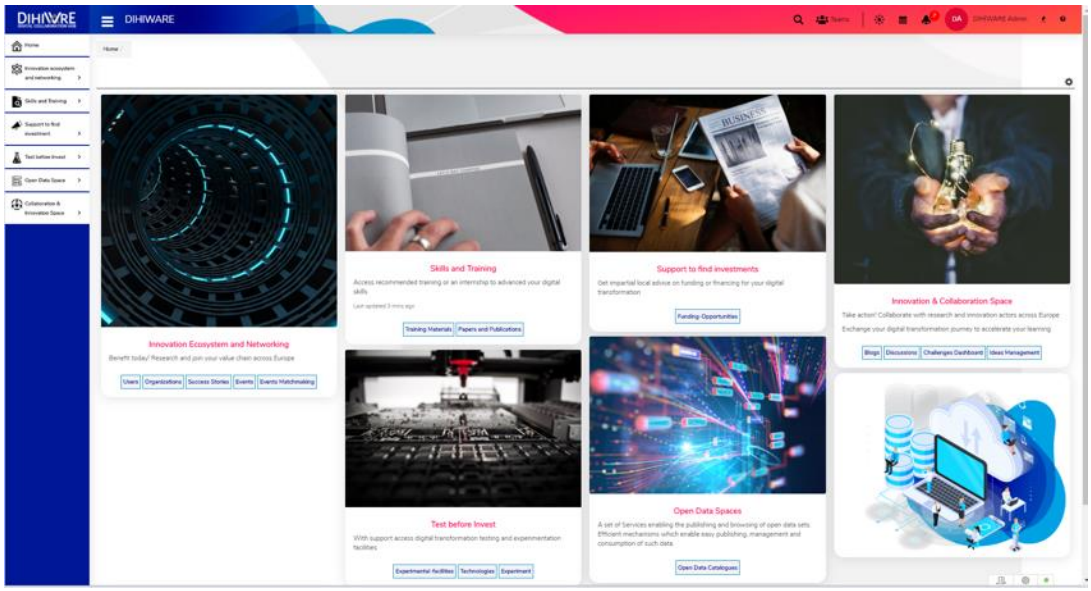

Figure 6 - DIHIWARE Knowledge Management

b. **Catalogue Management**. The Catalogues Management System handles with the resources organization and cataloguing that can be configured according to the platform instance requirements.
It acts as a new way of managing information where the use of taxonomies and the power of metadata enable the organization of product and services and their dynamic modelling and visualization.
The system offers a single access point for users leveraging on already existing information in different organizations by creating a federation of catalogues for a scalable system.

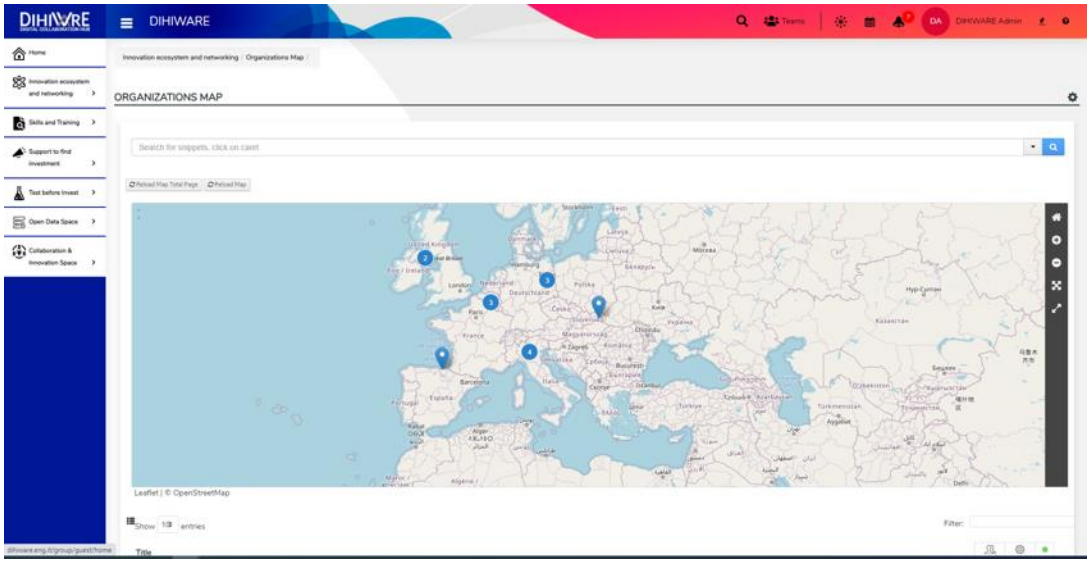

Figure 7 - DIHIWARE Catalogue - Maps view

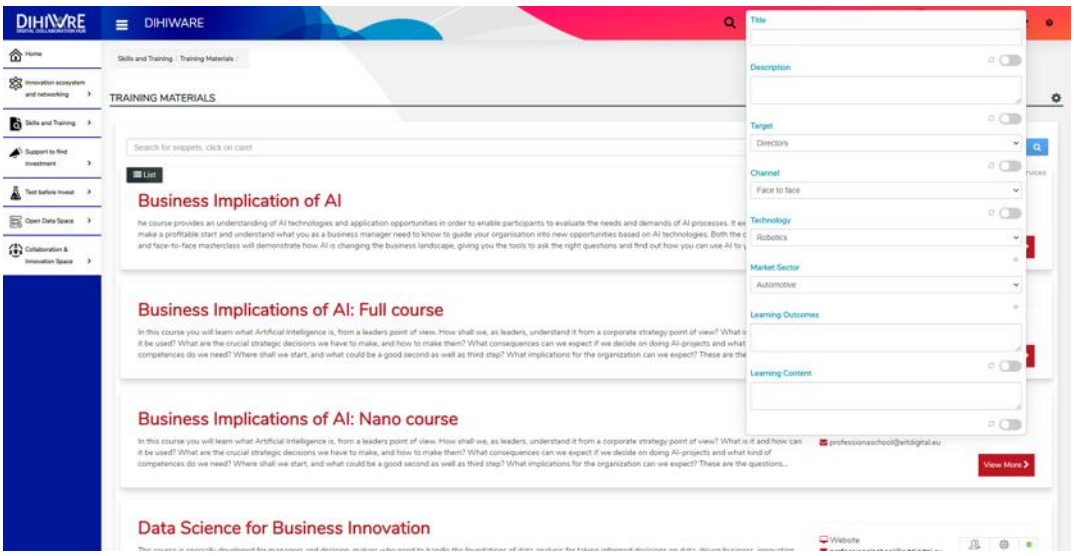

Figure 8 - DIHIWARE Catalogue - Search results and filters

c. **Collaboration and Innovation**. Building consensus, increasing levels of motivation and participation, pulling teams together and providing a fertile ground for experimentation: this is possible thanks to the suite of integrated and interconnected solutions of the platform (blog, forum, wiki, events matchmaking etc.) aiming to support efficiency, visibility and collaboration processes.

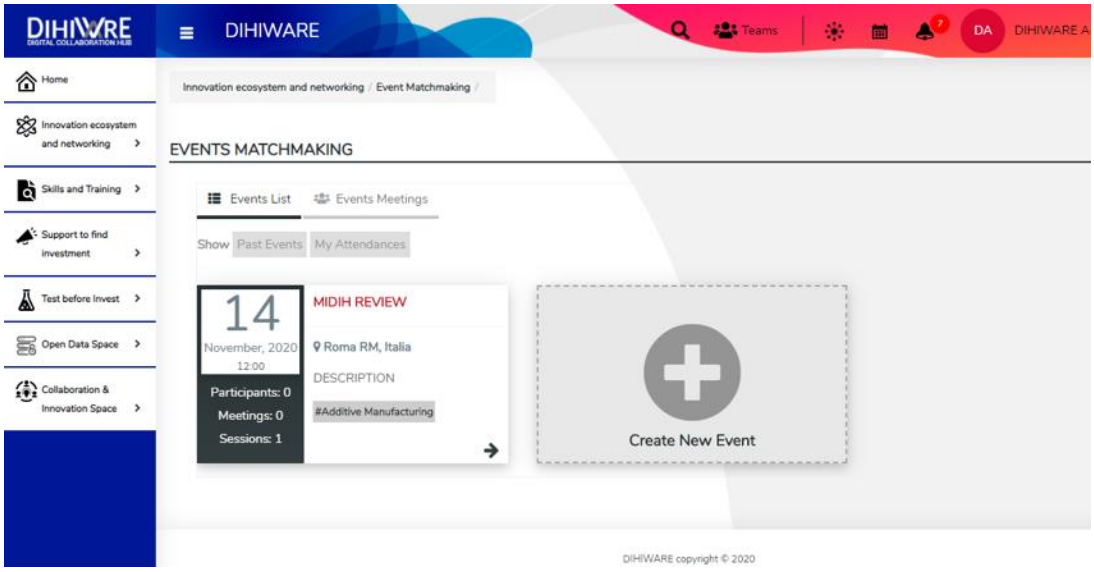

Figure 9 - DIHIWARE Collaboration Tool

d. **Open Data Space**. A set of services enabling the publishing and browsing of open Data sets. Efficient mechanisms which enable easy publishing, management and consumption of such data.

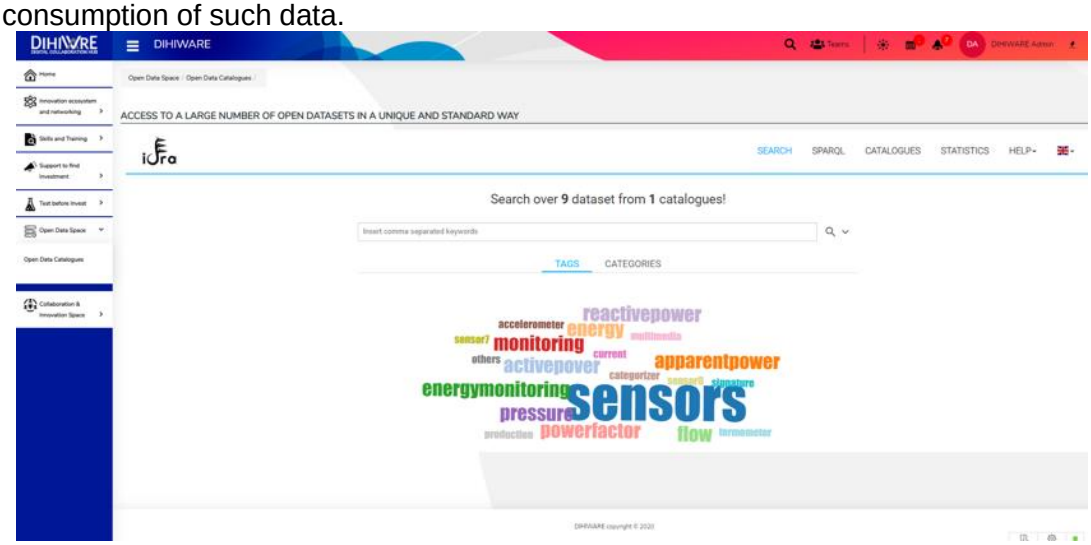

Figure 10 - DIHIWARE Open Data Space Landing Page

3. **Open Digital Manufacturing Platform for CPS/IIOT**. This third main outcome of MIDIH is realized by a Reference Architecture and two lanes of Open Sources Reference Implementations for CPS/IoT adoption in Manufacturing.
   The MIDIH open-source Reference Architecture (MIDIH RA) has been designed with consideration to compliance with other IIoT reference Architectures such as RAMI 4.0 (Reference Architecture Model Industrie 4.0), IDS RAM3.0, FIWARE4Industry, Industrial Internet Reference Architecture (IIRA) from IIC, The Industrial Value Chain Reference Architecture (IVRA) from IVI, and the Industrial Internet Architecture from the China Alliance of Industrial Internet (IIA) among others.

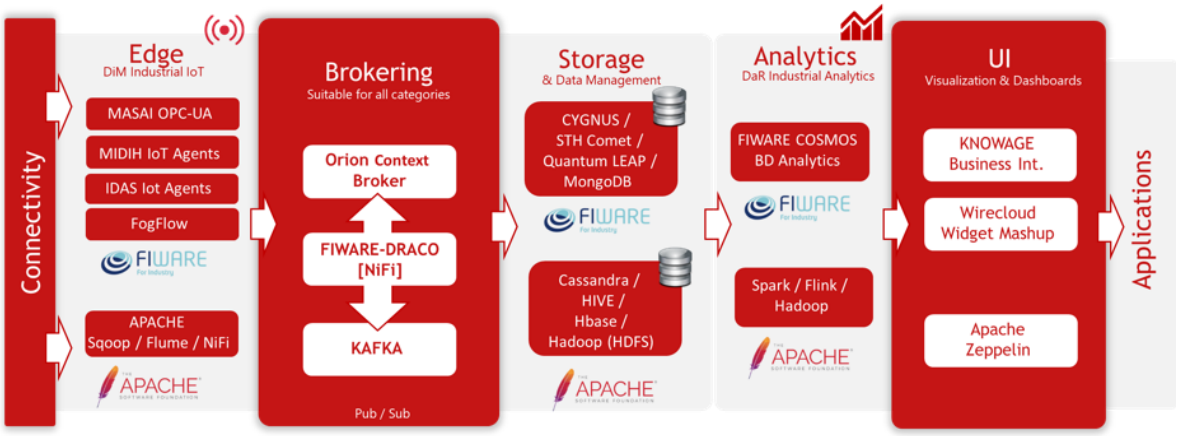

Figure 11 - MIDIH Reference Architecture for CPS / IOT in Manufacturing

The MIDIH RA aims to cover a unified analytics framework interconnected contemplating the Data in Motion (Industrial IoT) and the Data at Rest (Industrial Analytics) and offering AI-enabled data analytics services. It is based on well established guidelines and best practices, as well as proven technologies; but also includes emerging technologies in the manufacturing and automation domain such as Advanced analytics, Machine learning and Digital Twin concept providing innovative solutions that will make the MIDIH Reference Architecture a functional and modular open-source Reference Architecture to be considered in the future by manufacturing industries.

By leveraging on the mapping between FIWARE GEs and some further Open Source DiM and DaR components, the Open Platform model has two basic lanes, one FIWARE-based and the other based on worldwide known open-source projects and Foundations, such as APACHE. The lanes are linked through some cross-components at brokering/storage level making the platform able to cover a large kind of scenarios and several kinds of requirements from the Connectivity to the Applications.

The two OSS implementation lanes are depicted here below.

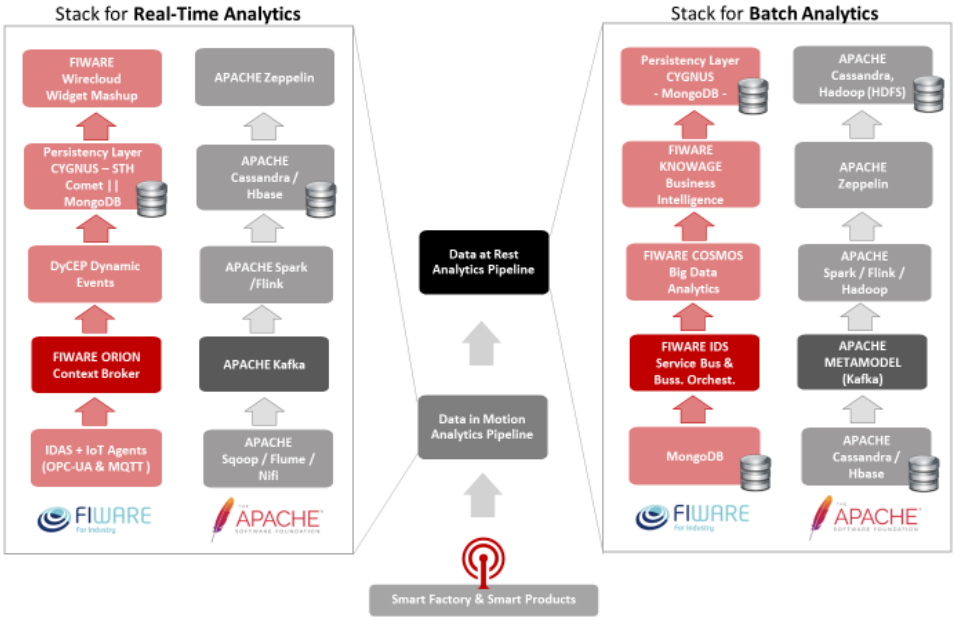

Figure 12 - MIDIH two implementation Lanes in CPS / IOT in Manufacturing

The FIWARE Lane

The FIWARE lane is composed of FIWARE open-source Generic Enablers aiming to describe and support data exchange through NGSI and NGSI-LD data models. Starting from the bottom, the FIWARE lane is able to collect data coming from several sources (plant, cloud, and enterprise systems, etc.) and scope (real-time and historical data).

Thanks to the core component Orion Context Broker, the lane can be extended and integrated with external context providers totally adopting the LEGO philosophy (components and data). After collecting, data can be processed in several and complementary ways, enabling the Complex Event Processing (CEP) or the Big Data Apache components (deploying Draco and Cosmos).

Finally, data can be presented by creating custom dashboards and cockpits.

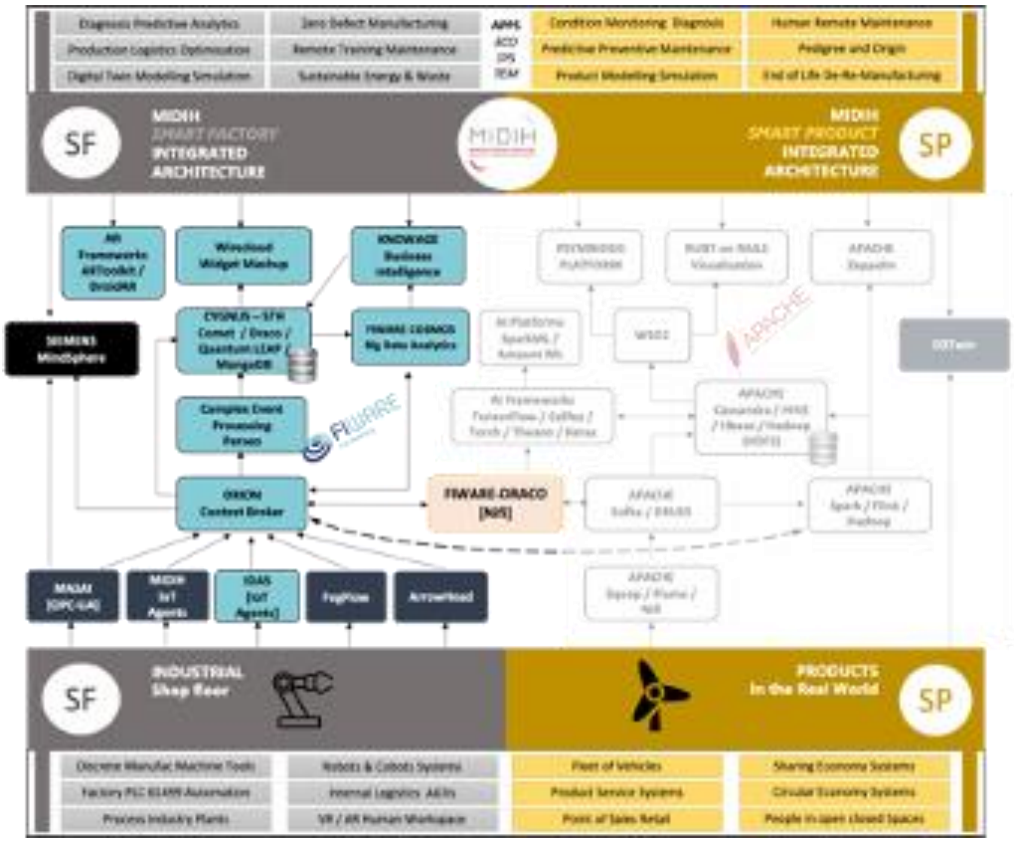

Figure 13 - FIWARE for INDUSTRY Lane for CPS / IOT in Manufacturing

The APACHE Lane

The APACHE lane consists of several layers of APACHE Open-source components which realize complex processing pipelines, starting from Data Ingestion layer (represented through Sqoop, Flumi, Nifi) which is responsible for gathering data from various data sources. Integration layer that provides flexible and scalable integration of components in the system (e.g. based on Apache Kafka - persistent distributed message broker, also as a queue). Next layer enables on the fly/move processing of the data using various streaming processing tools (Spark,

Flink). Data is stored persistently in various types of data storages (e.g. Cassandra, HBase) and processed using different types of batch processing methods (e.g. Spark, Hadoop). On the top is the layer for visualizing the result, enabling a very rich user experience.

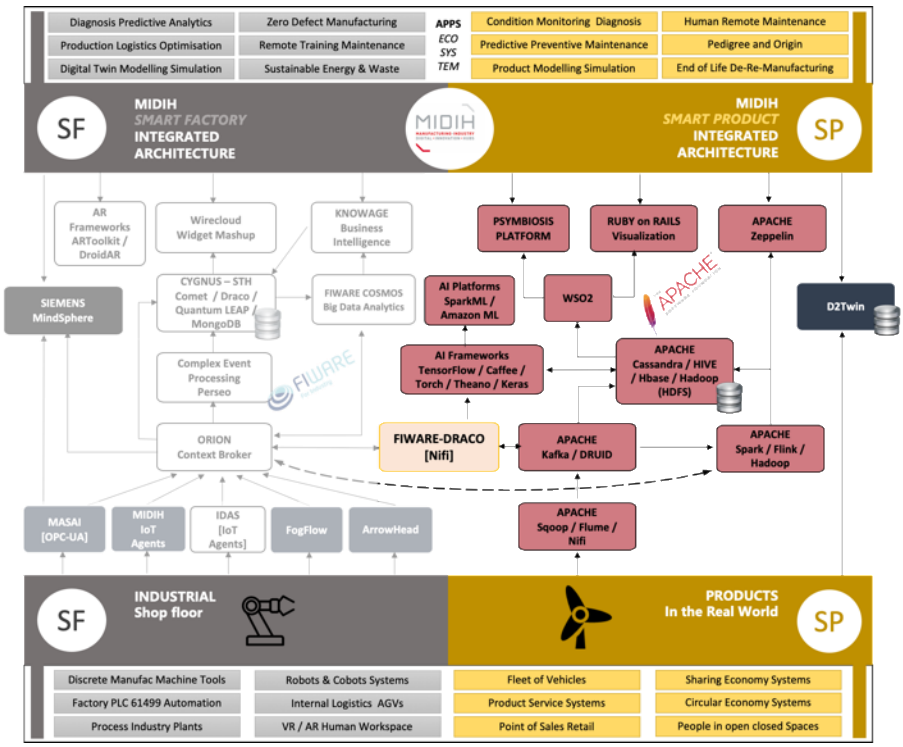

Figure 14 - APACHE Lane for CPS / IOT in Manufacturing

The Transition between Phase III and Phase IV of I4MS represents a substantial change of focus of the initiative, with a major interest on DIHs as intermediators between ICT solution providers and manufacturing SMEs. This has someway been anticipated by MIDIH and its first and second assets reported above (DIH methods and tools and the DIHIWARE platform). From the technological viewpoint, new topics have been added, as the AI one which substantially unifies CPS/IoT and HPC/Cloud in a unique pipeline. This will be the major technical challenge of AI REGIO (WP4-WP5) with respect to Phase III projects and MIDIH in particular.

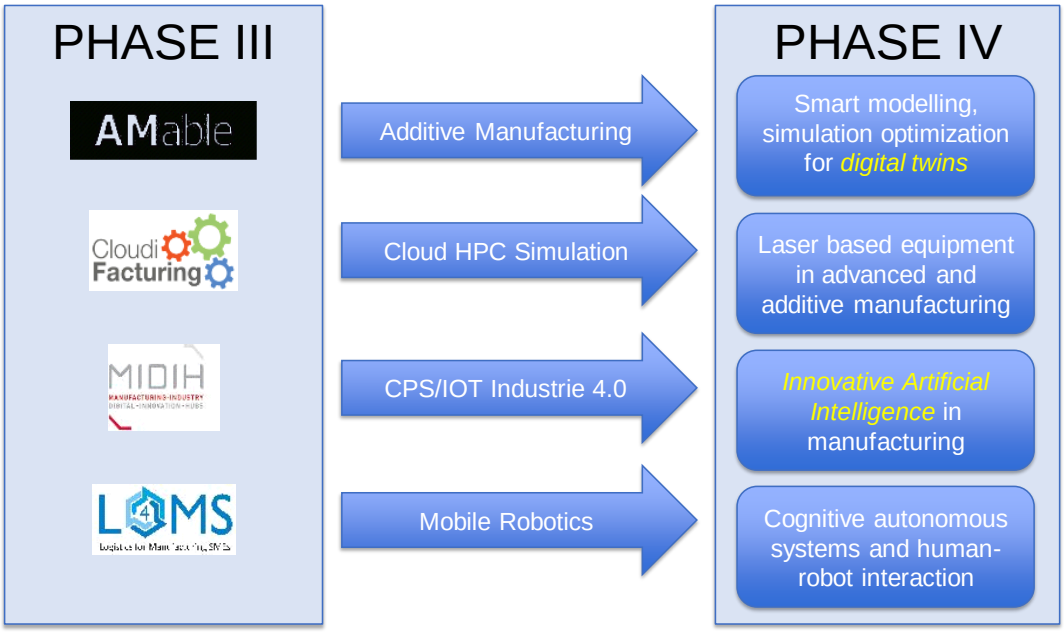

Figure 15 - The Transition between I4MS Phase III and Phase IV

2.2 I4MS Phase IV DT-ICT-03 and I4MS4Ts CSA

Among the five subtopics of the DT-ICT-03 call, AI REGIO will set up privileged collaboration relations with KITT4SME which has been funded under the same bullet of AI Innovation. Moreover, special liaisons will be sought with Digital Twins (**DIGITBrain** and **Change2Twin** projects) and Widening DIH to new Regions and Countries (**DIH-World** project). Other projects of this call, i.e. Cognitive Systems (VOJEXT and Better Factory projects) and Laser-based Equipment (PUSATE) will be involved through the DT-ICT-03 CSA called I4MS4Ts. All the projects mentioned have just started in Summer/Fall 2020, like AI REGIO.

2.2.1 KITT4SME in Innovative AI applications

KITT4SME specifically targets European SMEs and mid-caps to provide them with scope-tailored and industry-ready **hardware, software** and **organizational kits**, delivered as a modularly **customizable digital platform**, that seamlessly **introduce artificial intelligence** in their production systems.

Uptake of the resulting packages and of the provided services is strongly supported by the clear characterization and market readiness of the individual components as well as by the platform grounding on the already established RAMP marketplace. Leveraging on the network of Digital Innovation Hubs, three of which are represented in the consortium, ensures that KITT4SME are widely distributed to a wide audience of companies in Europe. Seamless adoption of the customized kits is made possible by a **Powered by FIWARE** infrastructure that flawlessly combines factory systems (such as MES and ERP), IoT sensors and wearable devices, robots, collaborative robots and other factory data sources with functional modules capable to trigger data-driven value creation.

***KITT4SME** just started in October 2020 and AI REGIO is in constant contact with the coordinator (Andrea Bettoni, SUPSI Scuola Universitaria Professionale della Svizzera Italiana) and some relevant key beneficiaries (e.g. CRIT, R2MSolutions, VTT, MARTEL, ART-ER) for collaborations. At the moment of writing D8.1, we started envisaging a collaboration about "AI for Manufacturing" market surveys and maturity models for SMEs. This is expected to be conducted in the Connected Factories CSA and DMP cluster (Ch6).*

2.2.2 DIGITBrain project in Digital Twins for Manufacturing SMEs

The **DIGITbrain** project is deeply rooted in the innovation ecosystem of the I4MS project CloudiFacturing and the industrial platforms FIWARE and IDS, and it will build on these results, by means of extending the CloudiFacturing solution with an augmented digital-twin concept called "**Digital Product Brain**" (DPB) and a smart business model called "**Manufacturing as a Service**" (MaaS). By having access to on-demand data, models, algorithms, and resources for industrial products (i.e. mechatronic systems supporting the production of other products), the DBP will enable their customisation and adaptation according to individual conditions. The availability of industrial-product capacity will facilitate the implementation of MaaS, which will allow manufacturing SMEs to access advanced manufacturing facilities within their regions or to distribute their orders across different ones.

The DIGITbrain project will address four principles that will foster the uptake of advanced digital and manufacturing technologies.

a. **Technology**: leverage edge-, cloud- and HPC-based modelling, simulation, optimisation, analytics, and machine learning tools and augment the concept of digital twin with a memorizing capacity that records the provenance of the industrial product over its full lifecycle.
b. **Feasibility**: support more than 20 highly innovative cross-border experiments, bringing together technology providers and manufacturing end users, and facilitating cost-effective distributed and localised production, based on on-demand manufacturing machine capacity.
c. **Sustainability**: coach and empower DIHs to implement the smart business model MaaS and contribute to their long-term sustainability, by increasing their portfolio with services tailored to the industrial needs of their regions.
d. **Network of DIHs**: engage DIHs across Europe that implement MaaS, enable manufacturing SMEs to co-create and experiment with digital innovations before investing, and attract national and regional funding.

***DigitBrain** celebrated its KOM at the beginning of June. AI REGIO is in constant contact with some relevant key beneficiaries for future collaborations (ATOS, DFKI, IMR, Piacenza, STAM, START4.0 Competence Centre in Genoa) especially in the domain of security for critical infrastructures. Activities on Digital Twins for Manufacturing (AI REGIO WP5) will be specifically addressed in BDVA SMI group (Ch7)*

2.2.3 Change2Twin project in Digital Twin for Manufacturing SMEs

The main ambition of Change2Twin is to ensure that 100% of manufacturing companies in Europe have access to 100% of **technologies needed to deploy a digital twin**.

Change2Twin will adopt the best practices developed so far in I4Ms – focus on local support provided by DIHs, keeping FSTP grants as accessible as possible.

The main ambition of Change2Twin is to ensure that 100% of manufacturing companies in Europe have access to 100% of technologies needed to deploy a digital twin. Specifically, the project will focus on three sub-objectives:

- Developing and providing a truly **end-to-end service** to the manufacturing SMEs where the end user receives from its local, trusted party (e.g. a DIH) a thorough **analysis of the digitalization potential** and a cross-border, multi-stakeholder (involving both components providers and an integrator), and ready-to-use recipe for implementation.
- Providing an architecture-agnostic **technology marketplace** with dedicated knowledge models supporting the entity preparing the recipe for a complete solution in selecting the best components and most suitable providers.

- Taking one step back to see the bigger picture and to find the minimal interoperable model facilitating modularity, composability and interchangeability of components used, regardless of the individual architectures or frameworks.

Change2Twin will deliver:

- A new benchmarked service model facilitating DIHs in providing support to manufacturing companies
- A Pan-European marketplace populated with the state-of-the-art service providers that create coverage for end-to-end Digital Twinning solutions
- A growing network of DIHs that have adopted the service model and marketplace based on a sustainable business model
- An open, widely available toolbox for establishing a new marketplace consisting of software and body of knowledge gathered during the project
- 4 Pilots proving the concept and 2 Open Calls for application experiments with a selection and support programme

Change2Twin just started in June 2020*. AI REGIO is in constant contact with some relevant key beneficiaries for future collaborations (TTTECH, JOTNE, TNO, BOC, University of Bologna). Activities on Digital Twins for Manufacturing (AI REGIO WP5) will be specifically addressed in BDVA SMI group (Ch7)*

2.2.4 DIH-World project in Widening DIHs

DIH-World aims to accelerate the uptake of advanced digital technologies by European manufacturing SMEs in all sectors and to support them in building sustainable competitive advantages and reaching global markets strengthening the capacities of regional DIHs, particularly in underrepresented regions across Europe. As intermediaries of successful local SME digital transformation, DIH-World aims at providing DIHs with access to harmonized tools, well proven technologies, effective methodologies, sound knowledge, smart investment sources, rich training assets and overall a vibrant innovation environment.

The final aim is to accelerate the maturity of DIHs and the development of their collaboration capabilities, and to avoid a DIH divide due to lack of access to technologies, skills, networks, investment and infrastructures with special emphasis in underrepresented regions; so they can capitalize and leverage on the European DIHs Networks their resources and facilities for the benefit of their local SMEs.

This will be achieved thanks to

- the **DIH-World platform**, that will provide a full coverage of the services needed by the DIHs and the SMEs willing to identify the right DIH for them,
- the **DIH-Academy** that will provide the tools to train DIHs and bring them to the next level,
- **Open calls for experiments**, that will provide sufficient technological support to SMEs and midcaps.

The goal will be pursued, as well as with a broad geographical coverage, with more than 26 countries to be covered in Europe, including specific activities to involve regional and national actors in the DIH network.

***DIH-WORLD** has just celebrated its KOM at the beginning of July 2020. AI REGIO is in constant contact with the coordinator (CARSA) and some relevant key beneficiaries for future collaborations (INNOVALIA, PwC, Effizienz Cluster, Uninova, Chalmers, LMS) in the domain of methods, tools and platforms for DIH governance and DIH-to-DIH collaboration. Special attention will be provided*

to mentoring and coaching activities from Vanguard advanced DIHs to less mature and developed DIHs.

2.2.5 VOJEXT project in Cognitive Systems and Human Robot Interaction

The VOJEXT project aims at providing a favourable business and technological framework to enable matchmaking and encourage producers and adopters (mainly SMEs including small crafters) of **Cognitive autonomous systems for human-robot interaction**, specially "cobots", dynamizing science-driven industry approaches for the European industry.

For this purpose, VOJEXT will design, develop, validate and demonstrate affordable, market-oriented, agile, multipurpose and easy-to-repurpose, autonomous, mobile and dexterous **robotic systems** as the main component of a smart, agile and scalable cognitive CPS for industry; under the vision of providing Value Of Joint EXperimentation (VOJEXT) in digital technologies to manufacturing and construction industry; while having DIHs as drivers of innovation based economic development in Europe.

VOJEXT will demonstrate its value by:

- deploying the solution through a 42-months work plan, scaling the project to at least 5 additional different markets;
- starting with 5 experimental pilots (and 9 SMEs) in the plastic textile, electronics, automotive, construction and creative architecture for urban regeneration, covering traditional and non-traditional areas for AI-robotics and cognitive ICT developments;
- aiming to extend to 15 experimental pilots, integrating 20 more SMEs through open calls.

The open calls will foster scientific and business driven innovation together with Digital Innovation Hubs led by UPM-AIR4S (Spain), together with other 3 DIHs – fortiss (Germany), PIAP (Poland) and EMC2 (France). These Open Calls will gather the most innovative SMEs, that will bring new challenges into project's pilots and propose alternative scenarios.

Moreover, the project will carry out with 2 S+T+ARTS residencies, that will allow artists stimulate the creation of new product in different contexts and support creative craft experimental pilots in Italy. DIHs will create a new niched oriented offering based on VOJEXT technical areas and for crafting sector.

***VOJEXT** just started in July 2020 and AI REGIO will be in contact with the coordinator (UPM) via the I4MS CSA (§2.2.8) and some relevant key beneficiaries for future collaborations (fortiss, EMC2, IIT). In particular, the Industry 5.0 paradigm (AI REGIO WP5) can be very relevant to be discussed in the field of Human-Robot Interaction.*

2.2.6 BETTER FACTORY project in Cognitive Systems and Human Robot Interaction

BETTER FACTORY will provide methodologies for **Manufacturing SMEs** to collaborate with Artists to develop **new and personalized products**. At the same time Better Factory will provide technology for SMEs to become fully connected cyber-physical-systems, transforming them into Lean-Agile production facilities capable of manufacturing new and personalized products alongside existing products.

Main results:

- An **Advance Production Planning and Scheduling** (APPS) system which can be deployed on a free and open IoT platform at 10% of the cost in 50% less time. APPS will automatically reconfigure the collaborative robots considering the individuality and gender of worker, and will also reduce 10% assets, 25% area, 30% resources, 35% logistics, 40% machines and tools and workplaces, resulting in 13% cost reduction, 15% production increase and 30% time to market.

- A **Marketplace**, a one-stop-shop, where Manufacturing SMEs can buy services from Technology suppliers, Artists, CCs, training providers and financial brokers.
- A portfolio of 16 cross-border **Application Experiments** by 48 SMEs selected through 2 competitive Open Calls, that will test APPS, SME + Artist collaboration and other services, and leveraging 11M€ of public and private funding becoming success stories.
- Services, including Technical, Business and Art mentors, infrastructure, training and access to finance.

Better Factory network consists of 28 members. 18 DIHs (10 CCs, 8 industry associations), 6 Technology suppliers and 4 service providers for marketing, access to finance, FSTP management and legal framework. Partners are currently engaged in I4MS-Go, DIH, HORSE, L4MS, MIDIH, AMABLE, BOWI, SHOP4CF. Better Factory covers 16 EU countries, 17 regions with **10 of them from EU-13**.

Better Factory will demonstrate that public funded research can help manufacturing SMEs & Mid-Caps achieve digital excellence and global competitiveness through Lean-Agile production for the manufacturing of new and personalized products.

***Better Factory** just started in October 2020 and AI REGIO will be in contact with the coordinator (VTT) via the I4MS CSA (§2.2.8) and some relevant key beneficiaries for future collaborations (INESC TEC, SUPSI, HOLONIX, FBox, MWC). In particular, the Industry 5.0 paradigm (AI REGIO WP5) can be very relevant to be discussed in the field of Human-Robot Interaction.*

2.2.7 PULSATE project in Laser Based Advanced and Additive Manufacturing

Digitizing European industry is essential for European competitivity in the 21st century, but only 20% of EU SMEs is highly digitized.

Laser Based Advanced and Additive Manufacturing (LBAAM) technologies are regarded as Key Enablers for Digital Production and offer important advantages to the adopters. SMEs have strong entry barriers for the technology: investment cost, technology complexity, system integration and awareness/adoption readiness. PULSATE aims to lower all said barriers to boost the adoption of **Laser Based technologies by SMEs** and promote the development of SME-friendly laser based equipment and solutions.

PULSATE will establish a Pan-European Network to stimulate SMEs to take part in Innovation Ecosystem of LBAAM, by connecting Digital Innovation Hubs (DIHs) to a support structure of knowledge, infrastructure and services, designed to tackle the issues currently limiting the adoption of LBAAM technology. A balanced combination is proposed between wide outreach using interconnected Virtual Communities and ICT tools (a Single Entry Point will connect a wide range of networking and servicing tools), and close exchange and interaction via DIHs.

The project relies on a consortium of 6 competence centres (AIMEN, FTMC, MTC, SINTEF, Fraunhofer, CEA), service communities and marketplace providers (FBA, CLESGO) and a photonics industry association (EPIC). With >50 previous projects outcomes, existing tools and services, connections with 74 running DIHs, Clusters and regional initiatives, PULSATE counts with the explicit support of companies and institutions (>80LoS), and an independent Board of Stakeholders gathering key players in LBAAM will ensure the quality and pertinence of PULSATE orientation.

PULSATE will operate under 4 action areas: Business, Technology, Competence & Awareness, addressing the following technology domains: Nano/Micro Fabrication, AM, High Power Laser Manufacturing and Digitalisation, and implementing 4 Open Calls and a catalogue of services.

***PULSATE** just started in September 2020 and AI REGIO will be in contact with it via the I4MS CSA (§2.2.8) and some relevant key beneficiaries for future collaborations (MTC, CEA, SINTEF, FBox).*

2.2.8 I4MS4Ts project in Tool and Technologies for Transformation

I4MS Tools and Technologies for Transformation (I4MS4Ts) contributes to I4MS ecosystem structuration and visibility. It collaborates with Innovation Actions, Digital Innovation Hubs and other related networks (SAE, EFFRA, EIT Manufacturing, Blueprint for Sectoral Cooperation on Skills: etc.) to solve the challenges faced by tech suppliers and public bodies (innovation support/economic development agencies) when trying to accelerate digital take up by manufacturing SMEs and midcaps in Europe.

While sustaining and enhancing the work done in previous I4MS Phases, I4MS4Ts will contribute to a more **efficient, collaborative and clustered ecosystem** structure and will make use of best practises from early adopters to reach the late majority of manufacturing SMEs.

The CSA will:

1) **provide I4MS Innovation Actions and network of DIHs with tools** (raising awareness materials, brokering support, community engagement activities) to convey their value proposition and attract manufacturing SMEs/midcaps, particularly those from underrepresented regions and/or sectors;
2) **put together I4MS offering** (IA/DIHs demonstrators, tech & business services, trainings) and share it under an evidence-based approach (impact in competitiveness, best practises);
3) maintain and enlarge an engaged community and provide I4MS with a strong **communication and dissemination platform** under a joint brand.

This work will contribute to solve I4MS challenges, increasing sectoral and regional coverage of the initiative and encouraging national/regional financing entities to dedicate resources to support most promising Application Experiments and to consolidate I4MS work locally. A lean consortium of 3 expert entities (FBA, MWCapital, TEC) will guarantee a smooth connection with previous Phases of I4MS and other initiatives and networks, a clear vision and high-quality community engagement, identification and characterisation of I4MS assets and best practises, targeted upskilling, brokering and communication.

***I4MS4Ts** just started in June 2020 and AI REGIO already attended the first meetings of the CSA and its working groups (10 November 2020). WG1 Best Practices for Digital Transformation and WG2 Training and Skilling have been launched. Next collaborations will concern Customer Journeys and Open Call workshops in January 2021.*

2.3 Collaboration Action Plan with I4MS Phase IV

I4MS Phase IV is the most natural community where AI REGIO will implement its T8.6 plans.

Collaboration Item	Action Plan
Joint Dissemination	YES through the I4MS CSA
Synergies with Projects	YES systematic with KITT4SME (AI for Manufacturing market survey and maturity model); YES on spot with the other I4MS IAs
Link to innovation networks	YES through the I4MS CSA
Common Marketplace	YES through DIH4INDUSTRY

Cluster Meetings	YES through the I4MS CSA and CF2 CSA
Mentoring Activities	YES through the I4MS CSA Training Program
Digital Innovation Hub Catalogue	YES specifically for DIH4INDUSTRY

3 Support to Hub priority in Digital Transformation focus area

In the LEIT ICT 2018-2020 H2020 Workprogramme, the Call - **Digitising and transforming European industry and services: digital innovation hubs and platforms** is central for the materialization of the **Digitising European Industry**[27] communication of April 2016 and its principles.

The Call is implemented by a set of thirteen topics, organized in two subgroups: Support to Hubs (this Chapter 3) and Digital Platform and Pilots (Chapter 6).

Support to Hubs includes 6 topics focusing on the implementation of SME-oriented regional Digital Innovation Hubs (DIHs) in the domains of Smart and Embedded Systems (SAE DT-ICT-01), Robotics (DT-ICT-02), ICT Innovation for Manufacturing SMEs (I4MS Phase IV DT-ICT-03 see Chapter 2), Photonics (DT-ICT-04) and Big Data (DT-ICT-05). The DT-ICT-06 topic is for the CSA supporting Hubs which is called DIHNET.EU[28].

In this AI REGIO context, we will envisage collaboration especially with SAE (§3.1), ROBOTICS (§3.2) and the DIHNET.eu CSA (§3.3).

3.1 The SAE Phase III and S4E CSA in DT-ICT-01

In the domain of Smart and Embedded System, the DT-ICT-01 topic is coordinated by the **Smart4Europe2** CSA[29], Catalysing Digitisation throughout Europe, where some AI REGIO beneficiaries are represented (SEZ POLIMI). The main goals of the SAE area are:

- Provide services supporting the SAE network including a single Innovation Portal, Market Place (based on the DIHIWARE platform), Service Centre, broad dissemination activities and coaching & training of SMEs and DIHs
- Strengthen the SAE community cohesion and facilitate collaboration and knowledge transfer
- Attract new stakeholders (SMEs and mid-caps) and achieve broad coverage by targeted outreach activities via own networks and multipliers (ENN, NCPs, and clusters)
- Grow the SAE ecosystem by connecting with new stakeholders and multiplying the impacts by collaborating with related projects, initiatives and networks and enable brokering
- Sustain the SAE network by creating a strategic roadmap based on a SAE technology and innovation radar, DIH business and collaboration models, strategic linkage of national and regional initiatives and via leveraging investment.

The work expands upon the successful Smart4Europe1 CSA, driven by a strong consortium of partners that have already demonstrated their commitment in shaping the SAE Initiative. Under the SAE umbrella there will be a growing number of projects, focusing on different technology domains which Smart4Europe2 brings together to collaborate and link to other initiatives, helping it to grow organically to catalyse digitisation throughout Europe.

Phase III SAE projects with particular focus on **Smart Manufacturing** are:

- **DIGIFED**[30] Digital Innovation Hubs (DIH) federation for large scale adoption of digital technologies by European SMEs (CEA coordinator). The EU-funded DigiFed project will

[27] https://ec.europa.eu/digital-single-market/en/news/communication-digitising-european-industry-reaping-full-benefits-digital-single-market

[28] https://dihnet.eu/

[29] https://smart4europe.eu/

[30] https://digifed.org/

develop a business model for the sustainability of the federation of digital innovation hubs (DIHs). Its model is based on collaborative investments and reduced innovation risks. The project will focus on cyber-physical and embedded systems with special emphasis on security and privacy, autonomy and human-machine interaction.

- **DIH4CPS**[31] Fostering DIHs for Embedding Interoperability in Cyber-Physical Systems of European SMEs (POLIMI INNOVALIA INTELLIMECH beneficiaries). The EU-funded DIH4CPS project intends to create an interdisciplinary network of DIHs and solution providers that focus on CPSs and embedded systems, interweaving understanding and technologies from diverse territories, and to connect it with European experts. The project will support European SMEs to overcome obstacles posed by innovative technology.
- **HUBCAP**[32] DIGITAL INNOVATION HUBS AND COLLABORATIVE PLATFORM FOR CYBER-PHYSICAL SYSTEMS. The EU-funded HUBCAP project will provide a one-stop-shop to assist European SMEs in joining the CPS revolution. It will build on digital innovation hubs (DIHs) in seven European countries by creating a growing and sustainable European network offering SMEs opportunities to undertake experiments, seek investment, access expertise and training and form new business links. The aim of the project is to lower barriers for SMEs to realise the potential of growing autonomy in CPS by accessing advanced model-based design (MBD) technology, providing training and guidance.

*AI REGIO contribution to **DT-ICT-01** is mostly related to some of the AI solutions developed at edge level in WP4. On the business aspects, and especially to the support given to SMEs, strong connections with DT-ICT-01 objectives can also be built within DIH4INDUSTRY marketplace (WP8), as well as other exploitation strategies under development in WP7.*

3.2 The Robotics DIHs in DT-ICT-02

The DT-ICT-02 topic is dedicated to Robotics DIHs in different application domains. The RODIN[33] CSA RObotics Digital Innovation Network, is in charge of supporting all the Innovation Actions in this area. Main objectives of the project are to:

- Disseminate best practice in the operation of robotics DIH networks
- Gather information from DIH networks on their composition, service offers, assets and infrastructure relevant to applying robotics
- Develop collaboration with and between the DIH networks, developing links to key stakeholders in robotics and technology
- Deliver communication and outreach activities to external stakeholders and policy makers
- Establish a resource to share information with DIH IAs
- Assess the performance of DIH networks and provide feedback to the consortia to improve and enhance their operation
- Coordinate access to, and development of, platforms, pilots and demonstrators
- Enable industry-led standards development
- Assess the access to finance for SMEs and the role DIH networks play in developing synergy between national, regional and European funding mechanisms
- Develop means of extending the networks across Europe
- Develop strategy around the future development of DIHs in robotics

In the domain of **Agile Production**, two DIH Innovation Actions are relevant for AI REGIO:

- **DIH^2**[34] A Pan-European Network of Robotics DIHs for Agile Production, is a network of 26 DIHs, with a target to reach over 170 DIHs. The sole aim of the network is to spark

[31] http://dih4cps.eu/project/

[32] https://www.hubcap.eu/project-details

[33] https://rodin-robotics.eu/

[34] http://dih-squared.eu/

incremental (cutting 50% cost of advance robotics solutions, doubling the growth of robotics market) and disruptive (maximum productivity & optimum agility) innovations in over 300,000 Manufacturing SMEs and Mid-Caps. It will support SMEs in their Agile Production challenge (50% increase in productivity) and unleash their digitalization potential by enabling robot solutions cost effective at lower lot sizes.

- **TRINITY**[35] Digital Technologies, Advanced Robotics and increased Cyber-security for Agile Production in Future European Manufacturing Ecosystems (coordinator TAU). The main objective of TRINITY is to create a network of multidisciplinary and synergistic local digital innovation hubs (DIHs) composed of research centers, companies and university groups that cover a wide range of topics that can contribute to agile production: advanced robotics as the driving force and digital tools, data privacy and cyber security technologies to support the introduction of advanced robotic systems in the production processes. The result will be a one-stop shop for methods and tools to achieve highly intelligent, agile and reconfigurable production.

*AI REGIO contribution to **DT-ICT-02** Robotics DIHs is mostly related to WP7 and WP8, thanks to the activities related to the DIH4INDUSTRY Marketplace, as well as the standardization and clustering activities. On the technical level, several synergies can also be found in many contributions to be delivered by AI REGIO (e.g. solutions for Adaptive Digital Shopfloor Automation in wp4) as well as in some of the AI REGIO pilots (e.g. Tampere, Kautenburger,* Arculus) *where robotics technologies will be experimented*.

3.3 The DIHNET.eu CSA DT-ICT-06

According to the DT-ICT-06 call "Coordination and Support Activities for Digital Innovation Hub network", the action will link up sectorial and technological hubs with regional/national innovation hubs to improve collaboration, reinforce specialisation and offer the best possible support for SMEs and mid-caps everywhere in Europe.

The DIHNET.eu[36] CSA enables the coordination of European, national and regional initiatives directly supporting the digital transformation and Digital Innovation Hubs (DIHs). The project aims to create a sustainable **pan-European network of networks**, with a focus on regional DIHs.

More specifically, DIHNET.EU will contribute by:

- Enhancing the **collaboration** between the different stakeholders from the **European DIH Community** with a wide range of services, information and tools that will help DIHs to communicate, align, collaborate and synchronize activities.
- Developing a clear overview of the DIHs related services provided in Europe and align them.
- Upgrading the **DIH Catalogue** by identifying/triggering activities in the DIH Community in coherence with regional, national and EU policies.
- Creating a strategy to reinforce the specialisation of these services, as well as supporting its uptake by relevant DIHs and DIH networks.
- Creating a vision and strategy on a self-sustaining business model for this network of DIHs, and to make this operational.
- Creating an **online community** to foster interaction among hubs, information exchange and peer-learning.

More recently and in preparation of the EDIH call in the Digital Europe 2021-2027 programme, DIHNET.eu created the EDIH precursor network, an open informal initiative aiming at exploring possibilities on how to organize and what to expect from the future DIH network and collaboration.

[35] https://trinityrobotics.eu/

[36] https://dihnet.eu/

At the moment of writing this report, the precursor network consists of more than 50 DIHs participating in the national selection processes for EDIH in DEP and already held some remote meetings, issued an online survey about business and governance models of the future network of EDIHs. The main objective of the precursor network is:

1. Identification of possible business models for collaboration
2. Exploration of possible activities to be organised by the network
3. Exploring organisation and governance models
4. Testing actual operation in creating a sandbox collaboration

The precursor network envisages two basic roles: the **Coordinator** to initiate the use of European capacities/capabilities for all regions and the **EDIH network** to initiate/engage in interregional collaborations between their regional stakeholders.

In a Business Model Navigator[37] perspective (value, audience, organisation, revenues): regarding the EDIH network

- Value: Economy of scale of establishing EU collaborations, pan EU using experience.
- Target audience: The EDIHs and overall EDIH network stakeholders.
- Organisation: the Digital Transformation Accelerator DTA, with help of selected partners.
- Revenues: Mainly EC funding (but more in a later stage?)

The bilateral and multi-lateral collaborations between the "200 EDIHs" can instead be modelled in the following way.

- Value: Import/export of infrastructures, expertise and innovations.
- Target audience: the EDIHs, their customers and partners.
- Organisation: The EDIHs and their partners.
- Revenues: Tit for tat, performance fees, commercial fees.

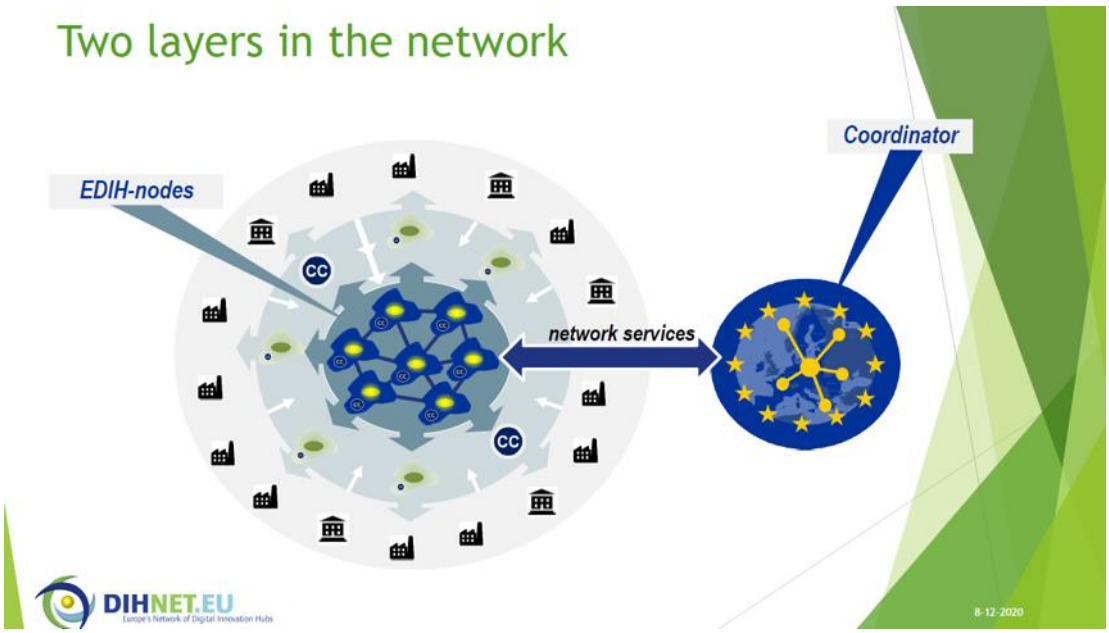

Figure 16 - The two layers in the EDIH Network

[37] https://businessmodelnavigator.com/about

In particular, following a four-fold approach, the list of DTA services are depicted here in after and have been prioritised during a recent interactive participative meeting by the community of 50+ candidate EDIHs.

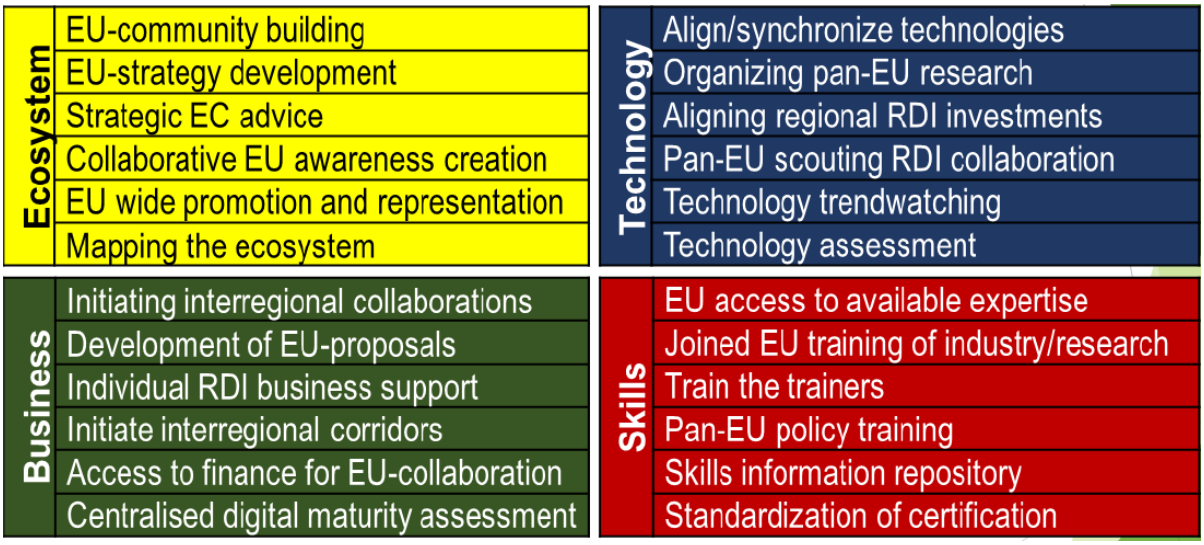

Figure 17 - DTA Services

Finally, and very relevant for AI REGIO is the list of possible Business Models for EDIHs: i) Public co funding, getting funded for reducing market failures; ii) Partner co funding, in kind contributions from core partners; iii) Subscription/membership, a periodic fee to access standard services; iv) Integrator/orchestrator, being payed to put things together; v) Add on, razor and blade, Additional services connected to membership; vi) Tit for tat, no money is changing hands; vii) Commission fees, act as a sales office for the community; viii) (Indirect) Branding, using the network brand as an income; ix) Digitalization and mass customization, virtualize products, reducing costs of delivery; x) Crowdsourcing, using the community expertise for free; xi) Performance based, individual services, paid based on rate of success; xii) Full cost service provision, individual services paid in full (+ profit).

And the following Business Models for EDIH collaborations: i) EDIH facilitated, interregional SME brokerage; ii) Performance based interregional partnerships; iii) Commission based Sales offices (infrastructure, IPR, etc.); iv) Satellite based joined innovation development; v) Secondments of experts; vi) Joined internal trainings.

*AI REGIO contribution to **DT-ICT-06** DIHNET.eu is especially related to WP3, the DIH service portfolio analysis, the customer journeys and the DIHIWARE Innovation and Collaboration platform. More in particular, close collaboration is foreseen regarding business and governance models for DIHs and DIHs networks. AI REGIO moreover aims at becoming the DIH4INDUSTRY interface to DIHNET.eu and EDIH network.*

3.4 Collaboration Action Plan with Support to Hub initiative

Support to Hub (SAE ROBOTICS and DIHNET.eu) is another natural community where AI REGIO will implement its T8.6 plans.

Collaboration Item	Action Plan

Joint Dissemination	YES through the DIHNET.eu CSA
Synergies with Projects	YES systematic with TRINITY (led by Tampere, sharing the same TEF) and with DIH4CPS (led by UNINOVA, sharing the same ETBSD model for DIH services); YES on spot with the other SAE and Robotic IAs
Link to innovation networks	YES through the DIHNET.eu CSA
Common Marketplace	YES through DIH4INDUSTRY (TRINITY and DIH4CPS are already in)
Cluster Meetings	YES through the CF2 CSA
Mentoring Activities	YES synergies with the Open Calls
Digital Innovation Hub Catalogue	YES specifically for DIH4INDUSTRY

4 Other initiatives in DIHs for Manufacturing and AI

Inside the DIH landscape (see §4.1), AI REGIO is by DOA work plan supporting the DIH4INDUSTRY initiative and collaboration marketplace (Manufacturing-oriented DIHs). In addition, in the AI technology domain, the AI DIH Network (see §4.2) and the coming ICT-49 Innovation Action DIH4AI (see §4.3) need to be addressed and studied for collaborations.

4.1 The DIH Catalogue and Vanguard Initiative

The **Digital Innovation Hubs** (DIH) catalogue[38] was set up to provide a comprehensive picture of DIHs in the EU across varying competences, structures and service offerings. Today, it is a repository with more than 600 DIHs, over 400 of which are fully operational, including information on the technology and application specialisation, geographical coverage, markets addressed and general digitisation support available. The Catalogue represents therefore a fundamental source for information where to disseminate Open Calls announcements and where to exploit AI REGIO assets.

In particular, by selecting the 13 different sectors of **Manufacturing**, an ecosystem of **256** operational DIHs is selected in many EU Countries and represented in the following picture.

Figure 18 – The European ecosystems of DIHs

[38] https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-catalogue

Another relevant regional initiative in the Smart Specialisation Strategy is **Industrial Modernisation**[39]. The Smart Specialisation Platform for Industrial Modernisation (S3P-Industry) aims to support EU regions committed to generate a pipeline of industrial investment projects following a bottom-up approach - implemented through interregional cooperation, cluster participation and industry involvement.

One of the Thematic Areas of S3P-Industry is the Vanguard PILOT ESM **Efficient and Sustainable Manufacturing**[40] where 20 vanguard EU regions, chaired by Lombardy and Catalunya, share the objective of providing industry with innovative solutions from research and exploiting the potential of smart specialisation to promote new efficient supply chains with added high value. The idea is to conceive and develop a European network of infrastructure and pilot plants in key-manufacturing areas, where companies can test innovative solutions before the industrial uptake.

By exploiting and valorising available research results, ESM European pilot plants have the potential to support innovation of companies in breakthrough technologies and applications that require manufacturing efficiency and sustainability. This approach will increase the competitiveness and development of European value chains, exploiting synergies and complementarities of different regional specialisation. The ESM Vanguard pilot is aimed at overcoming the barriers limiting innovation and transfer of research results to the European industry through the development of a European synergic network of pilot plants accessible to companies in a logic of Smart Specialisation. Each Region will develop and operate pilot plant nodes coherent to regional industry and competences, offering to European companies a "one-stop shop" for the industrial uptake of new technologies and innovative business model.

Inside ESM, the **Digital Transformation** democase, led by Brabant, Tampere and Lombardy regions, represents a relevant contact point for AI REGIO. In its last Meeting in February 2020 in Bruxelles, the DT democase launched a call for industrial pilots to be implemented across the EU Regions along the 2020. The success of the AI REGIO innovation action (see above DT-ICT-03) will implement such a call in the next three years through local experimentations and Open calls.

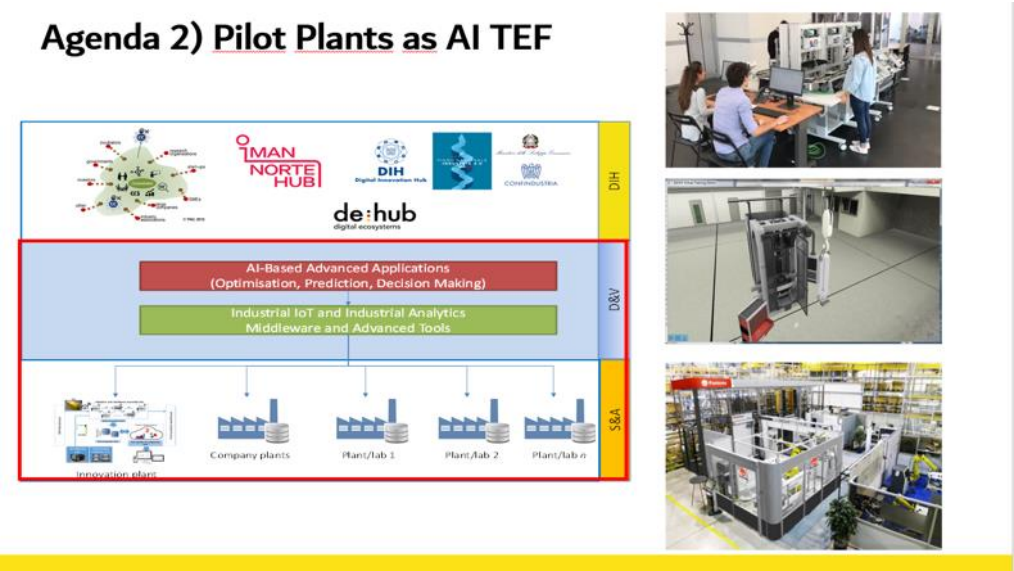

Figure 19 – Pilot Plants (AI TEF) in Digital Transformation democase

[39] https://s3platform.jrc.ec.europa.eu/industrial-modernisation

[40] https://s3platform.jrc.ec.europa.eu/efficient-and-sustainable-manufacturing

In the last Vanguard ESM meeting on December 2020, the 2021 action plan of the DT democase has been presented along the Twin Transition challenge: DIGITAL and GREEN Manufacturing. A collaboration framework with AI REGIO has been discussed, to be implemented along the 2021.

Figure 20 – Implementation of the TWIN TRANSITION in Vanguard ESM

4.2 The AI DIH Network Initiative

In the last 2018-2020 H2020 LEIT ICT work programme, the DIH focus area is being implemented in five different domains (DT-ICT-01 to 05) and coordinated by DIHNET.EU[41] DT-ICT-06 CSA (Coordination and Support Action), including three other domain specific CSAs and tens of IAs. If we consider that each of the mentioned Innovation Actions is involving in average more than 10 DIHs, the DIH focus area in ICT work programme will mobilize 200+ selected DIHs in its five application domains: Smart Systems and SAE, Manufacturing and I4MS, Robotics, Big Data and Photonics.

In the presence of such a huge community of DIHs selected in H2020, how to create coherent and consistent networks of sustainable DIHs (per sector and/or per technology) and to incentivize their cross-border collaboration and integration? Cooperation offers DIHs to perform this role more effectively, as it gives them the possibility to upgrade their respective technological capacities, service offerings and in-house skills.

Aware of the potential of collaboration, the European Commission and the European Parliament launched a preparatory action to create a European Network of 30 Digital Innovation Hubs with a focus on AI. The **AI DIH Network**[42] initiative aims to develop schemes for structured cooperation among DIHs, to create a European Network of DIHs with focus on AI, and to provide policy recommendations for enhancing DIHs' collaboration. The AI DIH Network project involved **30 DIHs from 20 countries**, selected among **150 applications** coming from DIHs part of different networks

[41] https://dihnet.eu/

[42] https://ai-dih-network.eu/

in a **coaching and mentoring** programme centered on **cooperation**, including **collaborative workshops**, a **peer-learning** programme and webinar training sessions, with remote and on-site support of individual tutors. At the end of the programme, a Framework Cooperation Agreement has been signed by **25 DIHs.** Such agreement is open for applications from additional AI DIHs.

In the domain of AI-driven DIHs, the **"AI DIH Network" initiative** identified methods and tools to make an inventory of **Ecosystem-Technology-Business Services,** to describe and validate typical service-driven Customer Journeys inside each DIH, to define and implement cross-DIH co-operation scenarios and legal collaboration agreements. Finally, Skills development and in general Digital Transformation services for **SMEs and Public Agencies** are to be carefully designed and provided to the respective constituencies.

The AI DIH Network plays a fundamental role in this EU strategy towards AI along two main dimensions: the **SME dimension**, as every AI DIH has a potential of thousands (or hundred thousand in the case of Large regions such as Lombardy or Bayern) SMEs both in the demand and in the supply side; the **Regional dimension**, as an AI-on-demand platform needs to have a European one-stop-shop center of gravity, but also **networks of federated interoperable platforms** characterized by a regional smart specialization especially in the identification and implementation of complementary funding channels.

A methodological framework for cross-DIH collaboration has been developed in the AI DIH Network initiative (https://ai-dih-network.eu/), promoted by the EC. Schemes and processes that AI DIHs can use to collaborate are co-defined with hubs representatives[43]. The first step is to identify situations in which cross-border collaboration could deliver tangible benefits to the DIHs and other stakeholders. To this end, DIHs service offerings are analysed from a user perspective. The aim is to identify the stages of AI service delivery that can be enhanced/enabled by collaborating with partners at a cross-regional level. A standard customer journey mapping methodology aims to represent the specific activities of the DIHs during service delivery and the opportunities to improve those activities through cooperation. This approach leads to the identification of different **'cooperation use-cases'**. Analysis of the objectives and processes of these co-created use-cases results in the identification of three final cooperation scenarios that represent the possible processes that could take place when DIHs cooperate with each other. These 'cooperation use-cases' and the described methodology can be used to enhance cross-DIH collaboration and facilitate the use and uptake of AI-on-demand-platform.

The Network of DIH can provide SME manufacturers with access to AI4EU pan-EU AI solutions and complementary assets like training, business support and innovation management services. Likewise, it will also facilitate providers of AI solution in validating their solutions. The network of DIHs that will be formed in the project will serve as one of the main exploitation vehicles of the project. It will be empowered and supported by a multi-sided platform that will integrate the main innovation outcomes of the project and that will serve as a single-entry point to the full range of project's AI solutions and related innovation management and support solutions that will be provided by the network of DIHs.

The AI DIH Network initiative focussed on AI DIH specialised in different sectors and in its **12 months trained 30 selected DIHs** towards materialising three Grand Collaboration scenarios of **Joint Service Provision**, **Collaborative New Service Development and Demand-Offer Matchmaking**. The four EDIH pillars of test before invest (Technology Services); skills development (Transformation Services); finding investments (Business Services) and Ecosystem Building (Ecosystem Services) are implemented in a cross-DIH collaboration network enabled by the DIHIWARE platform.

[43] AI DIH Network, Final Study Report (2020), presented by PwC, in partnership with CARSA and Innovalia, to the European Commission – DG CONNECT (*under publication*)

The DIH4INDUSTRY marketplace, powered by DIHIWARE, will be developed upon the results of AI DIH network and will extend the scope of collaboration services. The aim in AI REGIO is to develop a collaboration framework inside the DIH4INDUSTRY marketplace with the aim to (a) ensure **flawless interoperability** between components developed inside and outside the project, and (b) develop **further collaboration model** to ensure services capable of covering any geographical or technological scope and ensure vertical collaboration between different levels of the supply chain.

4.3 The DIH4AI AI on-demand platform

In the framework of the call ICT-49-2020 Artificial Intelligence on demand platform, the DIH4AI project "AI on-demand platform for regional interoperable Digital Innovation Hubs Network", starting in January 2021, aims at creating a pan-EU network of regional DIHs to be interoperated with the AI4EU centralised services and facilities. The first nucleus of this network is composed by 5 AI DIHs, who participated with success to the AI DIH Network initiative, as depicted in the figure below.

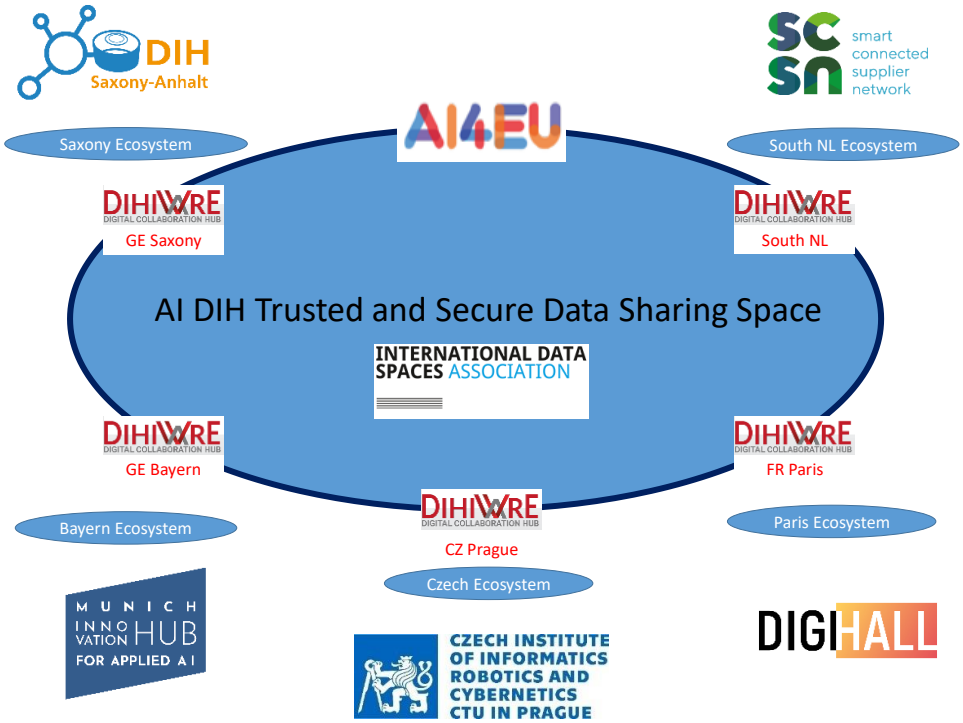

Figure 21 – The 5 AI DIHs of the DIH4AI Network

The DIH4AI project will develop a three layers' interoperability framework between DIHIWARE platform and AI4EU services which allow a seamless access to both DIH and AI4EU Portals, to exchange data according to the Data Sovereignty principle and to remotely execute XaaS services provided by the AI4EU AI infrastructure.

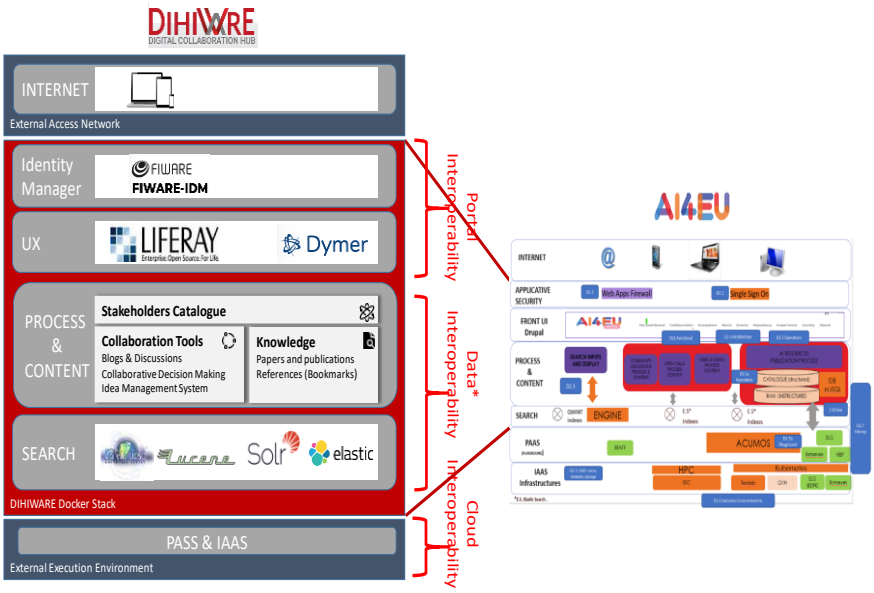

Figure 22 - Interoperability between DIHIWARE and AI4EU Platforms

AI REGIO is interested in the DIH4AI outcomes, for the development of a cross-regional and region-EU "AI for Manufacturing" interoperability framework. The usage of the same DIHIWARE platform will allow a seamless transfer of results between the two projects.

4.4 Collaboration Action Plan with other DIH initiatives

Vanguard Initiative, AI DIH Network and the future DIH4AI project are another natural community where AI REGIO will implement its T8.6 plans.

Collaboration Item	Action Plan
Joint Dissemination	YES through the Vanguard Initiative, the ESM Pilot and the new-born AI Pilot
Synergies with Projects	YES this is one of the most relevant results of the AI DIH Network initiative where CARSA has been involved
Link to innovation networks	YES through AI4EU and DIH4AI new project
Common Marketplace	YES through DIH4INDUSTRY (Vanguard Initiative AI Pilot)
Cluster Meetings	NO joint cluster envisaged
Mentoring Activities	YES synergies with the AI DIH Network and its mentoring and coaching program to 30 DIHs
Digital Innovation Hub Catalogue	YES specifically for DIH4INDUSTRY

5 AI DIHs Towards next 2021-2027 Multiannual Financial Framework

At the moment of writing this Collaboration Plan deliverable, just draft versions of the next MFF 2021-2022 work programmes have been circulated among member states. Inside Digital Europe, we envisage a clear influence of AI REGIO in the EDIH initiative (§5.1), the "Data Spaces for Manufacturing" topic (§5.2) and the "AI TEF for Manufacturing" topic (§5.3).

Inside the Twin Digital and Green Transition call of Horizon Europe, we can find the "Artificial Intelligence for sustainable, agile manufacturing" topic in 2021 (§5.4) and the "ICT Innovation for Manufacturing Sustainability in SMEs (I4MS2)" topic in 2022 (§5.5). Both calls are part of the **Made in Europe Partnership**.

5.1 EDIHs in Digital Europe Programme

In the context of AI REGIO, DIHs represent a twofold perspective.

The most obvious and direct perspective lays in the very same mandate of DIHs and its four pillars of "test before invest", "skills and training", "support to find investments", "innovation ecosystem and networking". In this perspective DIHs are dissemination and exploitation channels towards SMEs / Midcaps and Local Public Administrations (e.g. Regions) and represent a privileged interface to test and experiment the outcomes of Digital Platforms projects.

This first perspective is also well defined and present in the future plans of the Digital Europe Programme in the coming 2021-2027 MFF (Multiannual Financial Framework) as represented in the following EC picture where the new network of European DIHs (EDIH) will act as a dynamic "Networking Transfer of Expertise" between technology deployment and final users.

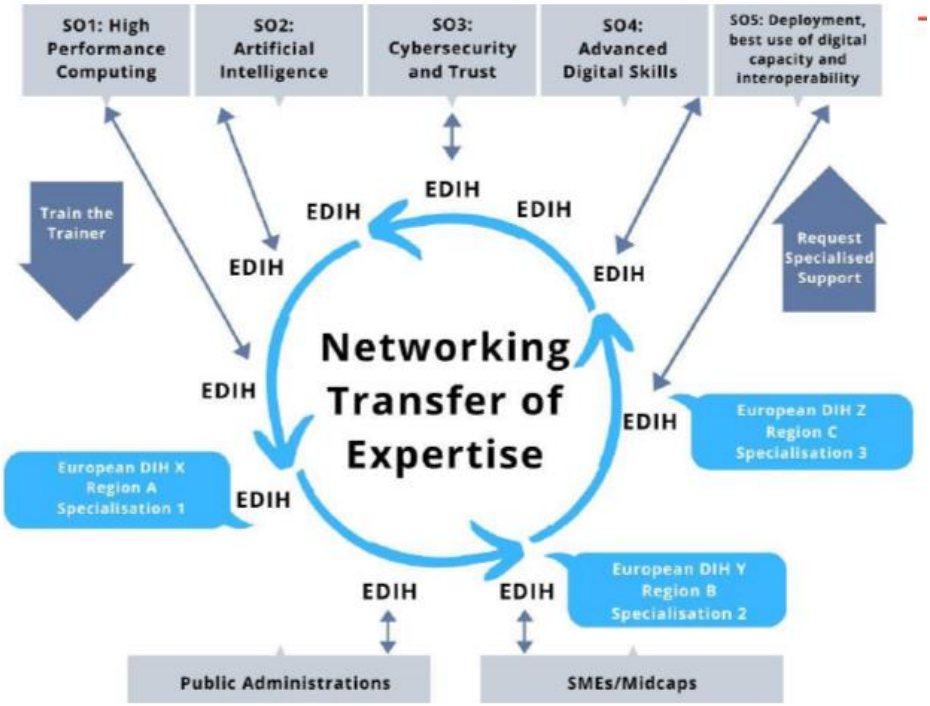

Figure 23 - The role of EDIHs in transferring of expertise

More specifically, in the technological domain of Artificial Intelligence, the EC foresees Capacity Building actions, Testing and Experimental Facilities and DIHs as distribution channels (DEPLOY) of innovative solutions (test before invest).

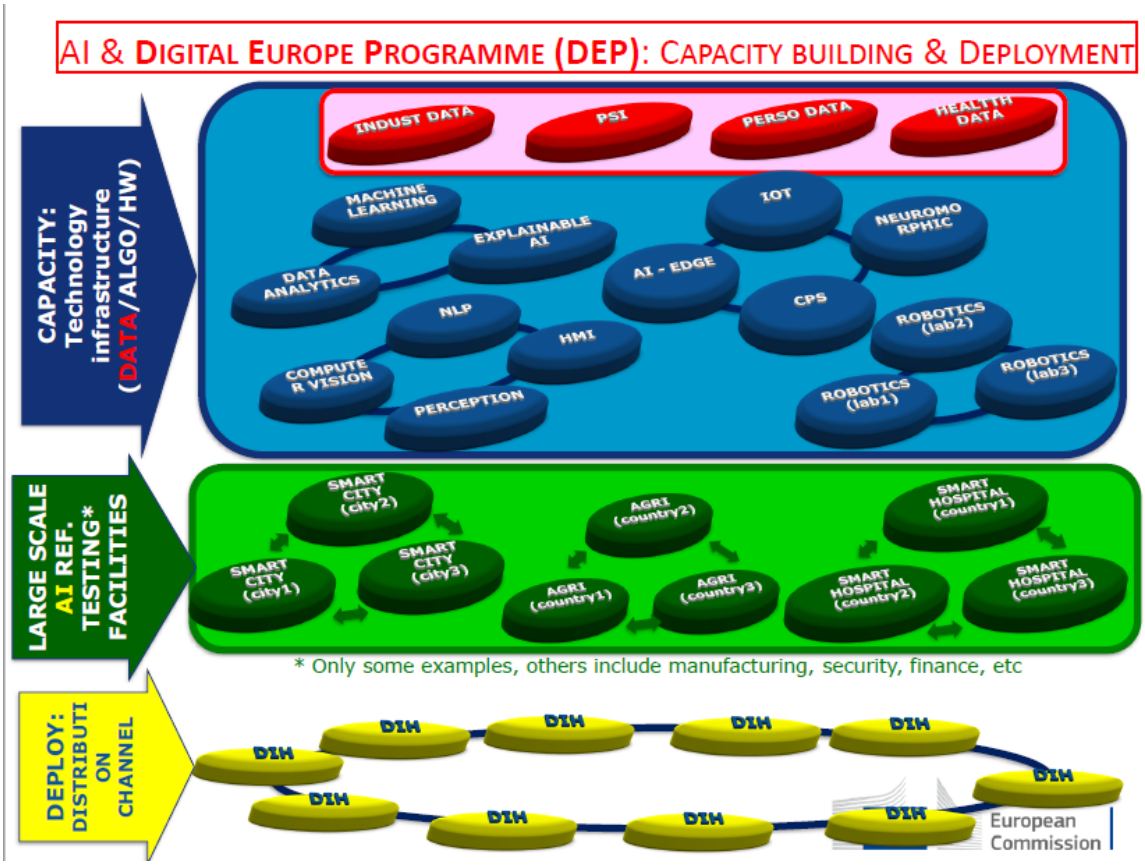

Figure 24 - AI & DEP: Capacity Building and Deployment

A **second perspective** is also quite important and relevant for AI REGIO: DIHs can intercept, nurture and scale-up local innovation actors and make them visible to the European R&I landscape and Large Scale Pilots or Innovation Actions.

Especially thanks to the mechanism of FSTP (Financial Support to Third Parties), highly innovative SMEs and Start-ups could participate in the most advanced R&I programs in H2020 and let their findings visible to a much larger audience and prospects.

In this second perspective, "support to find investment" pillar but also "ecosystem building" and "skills development" pillars of DIHs represent a fundamental chance for increasing visibility and market outreach of local entities. In some Open Calls initiatives, mini-consortia between highly innovative SMEs and their DIHs are allowed, in other cases just SMEs are allowed, but the DIH boost is in any case very opportune and useful.

AI REGIO needs to set-up win-win relationships with all the DIH movement but especially with those DIHs which could be both dissemination and exploitation channels for AI REGIO findings, but also source for innovative ideas and solutions to be injected inside the AI REGIO architecture also by results of successful Open Call projects.

5.2 Data Spaces for Manufacturing in DEP

In the second call of DEP, *Manufacturing data spaces and their AI-based analytics and optimisation applications can influence company-internal processes as well as processes across organisations. The main objective is to build and deploy* ***two operational data spaces*** *for specific value chains in the manufacturing sector, which enable companies in different user roles (supplier, client, service provider, …) to interact with large amounts of industrial data across their organisational borders*.

The first data space will address **agile supply chain** management and execution, and the second one **dynamic asset management** and predictive/prescriptive maintenance. Both actions have an expected duration of 24 months.

The Data4AI platform developed inside AI REGIO WP4 could be adopted as a manufacturing data space infrastructure to be instantiated in the two domains envisaged by the call. For the benefit of European manufacturing SMEs, the implementation of both data spaces could be materialised by networks of regional Digital Innovation Hubs, inspired by the AI REGIO service portfolio and DIH-DIH collaboration model.

5.3 AI TEF for Manufacturing in DEP

Again in the second call of DEP, *the manufacturing TEFs will provide physical and virtual access to* ***real-life manufacturing resources*** *that can be used for testing and experimenting with AI solutions. Examples of such manufacturing resources are model factories that combine different technologies such as additive manufacturing, machine tools, intelligent conveyor systems, automated warehousing, IoT infrastructure and more, covering multiple industrial processes.*

The manufacturing TEFs will address the manufacturing sector's needs for Industrial AI, taking into account domain-specific requirements in terms of time criticality, safety, security and effective interaction and collaboration between robots, AI solutions and humans being in control. The TEF sites will offer support and best practices in AI solution implementation, testing and training of algorithms including: full integration, industrial validation and demonstration up to pilot manufacturing in dedicated assembly lines and production cells. The TEFs need to support testing and experimentation of main AI-related services, which cover areas of machine learning, robotics, planning and scheduling, optimisation, self-configuration, computer vision, formal methods, natural language processing, automated reasoning, game theory, multi-agent systems, complex systems, system verification, bioinformatics and others.

The network of regional DIHs in AI REGIO is one important layer in an AI TEF for Manufacturing architecture, at the top of the physical factory with advanced manufacturing technologies (ADMAT, WP7.2 in AI REGIO), of a Manufacturing Data Space characterised by manufacturing assets data models (RAMI Asset Administration Shell, Data4AI WP4.2 in AI REGIO) and ontologies and of an ecosystem of advanced AI tools and components (AI4Manufacturing Toolkit in AI REGIO WP4.3).

5.4 AI for sustainable, agile manufacturing in Horizon Europe

The 2021 topic *HORIZON-CL4-2021-TWIN-TRANSITION-01-07: Artificial Intelligence for sustainable, agile manufacturing* calls for Innovation Actions focussing *on manufacturing and* ***process industries****, addressing the entire lifecycle of products and services from design to remanufacturing and including all the aspects primarily relevant for industrial production.*

The objective is to exploit the potential of AI as a transformation tool for the entire manufacturing and process industry with due consideration for standardisation activities when relevant. AI will be a strategic instrument to improve sustainability, agility and resilience to external and internal influences, taking account of the European Green Deal objectives.

AI applications will be capable of optimising their actions based on limited human input, thanks to their awareness of the context and of the physical environment delivered by sensors and will have the long useful lifetime typical of industrial environments.

AI REGIO can provide a set of 17 SME-driven experiments (WP6 AI REGIO) which could be extended for the envisaged scale of the call. The transformational power of AI in the manufacturing industry can be modelled and measured by maturity assessment and AI migration methods as in AI REGIO.

5.5 ICT Innovation for Manufacturing Sustainability in SMEs (I4MS2) in Horizon Europe

The 2022 topic *HORIZON-CL4-2022-TWIN-TRANSITION-01-06: ICT Innovation for Manufacturing Sustainability in SMEs (I4MS2)* calls for Innovation Actions aimed to support manufacturing SMEs and mid-caps in adopting the latest innovative digital technologies for their business operations. I4MS2 builds on I4MS and addresses more significantly a sustainable and resilient production.

*The **pandemic and economic crises** demonstrated the key role of digital technologies in responding quickly to external changes. Digitalisation improves resilience, agility and competitiveness, and enables cost-efficient production in Europe. It will also support a radical reduction of the **environmental footprint** of the sector. In this context, experimentation with innovative and secure digital technologies in their production processes, products and business models guided notably by competence centers specialised in the technologies mentioned below will enhance manufacturing companies to successfully manage the twin digital and green transformation of the coming years.*

*I4MS2 calls for Innovation Action projects that will support European SMEs and mid-caps to innovate and make more sustainable their products, production processes and business models through experimentation and testing. **At least 50%** of the budget should be allocated to SMEs and mid-caps to participate in the experiments. **The proposals may include financial support to third parties to finance SMEs and mid-caps**. Proposals should describe their complementarity to existing initiatives, namely the network of European Digital Innovation Hubs, which is supported through the Digital Europe Programme. They should also indicate how they will collaborate with European Digital Innovation Hubs.*

AI REGIO can provide a set of 17 SME-driven experiments (WP6 AI REGIO) which could be extended for the envisaged scale of the call. The transformational power of the Digital Technologies in the manufacturing industry can be modelled and measured by maturity assessment and 6Ps migration methods as in AI REGIO.

5.6 Collaboration plan towards next 2021-2027 Multiannual Financial Framework

The future HEP and DEP 2021-2027 programmes represent an unique opportunity for AI REGIO to communicate, disseminate and to some extent exploit its assets, especially towards EDIH, Data Spaces and AI for Manufacturing topics. Moreover, the next generation of the I4MS programme is expected to run from 2022.

Collaboration Item	Action Plan
Joint Dissemination	YES through the EDIH Digital Accelerator and Data Spaces, AI TEF, I4MS2 initiatives
Synergies with Projects	YES this is one of the most relevant aspects of EDIH, where AI REGIO will try to exploit its methods, tools and platforms

Link to innovation networks	YES through the Digital Transformation Accelerator DTA
Common Marketplace	YES through DIH4INDUSTRY (Digital Accelerator)
Cluster Meetings	NO joint cluster envisaged
Mentoring Activities	YES synergies with the HEP / DEP training initiatives in capacity building
Digital Innovation Hub Catalogue	YES specifically for DIH4INDUSTRY

6 Digital Manufacturing Platforms in DT-ICT-07

In the LEIT ICT 2018-2020 H2020 Workprogramme, the Call - **Digitising and transforming European industry and services: digital innovation hubs and platforms** is implemented by a set of thirteen topics, organized in two subgroups:

i. **Support to Hubs** (see Chapter 3) from 01 to 06
ii. **Platforms and Pilots** (this **Chapter 6**) includes 7 topics focusing on the implementation of European Digital Platforms and their experimentation in real world, Pilots in the domains of Digital Manufacturing for Connected Smart Factories (**DMP DT-ICT-07**), Agricultural digital integration Platforms (**DT-ICT-08**), Rural Economies and cross-sector service Platforms (**DT-ICT-09**), Interoperable smart homes and grids (**DT-ICT-10**), Big Data solutions for Energy (**DT-ICT-11**) and AI for the Hospital of the Future (**DT-ICT-12**). The **DT-ICT-13** topic is for the CSAs supporting Digital Platforms in the four domains of Manufacturing, Energy, Health & Care, Agrifood (OPEN DEI[44]) and in the domain of construction (digiPLACE[45])

In the following paragraphs, we will analyse more in detail the community born around the DMP Cluster DT-ICT-07 §**6.1**, the CSA coordinating and supporting the DT-ICT-07 two waves of projects and promoting new future pathways for EU manufacturing industry §**6.2** (Connected Factories) and the CSA coordinating and supporting cross-domain R&I topics §**6.3** (OPEN DEI).

6.1 The DMP Cluster and its Working Groups

The DMP cluster was born from the DT-ICT-2018-2019 topic. The 2018 call was focusing on the following two topics where three Innovation actions have been funded; the 2019 call was focusing on other two bullets where again three Innovation actions and one CSA (ConnectdFactories2 see below) have been retained for funding.

I. **Agile Value Networks: lot-size one** (2018 call)
   - **eFactory[46]. European Connected Factory Platform for Agile Manufacturing**. *The eFactory project realises a federated smart factory ecosystem by primarily interlinking 4 smart factory platforms, from the FoF-11-2016 cluster, through an open and interoperable Data Spine. The federation of the 4 base platforms is complemented by industrial platforms, collaboration tools and smart factory systems, specifically selected to support connected factories in lot-size-one manufacturing. The federated eFactory platform enhances value and reduces the barrier to innovation by providing seamless access to services and solutions that are currently dispersed. In parallel the platform provides the necessary infrastructure, tools and support for novel service creation and validations by third parties. Further, by fostering healthy competition in the smart factory ecosystem, the eFactory platform will ensure that the needs of the evolving smart manufacturing industry are met for the long term*.

II. **Excellence in manufacturing: zero-defect processes and products** (2018 call)
   - **ZDMP[47]. Zero Defect Manufacturing Platform.** *Smart, SME Friendly, open, Zero-Defect Manufacturing Reference Platform, Apps, SDK, and Marketplace for Product and*

[44] https://www.opendei.eu/

[45] https://www.digiplaceproject.eu/

[46] https://www.efactory-project.eu/

[47] https://www.zdmp.eu/

Process Quality in any factory for achieving excellence in European and Global Manufacturing. The ZDMP project combines state of the art technological approaches based on commercial grade standard or open-source or previous-project software with an innovative integration concept based on proven and integrating technologies. It provides Process and Product Quality support on top of a platform layer. These all can utilise ZDMP core services which can also be used to build ZD Apps which are placed on the ZD Marketplace. The ultimate aim is to establish a sustainable business and technological approach at the end of the project and launch "ZDMP Limited" assisted by the possibility of a crowdsourcing approach and ZDMP ambassadors.

- ***QU4LITY Digital Reality in Zero Defect Manufacturing****. QU4LITY will demonstrate, in a realistic, measurable, and replicable way an open, certifiable and highly standardised, SME-friendly and transformative shared data-driven ZDM product and service model for Factory 4.0 through 5 strategic ZDM plug & control lighthouse equipment pilots and 9 production lighthouse facility pilots. QU4LITY will also demonstrate how European industry can build unique and highly tailored ZDM strategies and competitive advantages (significantly increase operational efficiency, scrap reduction, prescriptive quality management, energy efficiency, defect propagation avoidance and improved smart product customer experience, and foster new digital business models; e.g. outcome-based and product servitisation) through an orchestrated open platforms ecosystem, ZDM atomized components and digital enablers (Industry 4.0 digital connectivity & edge computing package, plug & control autonomous manufacturing equipment, real-time data spaces for process monitoring & adaptation, simulation data spaces for digital process twin continuity, AI-powered analytic data spaces for cognitive digital control twin composable services, augmented worker interventions, European quality data marketplace) across all phases of product and process lifecycle (engineering, planning, operation and production) building upon the QU4LITY autonomous quality model to meet the Industry 4.0 ZDM challenges (cost and time effective brownfield ZDM deployment, flexible ZDM strategy design & adaptation, agile operation of zero defect processes & products, zero break down sustainable manufacturing process operation and human centred manufacturing).*

III. **The human factor: human competences in synergy with technological progress** (2019 call)

- **SHOP4CF[48] Smart Human Oriented Platform for Connected Factories**. *Europe's factories are getting smarter, optimising production processes and enabling a more sustainable and competitive industry. Finding the right balance between cost-effective automation and repetitive tasks and involving workers in areas such as adaptability, creativity and agility is the ultimate aim. In accordance with the highly connected factory model, a lot of data is being generated within the factory – by the embedded sensors and connected production equipment. All this information is useful in improving processes. The EU-funded SHOP4CF project will develop a platform on an open architecture that can support humans in production activities and provide basic implementation as a free, open-source solution. It will rely on pilots acting as the testing facilities and seeds for adoption of the platform.*

IV. **Sustainable Value Networks: manufacturing in a circular economy** (2019 call)

- **DigiPrime Digital Platform for Circular Economy in Cross-sectorial Sustainable Value Networks**. *Digital technology plays a big role in our transition to a circular economy, which aims to make optimum use of resources within industries. Investing in innovation is good for the protection of the environment, and it also contributes to Europe's competitiveness. The EU-funded DigiPrime project will develop the concept of a circular economy digital platform in order to create circular business models based on*

[48] https://www.shop4cf.eu/

the data-enhanced recovery and reuse of functions and materials. Specifically, it will create and operate a federated model of digital platforms for cross-sector business in the circular economy. DigiPrime will be validated through several cross-sectoral pilots, further detailed in 20 use cases covering different European industrial sectors (automotive, renewable energy, electronics, textile, construction), and by additional pilots in new sectors, funded through an open call mechanism.

- **KYKLOS 4.0[49] An Advanced Circular and Agile Manufacturing Ecosystem based on rapid reconfigurable manufacturing process and individualized consumer preferences**. *In circular manufacturing (CM), manufacturers find ways to eliminate waste by reusing and recycling materials and goods. The EU-funded KYKLOS 4.0 project aims to show how cyber-physical systems, product life-cycle management, life-cycle assessment, augmented reality, and artificial intelligence technologies and methods are able to transform CM. It will achieve this through seven large-scale pilot projects that will demonstrate improvements in operational efficiency and deliver solutions for resource reuse. It will further ensure the scalability of novel CM technologies, engage over 100 European industry actors, transfer know-how and mobilise additional sector investments. The project's advanced ecosystem can reshape factory processes and services so as to benefit manufacturing throughout Europe*.

The DMP cluster was born just at the beginning of 2019 under the initiative of the ZDMP project including eight main working groups. At the moment, all the 5 working groups have a stable composition with active contributions from all the 6 Innovation Actions and collaboration in place, some examples are given below in the description of the March 12th, May 13th, June 4th, September 25th and December 2nd-3rd DMP cluster meetings.

WG1. **Standardisation**. *Standardization clustering activities will connect standardization forums to facilitate the compliance of the cluster results with existing standards. Furthermore, the cluster will also contribute to new standardization activities where possible. At this point several standards were already identified and some terminology is apparently missing. This will lead to the development of a Glossary and an Ontology for Digital Manufacturing Platforms with a view to submitting into CEN as a CEN Workshop Agreement*.

WG2. **Dissemination**. *Events participation is an important activity to disseminate/discuss the clusters' advances. This topic considers the active participation in joint dissemination actions to communicate and promote the cluster res*

WG3. *ults to technology and service providers as well as other business users and/or stakeholders. This activity foresees a) Joint event(s) participation, with joint booths, and b) Production of joint dissemination materials such as cluster brochure, poster, or video.* As an example see below the common DMP cluster template for presentations.

WG4. **Research and Socio-Economic Impact**. *Digital Manufacturing Platforms for Connected Smart Factories is a massive field of application, technology, and research on relevant innovation areas. Even within innovation projects, there is space to publish innovative results in leading journals and conferences. The main objective is to publish joint research papers on cluster projects' common topics. An initial set of 70 conferences, 80 journals has been for instance agreed as a basis for collaboration. COVID-19 crisis has severely affected the implementation of this WG*. As an example, a common training program has been proposed as concrete outcome of this WG. *The second main objective is to establish a joint DMP Market Analysis and portfolio of Business Models for DMP. This topic's strategy will be revised taking into consideration the confidentiality issues that are involved. Next actions should be agreed to share non confidential information about business models approaches for the three cluster projects as already individual projects work has progressed.*

WG5. **Experiments (Pilots and Open Calls).** *Pilot activities will be jointly addressed by the three + three projects to increase knowledge on pilots' description, conducting, and assessment. Analysis of existing pilots' templates and descriptions will be used to achieve a possible*

[49] https://kyklos40project.eu/

common representation methodology and semantic interoperability. The collection of strategies to raise SME engagement and common strategies on privacy GDPR issues will also be addressed. Also this aspect will be properly addressed in the CF2 CSA (EFFRA Innovation Portal) and in the OPEN DEI Pilots Dashboard for cross-domain Pilots mapping and analysis. The open calls approach will enable external stakeholders (software developers, services providers…) to permanently improve components and develop new applications. Joint work will be done to make external stakeholders aware of the available resources, to potentiate the open calls participation and to combine efforts on their evaluation.

WG6. **Platforms.** *Joint activities will exploit synergies between technology--based platforms addressing issues such as architecture, interoperability and standard approaches. This approach will enlarge the ecosystems surrounding the projects, facilitate the access for entrepreneurs / API developers/Makers and SMEs in general, and support the transfer of skills and know--how to industry. Activities will involve the analysis of existing reference architectures, specific requirements and needs. This will lead to the position of reference architectures, interoperability patterns and common cross-domain components, open source implementations mapped with reference architectures and Interoperability with existing projects marketplaces.*

Meetings have been held in those months and in particular, on December 2nd – 3rd meeting, the AI REGIO project has been represented by POLIMI and CARSA beneficiaries.

Next DMP cluster meetings are scheduled for February 2021 (especially focusing in the WG1 Standardisation), also with a closer collaboration with cross-domain aspects in OPEN DEI (see §6.3 below).

6.2 The ConnectedFactories CSAs and their Pathways

The ConnectedFactories (2016-2019) and ConnectedFactories2 (2019-2022) projects https://www.connectedfactories.eu/ aim to develop pathways towards advanced digitalization of manufacturing processes from different perspectives. These perspectives can be seen as different application areas.

6.2.1 ConnectedFactories I objectives and main actions

ConnectedFactories - Industrial scenarios for connected factories 2016-2019, CSA (Cordis https://cordis.europa.eu/project/id/723777) has ended in October 2019, under the coordination of VTT. Public reports are available at https://www.connectedfactories.eu/

The main goals of the ConnectedFactories project were:

- accompany manufacturing enterprises and technology providers in the fast **moving developments** around 'digitisation' and 'digital platforms'
- establish and maintain a **structured overview** of both available and upcoming technological approaches as well as best practices
- develop forward-looking **scenarios or pathways** of how the different platforms and architectures will co-exist, cooperate and compete in a concrete environment
- stimulate **consensus building** and intensify the dialogue amongst all stakeholders on manufacturing related issues and cross-cutting topics like standardisation, security and business models
- create **trust** and develop/deepen the links within the community

The mentioned **'scenarios and pathways'** play a central role. The scenarios and pathways should become practical tools for the development of company-specific innovation strategies in the context of digitalization of manufacturing and the deployment of digital platforms for manufacturing.

A pathway is composed of different levels of digitalization that are associated to a number of milestones. These milestones indicate practices of digitalization that, while evolving to the right-hand side of the pathways, become more advanced. Ultimately, the milestones on the right fit within the vision of digital manufacturing.

The first project 2016-2019 resulted in the initial versions of the following pathways and the start of the mapping of projects and their results on these pathways[50].

- The **Autonomous Smart Factories** pathway[51]: with a focus on intra-factory manufacturing automation and optimization, including advanced human-in-the-loop workspaces. The following levels are foreseen:

  - ✓ ***Level 1*** *reflects a situation that is still a reality in many manufacturing companies: data acquisition on the shop floor is done predominantly manually, while spreadsheets and text editors are used to do Enterprise Resource Planning (or ERP) and Manufacturing Operations Management (or MOM) including scheduling (also referred to as MES, Manufacturing Execution System).*
  - ✓ ***Level 2*** *involves the implementation of dedicated digital tools for doing ERP and MOM, while Supervisory Control and Data Acquisition (SCADA) solutions are implemented on shop floor level, connected to sensors and actuators and other field devices via PLCs or industrial PC's.*
  - ✓ ***Level 3*** *focuses on the company internal connection of ERP, MOM and SCADA-PLC levels. This connectivity will increase the awareness of Enterprise Resource Planning about the status and condition of manufacturing operations, such as possible delays due to break-down or maintenance. This level includes the introduction of Industrial connectivity approaches, such as the use of Industrial IoT, RFID, other wireless technologies or identification methods. There are different ways to achieve connectivity, as is illustrated by the 'IIOT connectivity stack that can be found An Industrial Internet Consortium and Plattform Industrie 4.0 Joint Whitepaper 'Architecture Alignment and Interoperability. In level 3 and beyond, the concept of Cyber-Physical Systems is relevant, leading to a less hierarchical interpretation of the Automation Pyramid.*
  - ✓ ***Level 4*** *focuses on the implementation of more advanced optimisation approaches, either on factory level or on machine level. Another achievement in this level is the inclusion of humans in the digital information or connectivity loop.*
  - ✓ ***Level 5*** *encompasses real time optimisation on factory or machine level. The deployment of digital platforms for manufacturing is situated on this level.*

- The **Hyper-connected Factories** pathway[52]: with a focus on networked enterprises in complex, dynamic supply chains and value networks. *The first levels of the Hyperconnected Factories pathway display similar levels as the Autonomous & Smart Factories pathway: Multi-purpose digital tools are progressively implemented and complemented by dedicated tools that are operating in silos within the company. Communication with other companies is primarily done by e-mails and attachments until reaching* ***Level 4****, where dedicated IT connections (such as private industrial networks) are established among a selection of long-term value chain partners.* ***Level 5*** *is a level where dynamic IT connection can be established with new business partners or suppliers.*

- The **Collaborative Product-Service Factories** pathway[53]: with a focus on data-driven product-service engineering in knowledge intensive factories has been developed according to the following five levels:

[50] https://www.connectedfactories.eu/pathways-digitalisation-manufacturing

[51] https://www.connectedfactories.eu/autonomous-smart-factories-pathway

[52] https://www.connectedfactories.eu/hyperconnected-factories-pathway

[53] https://www.connectedfactories.eu/collaborative-product-service-factories-pathway

- ✓ ***Level 1*** *is the situation where the full focus of the manufacturing company is on the product and where it does not or hardly address the services associated to that product.*
- ✓ ***Level 2*** *of the pathway implies that the manufacturing company has understood the opportunity for growth and job creation offered by associating services to their product in a structured way. This understanding is linked to the fact that products are seen within their full lifecycle and the complex interaction across different stages of their lifecycle. From the technological point of view this requires that the product can be tracked and traced remotely. A product lifecycle system (PLM) system should be able to manage this information and also provide insight into the evolution of the product, even to the stage of retro-fitting, re-use and recycling. The fact that a manufacturer does not lose the connection or even the control of the product along its lifecycle is a pre-condition for the structured development of services that are closely associated and integrated with the product.*
- ✓ ***Level 3*** *implies that design and engineering processes of the product are opened to the requirements and needs from the different stakeholders along the whole life-cycle of the product: suppliers, business partners, customers. Therefore, level 3 is about creating a collaborative environment beyond the boundaries of the manufacturing company (this involvement of users is different when the users are consumer or professional users). Level 3 is a preparation phase in order to be able to integrate innovative services in the product (design for service) in level 4. It also assures that the design of new products is not taking place in a silo anymore. It assures also that products, such as machine tools, are engineered more specifically according to the needs of the use of the machine tool.*
- ✓ ***Level 4*** *is the further evolution of the process started in level 3, where innovative services are designed (in partnership with the different stakeholders) and delivered, sometimes in cooperation with specialised 'service' companies. For example, predictive maintenance services are offered in cooperation with specialised predictive maintenance services companies. This requires the sharing of data among the different parties and the conclusion of associated B2B agreements.*
- ✓ ***Level 5*** *is when the company has transformed its business and product/services processes at all levels: embracing digital technologies (IoT, data analytics), integrating this with the hardware and manufacturing aspects (materials engineering, etc…), organisational aspects, where for instance sales people are both addressing the technical aspects as well as the business/service aspects.*

In collaborative product service pathway, the link between the business objectives and the technological and digital aspect that enable to reach these business objectives, is less obvious that in the two previously presented pathway 'Autonomous Smart Factories' and 'Hyperconnected Factories'.

AI REGIO Industrial Cases and Technology Solutions are mostly referring to the AI-oriented factory of the future concept which is an expression of the highest levels of the above CF pathways. AI REGIO pilots under implementation are developing/integrating AI solutions in Smart Factory scenario (e.g. Hohner, Kautenburger, Arculus, East NL, Tampere and Bask Country) and in Smart Product-Service scenario (e.g. Gualini, S2P, Visiativ/Swarm, Emilia Romagna, Slovenia), while only few pilots are also exploring the benefits of such an approach at the Value Chain level. This will be better addressed at the level of Open Calls. Finally, projects are invited to map their assets versus Horizon 2020 Factory of Future Pathways, as well as other European and national/regional research project results to the digitalization pathways defined in ConnectedFactories. **Pathways with research projects, results and demos,** etc. are available at EFFRA innovation portal structured

wiki[54]. For example, Digitalization pathway **Autonomous Smart Factories**[55] shows projects connected to this specific pathway, results and demos.

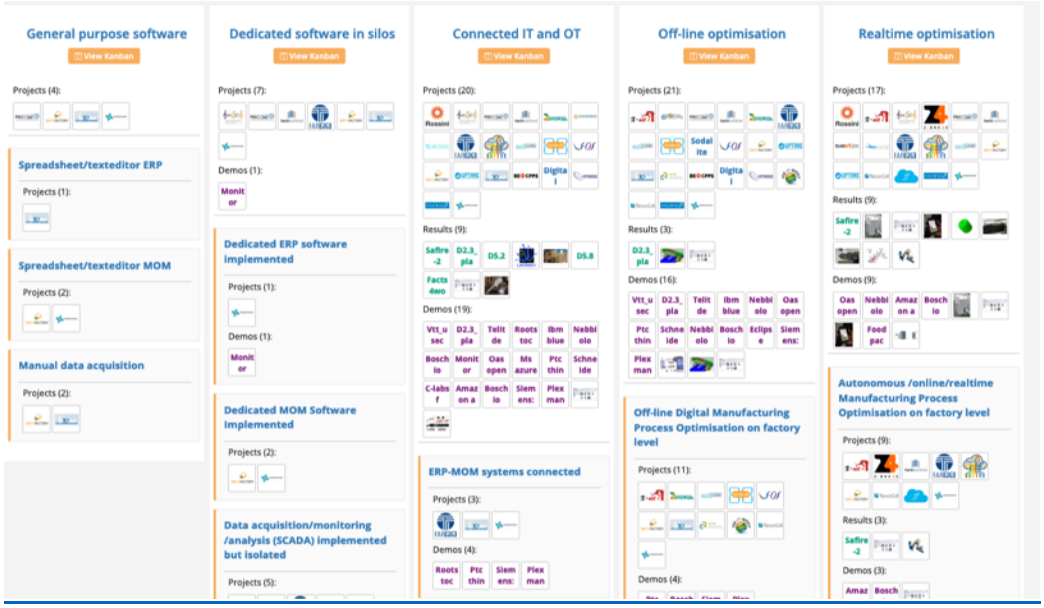

Figure 25 - Example of Digitalization pathway Autonomous Smart Factories pathways in Kanban

The EFFRA Innovation Portal is the most important dissemination channel to the Connected Factories communities. AI REGIO relationship with the Portal is following two main streams, related to AI REGIO innovation assets and to AI REGIO experimentation pilots. For the former aspect, relevant AI REGIO deliverables and assets are being uploaded into the portal as a public reference to AI for Manufacturing solutions and reference architecture.

Regarding the pilot experiments, the plan is to upload public versions of their achievements as soon as they are available: this will be done in the second period and reported in the final version of this deliverable.

6.2.2 ConnectedFactories II objectives and main actions

The **ConnectedFactories 2** project establishes a structured overview of available and upcoming technological approaches and best practices with regard to the digitalization of manufacturing. The project identifies present and future needs, as well as challenges, of the manufacturing industries. The project explores pathways to the digital integration and interoperability of manufacturing systems and processes and the benefits this will bring.

The ConnectedFactories 2 project (started on 1 December 2019) focuses on:

- Creating a common understanding of key enablers and cross-cutting factors for the development and deployment of digital technologies and digital platforms for manufacturing
- Deepening pathways by taking into account legacy systems, industrial requirements and challenges
- Situating inspiring research and industrial state-of-the-art cases, key enablers and cross-cutting factors along these pathways
- Matching of skills transfer offering with skills demand across Europe

[54] https://portal.effra.eu/wiki

[55] https://portal.effra.eu/wiki/kanban/taxon/911

- Engaging with the research and industrial actors in both European and local fora or ecosystems, bringing together manufacturing companies, technology and component suppliers, etc.
- Creating a broad awareness about the pathways, key enablers and cross-cutting factors, and about inspiring cases for SMEs
- Stimulating visibility and impact of Digital Manufacturing Platforms for Connected Smart Factories projects (call DT-ICT-07-2018-2019)

In particular, CF2 is currently discussing two new Pathways which are related to very recent fundamental acts of the EU Commission regarding the **Green Deal and Circular Economy** as well as EU **Data Strategy and common Data Spaces for Manufacturing**. AI REGIO project is called to contribute to the definition of the analysis dimensions and of the Data Spaces maturity levels, in order to create a matrix where both AI REGIO solutions and AI REGIO industrial cases could be mapped.

6.2.2.1 The CF2 Data Spaces pathway

The need for a common EU Data Space for Manufacturing Industry was recently highlighted by different initiatives and communications. In the field of Important Projects of Common European Interest (IPCEI[56]) at the beginning of 2019 a reference framework for EU common Industrial IOT, Data and AI ecosystem was presented, where the first pillar of the Digital Platform enabling is called: "Secure and Trusted Data Spaces: data access, sharing and valorisation". Manufacturing is one of the verticals where such an IPCEI is going to be developed.

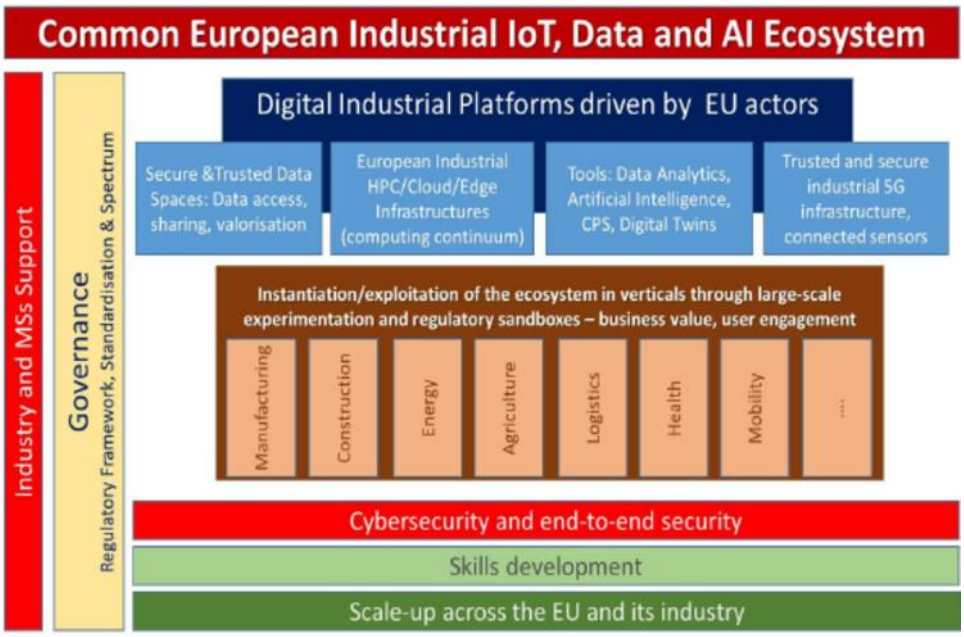

Figure 26 - EU common Industrial IOT, Data and AI ecosystem

More recently, the **EU Data Strategy**[57] of February 2020 has identified the four main pillars along which such a strategy will be implemented in the next few years: a new cross-sectorial **governance** framework for data sharing, a new technology development framework (**enablers** and building blocks), a new data-oriented education and **skills development** program and a set of **vertical rollouts** in crucial economic and business sectors (Manufacturing included).

[56] https://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupMeetingDoc&docid=28145

[57] https://ec.europa.eu/digital-single-market/en/policies/building-european-data-economy

Figure 27 - EU Data Strategy Four Pillars

But, what do we mean for a common EU Data Space? CF2 pathway invites to refer to BDVA publications and in particular the April 2019 (under revision currently) position paper "**TOWARDS A EUROPEAN DATA SHARING SPACE** Enabling data exchange and unlocking AI potential"[58] where Data Spaces, Data Platforms and Data Marketplaces are defined inside the overall EU Data Ecosystem and the BDVA "**SRIA Strategic Research and Innovation Agenda** version 4.0"[59] reference model where five plus one data-oriented challenges have been identified and materialized.

a. ***Data Management****: Principles and techniques for data lifecycle management including quality and integrity*
b. ***Data Protection****: Privacy and anonymisation mechanisms to facilitate data protection. This is shown related to data management and processing as there is a strong link here, but it can also be associated with the area of cybersecurity.*
c. ***Data Processing Architectures****: Optimised and scalable architectures for analytics of both data-at-rest and data-in-motion, with low latency delivering real-time analytics*
d. ***Data Analytics****: Data analytics to improve data understanding, deep learning and the meaningfulness of data*
e. ***Data Visualisation and User Interaction****: Advanced visualisation approaches for improved user experience*
f. ***Ecosystems for Data Sharing*** *and Innovation Support: Data platforms for data sharing include, in particular, IDPs and PDPs, but also other data sharing platforms like Research Data Platforms (RDPs) and Urban/City Data Platforms (UDPs).*

These six dimensions have been chosen for the analysis of "Data Space" maturity of a Manufacturing company (SME), along five levels of maturity defined as:

i. **No Data Control**. This is a level where companies do not have CONTROL of DATA along their lifecycle. DATA are of course generated but no models, no processes, no awareness is in place. Smart Machines, Smart Products and Smart Value Chains do produce data, but they are dispersed in several areas and the company does not have any control on them.
ii. **Data Silos.** This is a level where the company understands the relevance of Data lifecycle management as for feeding Enterprise applications such as PLM ERP SCM CRM MES. Data

[58] https://www.bdva.eu/sites/default/files/BDVA%20DataSharingSpace%20PositionPaper_April2019_V1.pdf

[59] https://www.bdva.eu/node/874

are captured, protected, processed, analysed, visualized in the context of their Enterprise application, so some data is NOT managed, some data is duplicated, but in any case DATA is SILOED.

iii. **Data Bridges.** This is a level where for feeding some advanced applications in the domain of planning, optimisation, prediction, the company needs to integrate data from different sources (e.g. ERP-CRM; ERP-MES, PLM-MES). Ad-hoc integration bridges are developed but without a holistic and comprehensive strategy for data management and governance.

iv. **Data Interoperability.** This is a level where enterprises define a strategy and a set of processes for managing and governing the Data generated inside and acquired from outside along their complete lifecycle. Data Spaces are generated where common standard data models, ontologies, industrial data platforms are set up inside the company and along the product lifecycle and the value chain. Any new application can be easily plugged & played in this data space just by configuration, so that scalability is assured.

v. **Data Valorisation.** This level is when the enterprise fully understands how data can be profitably exploited inside and outside of the value chain. Data Marketplaces and/or Trusted Data Networks are setup and managed in agreement with Data Protection (personal data) and Data Sovereignty (non-personal data) principles. This does not necessarily imply a monetisation and revenue stream, but the full exploitation of the intrinsic value of data-information-knowledge.

Now the DS pathway 6*5 contribution space is being filled by contributions of projects and DMP cluster is required to provide its view in the domain of Data Spaces for Zero Defect Manufacturing in Autonomous Quality scenarios. DMP industrial pilots will be soon required to compile an online survey and to be interviewed about their maturity regarding Data Spaces. Such a maturity analysis could also be interpreted as an action to improve Data Culture and Data Value Awareness also in the manufacturing industry, where Data Economy principles are now leading new business and innovation models in other domains such as Mobile Communication, Retail and Finance.

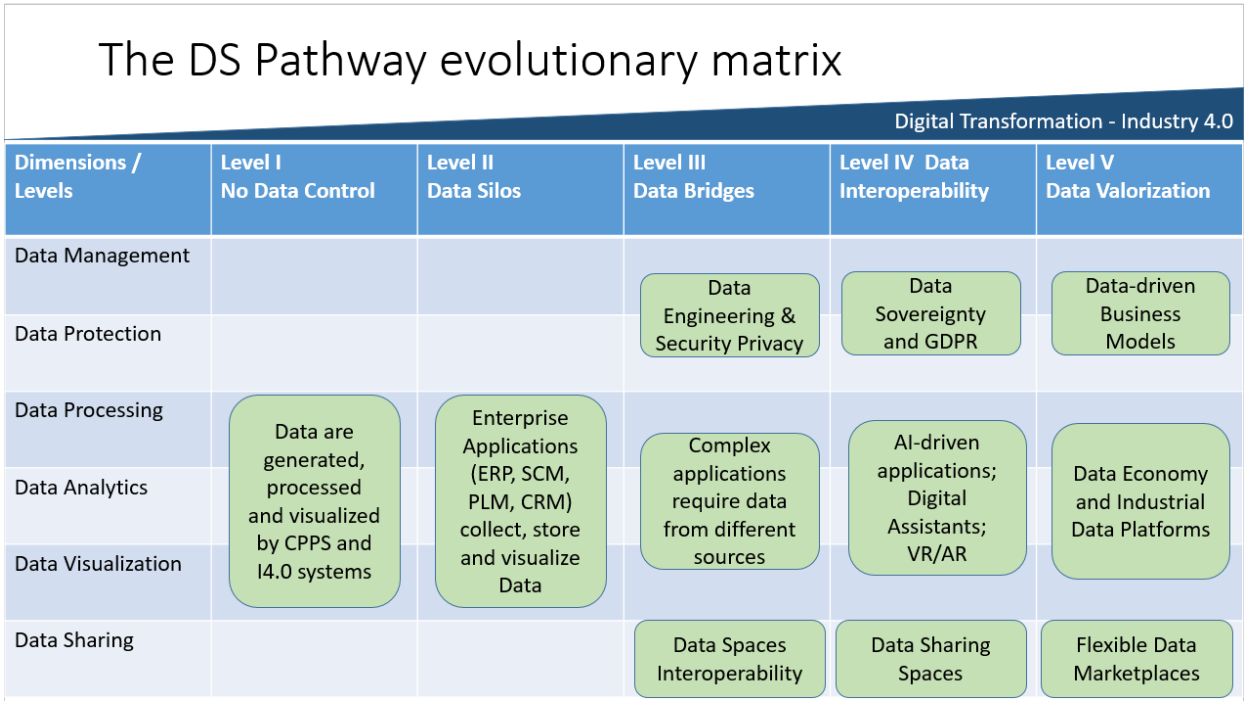

Figure 28 - DS Pathway evolutionary matrix

In the near future, AI REGIO will substantially contribute to the new Pathway "AI for Manufacturing" in close collaboration with the ICT-38 RIAs (Chapter 7).

6.3 The cross-domain OPEN DEI CSA and its Task Forces

All the Innovation Actions funded under DT-ICT-07 till to DT-ICT-12 (the cross-domain Digital Platforms and Pilots focus area) need to address all of the following four activities, namely platform building, large-scale piloting, ecosystem building, and standardisation.

***In platform building**, proposals need to develop next-generation digital platforms, which build on the state-of-the-art, reuse what is available, and integrate different technologies, such as IoT, AI, robotics, cloud and Big Data. Platforms should aim at openness and interoperability between platforms to avoid lock-in, preventing dominant positions of individual players, and comply with standards and regulation. Proposals need to target solutions for SMEs and mid-caps, taking into account interoperability with emerging and future solutions. This may require the mapping of reference architecture models for integrating existing sectorial platforms. The interfaces of the platform need to be described via open specifications and reference implementations need to be developed. A major aim is to offer platform functionalities that can be generically reused in multiple contexts to support various types of applications and services.*

***In large-scale piloting**, pilots are set up that make use of the digital platforms, develop prototype applications on top of the platforms, and validate the platforms in both reduced, controlled environments and in real-life use cases. Pilots may adapt platforms to specific application needs and validate their relevance for such needs, in order to foster take-up and large scale deployment. The pilots should cover innovative application scenarios with high socio-economic impact. Demonstration of cooperation between large-scale pilots in different domains and combination of services from different sectors/domains are welcome. The key need is to deliver interoperable solutions that provide an experience that customers or businesses require, to test them in complex regulatory environments, and to give guidance for secure and safe implementation.*

***In ecosystem building**, the take-up of digital platforms is fostered by expanding the ecosystem of players involved and through opportunities for entrepreneurs by promoting new market openings allowing also smaller and newer players to capture value. For instance, small and innovative ICT players can develop services/applications with a clear societal and economic value, on top of the digital platforms. Moreover, additional small-scale pilots can be conducted by SMEs, validating the digital platforms and prototype applications. Experiments running on top of the pilots, under specific scenarios, will allow for the validation and acceptance by any actors in the ecosystem and users in particular.*

***In standardisation**, contributions should be made to suitable standardisation bodies or pre-normative activities, as outlined in the Communication on Priorities of ICT Standardisation for the Digital Single Market.*

In order to provide support to the Innovation Actions, DT-ICT-13 was created and two CSAs funded: the former (digiPLACE) addressing the Construction domain and the latter (OPEN DEI) addressing the four domains of Manufacturing (DT-ICT-07), Agrifood (DT-ICT-08 waiting for DT-ICT-09 rural areas), Energy (DT-ICT-10 and DT-ICT-11) and Health & Care (waiting for DT-ICT-12 AI hospital of the future).

Owing to this a-synchronicity of the different DT-ICT calls, the OPEN DEI portfolio of Innovation Actions was extended with other projects which are providing needs and requirements regarding the implementation of the four activities listed in the work programme and above.

This extended portfolio of projects in the four domains, counts now for 27 Innovation Actions as in the picture below.

Figure 29 – OPEN DEI portfolio of Innovation Actions

In the manufacturing domain, all the 6+1 DT-ICT-07 projects are present, but further contributions are expected to come from other parallel initiatives such as I4MS, SAE, ROBOTICS, ECSEL I4.E and the ICT-08 call about cybersecurity in Manufacturing.

Beyond facilitating collaboration and joint dissemination among the projects, OPEN DEI is organizing Task Forces in order to engage experts from the projects on specific challenges of common interest among the four domains. In particular, from Fall 2020 **TF1 "Data Sharing Spaces"** has been activated while the **TF3 "Reference Architectures and Open Source implementations"** will be activated in early 2021, requiring contributions from all the OPEN DEI constituency, including AI REGIO.

For both OPEN DEI Task Forces, AI REGIO is required to identify common cross-domain challenges in the two topics and to establish a bi-directional exchange of knowledge and assets with the other application domains of Digital Platforms.

6.3.1 TF1 "Pan-European Data Sharing Spaces"

The OPEN DEI Digital Transformation Data Sharing Spaces task force has the aim to develop a common understanding, approach and design principles among the four OPEN DEI domains towards the development of a common European Data Space[60].

In particular, the EU Data Strategy, published on February 19th 2020, identifies four main pillars to be addressed in order to get to a common EU Data Space[61]: a legal framework for data access and use, a technical infrastructure and building blocks, a capacity building program for skills and competencies, a rollout in crucial economic sectors and domains of public interest. The following picture illustrates this last pillar and the need for a common approach and technical baseline among the four selected OPEN DEI domains.

[60] https://ec.europa.eu/digital-single-market/en/news/communication-towards-common-european-data-space

[61] "I want European businesses and our many SMEs to access high quality data and create value for Europeans including by developing Artificial Intelligence applications." Thierry Breton, Commissioner for the Internal Market

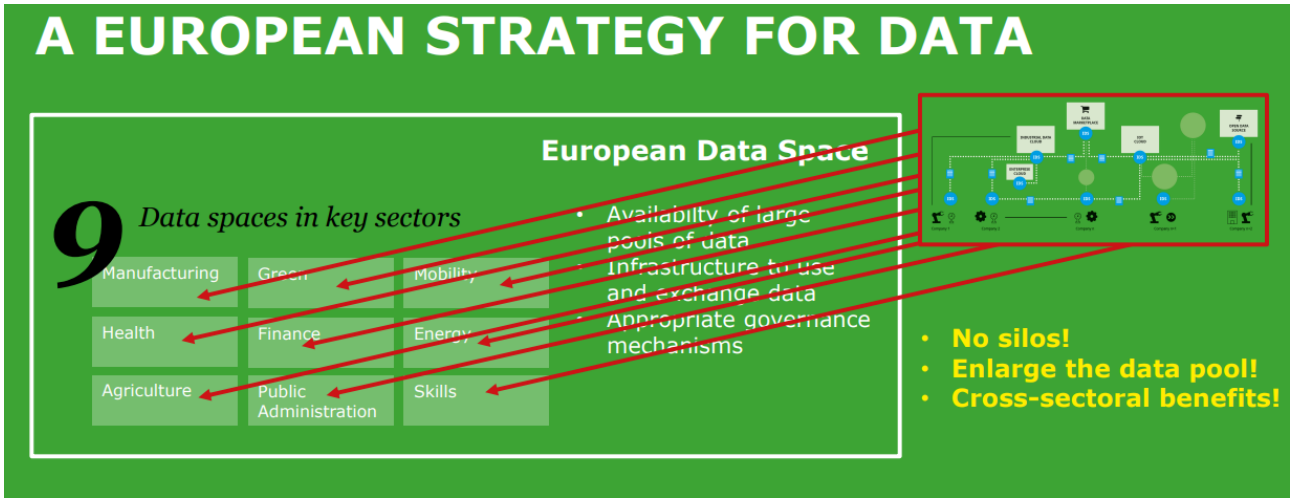

Figure 30 - A European strategy for data: data spaces in key sectors and IDSA components

In the context of OPEN DEI Task Force 1, IDS Association provides:

- Open Reference architecture setting the framework conditions – based on standards
- Trust framework and scheme for data sharing
- Coordination operations for essential data sovereignty services

The OPEN DEI task force 1 is discussing how to implement these data spaces in four of the above domains: manufacturing, health & care, agri-food and energy. Each DT-ICT-07 project will participate on OPEN DEI task force to identify common cross-domain challenges and to establish a bi-directional exchange of knowledge and assets with the other application domains of Digital Platforms.

One of the key challenges of the TF1 is to discuss and agree on a set of coherent and coordinated design principles for data spaces design, development and rollout, able to support and guarantee data sovereignty, i.e. "a natural person's or corporate entity's capability of being entirely self-determined with regard to its data[62]".

IDSA proposes the Essential Trust Services and Basic Data Services as main components to design data spaces.

Trusted infrastructures constitute the basis for ensuring data sovereignty in the first place. Such infrastructures must be equipped with a number of mutually adjusted operational components (e.g. identity management or dynamic trust management) and allow for unambiguous digital identities.

If either of these two preconditions is missing, data sovereignty cannot be enforced. It is these components and identities, together with additional features (such as a broker service provider or functions for data quality assessment), that make a data ecosystem based on data sovereignty valuable for its users.

[62] https://www.isst.fraunhofer.de/content/dam/isst-neu/documents/Publikationen/StudienundWhitePaper/FhG-ISST_DATA-ECOSYSTEMS.pdf

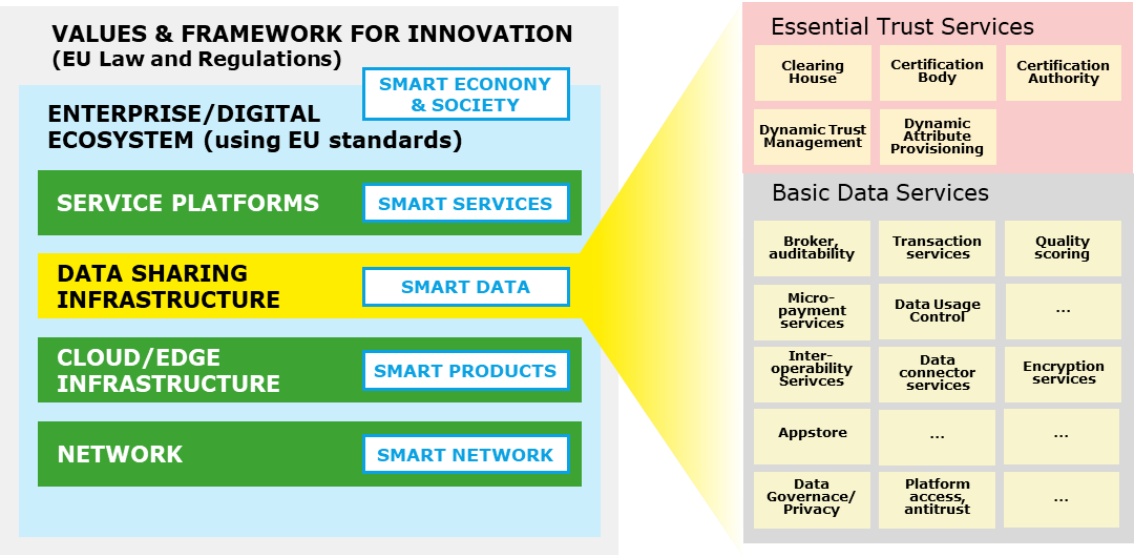

Figure 31 - Required services for Data Sharing Infrastructure

(source: Boris Otto, IDSA, http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=61799)

Data spaces in general consist of archetypal roles (in the sense of a generally applicable standard) for data ecosystems that follow the value propositions of EU Data Strategy and International Data Spaces of trust, data sovereignty and enforcement of terms of use for data (see IDS RAM).

Some of these roles are essential for the fulfilment of the value proposition:

- Certification Body (CB)
- Certification Authority (CA) (provisioning of X.509 certificates)
- Dynamic Attribute Provisioning Service (DAPS) (OAuth compatible)
- Dynamic Trust Management (DTM) (former Security Operation Center)
- Participant Information System (ParIS)
- IDS Broker (rudimentary broker-functionality)

These roles must be operated and controlled in operational terms under mutually and consensus-based rules of procedure. There is a make-or-buy option for each of these roles, i.e. they can be tendered to service providers (one or more) or developed inside the IDSA ecosystem.

Further roles are important but not essential for the prosperity of data ecosystems - these include the App store, vocabulary provider, the clearing house. It is not the IDSA's task to fill these roles or to give them a business structure. This is left to the market.

6.3.2 TF3 "Reference Architectures & Open Source Implementation"

This section presents the work done on OPEN DEI project related to the definition of the OPEN DEI Reference Architecture Framework and which will be essential part of the TF3 about cross-domain reference architectures and open source implementations.

Before designing the Reference Architecture, OPEN DEI defined the fundamental underlying principles of the architecture, which are:

- **Principle 1: INTEROPERABILITY**: As extracted from OPEN DEI deliverable (OPEN DEI D2.1 RA, 2020): "OPEN DEI RAF should foster technical interoperability, at syntactic and semantic levels, via the use of data sharing mechanisms, grounded on well-established standards and design/implementation patterns, grounded on well-established standards and design/implementation patterns".

- **Principle 2: OPENNESS**: As extracted from OPEN DEI deliverable (OPEN DEI D2.1 RA, 2020): "OPEN DEI RAF should ensure a level playing field for open source datasets/software/standards and demonstrate active and fair consideration of the coverage of functional needs, maturity and market support and innovation".
- **Principle 3: REUSABILITY**: As extracted from OPEN DEI deliverable (OPEN DEI D2.1 RA, 2020): "OPEN DEI RAF must support reusing and sharing of data and solutions, and cooperate in the development of joint solutions when implementing Digital Transformation pathways".
- **Principle 4: AVOID VENDOR LOCK-IN**: As extracted from OPEN DEI deliverable (OPEN DEI D2.1 RA, 2020): "OPEN DEI RAF should foster access and reuse of their digital services and data irrespective of specific technologies or products".
- **Principle 5: SECURITY and PRIVACY**: As extracted from OPEN DEI deliverable (OPEN DEI D2.1 RA, 2020): "OPEN DEI RAF must define a common security and privacy framework and establish processes for digital services to ensure secure and trustworthy data exchange between the involved stakeholders and in interactions with organization and businesses".

Following those principles, OPEN DEI has developed its RAF around three main different levels of Data Spaces and three orthogonal dimensions, focused on data-driven pipelines and workflows management, see Figure below. The final objective of the RAF is to cover three main topics related to data: i) gathering; ii) processing and iii) decision support.

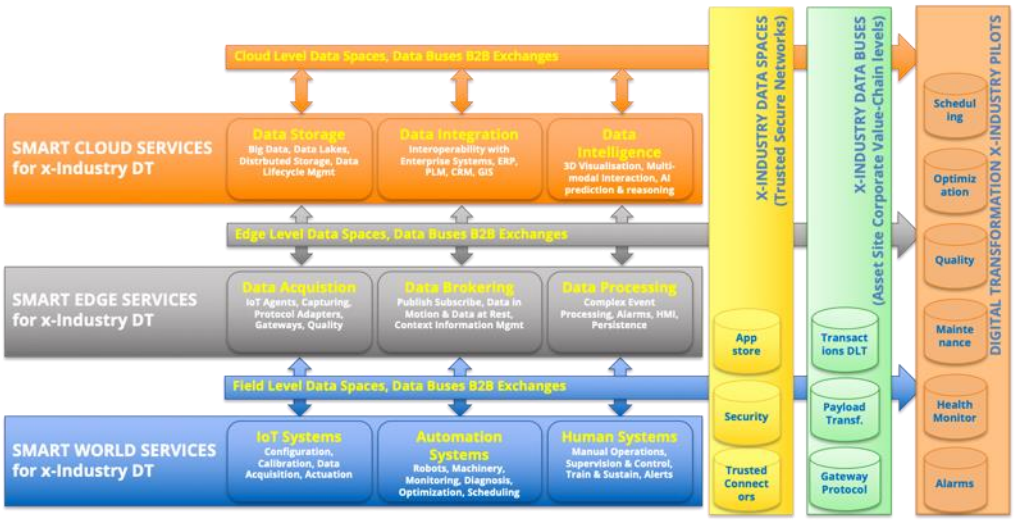

Figure 32 - OPEN DEI Reference Architecture Framework

The three Data Spaces levels are:

- **Field Level Data Spaces**, it refers to the data producers' level, and the capability to gather information from them. It is organized in three main blocks: i) IoT Systems (configuration, calibration, data acquisition, actuation, etc.); ii) Automation Systems (robots, machinery, and related operations), and iii) Human Systems (manual operations, supervision, and control, etc.).
- **Edge Level Data Spaces**, it refers to the first data processing layer. Nowadays, edge computing is gaining a key role for data analytics purposes. It acts from the data acquisition to the data processing through the data brokering.
- **Cloud Level Data Spaces**, it refers to the cloud level of the architecture with high computational capacities where activities like data storage, data integration and data intelligence can be performed. Among its main functionalities, cloud services will process big data, algorithms, integrate different platforms and services, provide AI service for prediction and reasoning, etc.

While the three transversal dimensions are:

- **Trusted Secure Networks**, which offers a trusted and secured framework for data exchange activities under the International Data Spaces Association principles.
- **Asset Site Corporate Value-Chain**, which enables the information transfer in the company value chain as Data Bus for the Reference Architecture Framework.
- **Digital Transformation Pilots**, which provides applications to support business scenarios from experiments.

6.4 Collaboration Action Plan with Digital Manufacturing Platforms

The AI REGIO contribution to the DMP Cluster is mostly implemented in WP4-WP5 and in the experimentations in WP6. This concerns the DMP Cluster, the Connected Factories CSA and its pathways, the OPEN DEI cross-domain CSA and its Task Forces.

Collaboration Item	Action Plan
Joint Dissemination	YES through the DMP Cluster WG2 and the CF2 EFFRA Innovation Portal
Synergies with Projects	YES identification of DIHs inside the DMP Cluster
Link to innovation networks	YES through the CF2 and OPEN DEI CSAs
Common Marketplace	YES through DIH4INDUSTRY (Digital Accelerator) to be interconnected with the Digital Factory Alliance (DFA) in DMP
Cluster Meetings	YES participation to DMP Cluster meetings and workshops
Mentoring Activities	YES synergies with the DMP cluster training initiatives
Digital Innovation Hub Catalogue	YES specifically for DIH4INDUSTRY

7 The AI for Manufacturing ICT-38-2020 Call

To fully exploit AI technologies in manufacturing and process industry, in order to increase the quality, the execution and the planning, it is required to promote the integration of Artificial Intelligence with industrial systems. To achieve the full adoption of AI technologies in manufacturing, they play a key role: fostering AI - Human collaboration, defining European standards, favouring international collaboration, respecting ethical/legal principles and requirements.

The ICT-38-2020 RIA Call focuses exactly on AI for manufacturing:

Leveraging on existing AI techniques, projects must be able to develop innovative solutions to integrate them in the manufacturing domain, taking into account ethical and legal principles and fostering the AI-Human collaboration. Solutions must be applicable to at least two different realistic manufacturing use cases. The final goal is to implement re-usable products and services aimed at improving the quality in manufacturing processes and to create an environment where human and AI systems collaborate together.

The 9 ICT-38-2020 selected RIAs are described below.

7.1 AI-PROFICIENT project in AI for efficiency, quality and maintenance

The AI-PROFICIENT project will pave the way for integration of advanced AI technologies to manufacturing domain through an evolution from hierarchical and reactive decision making to **self-learning and proactive** control strategies. The proposed approach is underpinned by predictive and prescriptive AI analytics at both component and system level, by cross-fertilizing edge and platform AI, while leveraging the human knowledge and feedback for reinforcement learning (human-in-the-loop). AI-PROFICIENT aspires to bring advanced AI technologies to manufacturing and process industry, while improving the production planning and execution, and facilitating the collaboration between humans and machines.

Taking the full advantage of AI capabilities and human knowledge, AI-PROFICIENT will develop **proactive control strategies** to improve the manufacturing process over three main vectors: production efficiency, quality and maintenance. AI-PROFICIENT will increase the positive impact of AI technology on the manufacturing process as a whole, while keeping the human in central position, assuming supervisory (human-on-the-loop) and executive (human-in-command) roles. AI-PROFICIENT intends to identify the effective means for human-machine interaction, while respecting the safety and security requirements and following the ethical principles, in order to enable: event identification and prediction, operation scenarios simulation, transparent decision and optimal control, and personalized shop-floor assistance.

Such an approach will ensure that the ambitious, but realistic project targets, namely to improve production planning and execution, as well as to facilitate the human-machine collaboration, are achievable for the European manufacturing and process industry. The implementation of this novel concept will be based on the results of several recently finished European R&D projects, which will be demonstrated in two pilot sites, under different scenarios of significant economic value.

AI-PROFICIENT just started in November 2020, with 10 participants and coordinated by UNIVERSITE DE LORRAINE.

7.2 ASSISANT project in decision support system for manufacturing

With a multidisciplinary consortium combining key skills in AI, manufacturing, edge computing and robotics, ASSISTANT aims to create intelligent digital twins through the joint use of machine learning (ML), optimization, simulation and domain models. The resulting tools permit to design and operate complex collaborative and reconfigurable production systems based on data collected from various sources such as IoT devices. ASSISTANT targets a significant increase in flexibility and reactivity, products/processes quality, and in robustness of manufacturing systems, by integrating human and machine intelligence in a sustainable learning relationship.

ASSISTANT provides decision makers with **generative design based software** for all manufacturing decisions. Rather than writing ad hoc code for each manufacturing sector, it provides a set of intelligent digital twins that self-adapt to the manufacturing environment. It promotes a methodology that enhances generative design with learning aspects of AI thanks to the data available in manufacturing. ASSISTANT aims to synthesize predictive / prescriptive models adjusted to the shop floor for each decision levels. Digital twins will be used as oracles by ML in order to converge towards models in phase with reality. This means that rather than writing specific code to cover a restricted set of goals/scenarios/hypotheses for a manufacturing system and a decision level, ASSISTANT will aim at learning models that can be used by standard optimization libraries.

In this context, ML is used to predict parameter values, characterize parameters uncertainty, and acquire physical constraints. ASSISTANT will experiment this methodology on a significant panel of use cases selected for their relevance in the current context of the digital transformation of production in major manufacturing sectors undergoing rapid transformations like the energy, the industrial equipment, and automotive sectors which already make extensive use of digital twins.

ASSISTANT just started in November 2020, with 11 participants and coordinated by INSTITUT MINES-TELECOM.

7.3 COALA project in intelligent assistant for training in manufacturing

Humans are at the center of knowledge-intensive manufacturing processes. They must be skilled and flexible to meet the requirements of their work environment. The training of new workers in these processes is time consuming and costly for companies. Industries, such as the Italian textile sector suffer from the shortage of skilled workers caused, e.g. by the demographic change. A second challenge for the manufacturing sector is the continuous competition through high quality products. COALA will address both challenges through the innovative design and development of a voice-first Digital Intelligent Assistant for the manufacturing sector.

The COALA solution will base on the privacy-focused **open assistant Mycroft**. It integrates prescriptive quality analytics, AI system to support on-the-job training of new workers, and a novel explanation engine - the WHY engine. COALA will address AI ethics during design, deployment, and use of the new solution. Critical components for the adoption of the solution are a new didactic concept to reach workers about opportunities, challenges, and risks in human-AI collaboration, and a concurrent change management process.

Three use cases (textile, white goods, liquid packaging) will evaluate the results in common manufacturing processes with significant economic relevance. COALA will contribute its results to the European AI community, e.g. via the AI4EU platform, and it will involve Digital Innovation Hubs to replicate its demonstrators for European first trustworthy digital assistant for the manufacturing industry. We expect to reduce the failure cost in manufacturing by 30-60% with the prescriptive

quality analytics feature and the assisted worker training. For the change over time we expect a reduction of 15% to 30% by shortening the worker training time.

COALA just started in October 2020, with 14 participants and coordinated by BIBA.

7.4 KNOWLEDGE project in edge to cloud AI

AI is one of the biggest mega-trends towards the 4th industrial revolution. While these technologies promise business sustainability and product/process quality, it seems that the ever-changing market demands and the lack of skilled humans, in combination with the complexity of technologies, raise an urgent need for new suggestions. Suggestions that will be agile, reusable, distributed, scalable, accountable, secure, standardized and collaborative.

To break the entry barriers for these technologies and unleash their potential, the knowlEdge project will develop a new generation of AI methods, systems and data management infrastructure. This framework will provide means for the secure management of distributed data and the computational infrastructure to execute the needed analytic algorithms and redistribute the knowledge towards a knowledge exchange society.

To do so, knowlEdge proposes 6 major innovations in the areas of data management, data analytics and knowledge management: (i) A set of AI services that allow the usage of edge deployments as computational and live data infrastructure, an edge continuous learning execution pipeline; (ii) A digital twin of the shop-floor to test the AI models; (iii) A data management framework deployed from the edge to the cloud ensuring data quality, privacy and confidentiality, building a data safe fog continuum; (iv) Human-AI Collaboration and Domain Knowledge Fusion tools for domain experts to inject their experience into the system to trigger an automatic discovery of knowledge that allows the system to adapt automatically to system changes; (v) A set of standardization mechanisms for the exchange of trained AI-models from one context to another; (vi) A knowledge marketplace platform to distribute and interchange AI trained models.

The knowlEdge consortium consists of 12 partners from 7 EU countries, and its solution will be tested and evaluated in 3 manufacturing sectors.

knowlEdge will start in January 2021, coordinated by VTT.

7.5 MAS4AI project in pervasive AI for human assistance

European industry has been very competitive on the global markets by utilizing highly efficient Artificial Intelligence (AI) tools and massively producing high quality products. The advent for mass customization has been stressing the capability of modularization and flexibility of production processes through the incorporation of AI technologies. However, the communication between the different automation systems has not been yet accomplished efficiently since they lack interoperability and are restricted to their own system of coordination.

The MAS4AI proposal proposes a system that allows the deployment and synchronization of different AI agents in manufacturing for autonomous modular production and human assistance.

The MAS4AI system will be heavily driven by large industrial cases and will aim towards digitizing European industry with AI tools according to the Industry 4.0 paradigm. MAS4AI will develop its overall ambition by the means of four Scientific and Technological objectives namely: a) Multi-Agents-System (MAS) for distributing AI components in different hierarchy layers, customers and suppliers for realising refurbishment activities, b) AI agents using Knowledge-based Representation

with Semantic Web Technologies, c) AI Agents for hierarchical planning of production processes, d) model-based Machine Learning (ML) AI agent. MAS4AI research and technological activity will be strongly driven by a set of industrial use cases which will be then used as demonstrators. The demonstrators involve important industrial sectors of high value added for Europe, namely AI technologies used for automotive, contract manufacturing, bicycle industry, bearings production and wood processing industry

MAS4AI just started in October 2020, with 17 participants and coordinated by DEUTSCHES FORSCHUNGSZENTRUM FUR KUNSTLICHE INTELLIGENZ GMBH-

7.6 STAR project in safe and trusted AI in manufacturing

AI systems in industrial plants must be safe, trusted and secure, even when operating in dynamic, unstructured and unpredictable environments. STAR is a joint effort of AI and digital manufacturing experts towards enabling the deployment of standard-based secure, safe reliable and trusted human centric AI systems in manufacturing environments. STAR will research and make available to novel technologies that will enable AI systems to acquire knowledge in order to take timely and safe decisions in dynamic and unpredictable environments. Moreover, it will research technologies that enable AI systems to confront sophisticated adversaries and to remain robust against security attacks. STAR's will research and integration leading edge AI technologies with wide applicability in manufacturing environments, including:

- Active learning systems that boost safety and accelerate the acquisition of knowledge.
- Simulated reality systems that accelerate Reinforcement Learning (RL) in human robot collaboration scenarios.
- Explainable AI (XAI) systems that boost the transparency of industrial systems and increase the trust on them.
- Human Centric digital twins enabling worker monitoring for safer and trustful production processes.
- Advanced RL techniques for optimal navigation of mobile robots and for the detection of safety zones in industrial plants.
- Cyber-defense mechanisms for sophisticated poisoning and evasion attacks against deep neural networks operating over industrial data.

These technologies will be validated in challenging scenarios in manufacturing lines in the areas of quality management, human robot collaboration and AI-based agile manufacturing. STAR will eliminate security and safety barriers against deploying sophisticated AI systems in production lines. The results will be fully integrated into existing EU-wide initiatives (EFFRA, AI4EU), as a means of enabling researchers and the European industry to deploy and leverage advanced AI solutions in production lines.

STAR will start in January 2021, with 15 participants and coordinated by INTRASOFT INTERNATIONAL

7.7 TEAMING.AI project in maintaining AI systems with Human-AI teaming platform

Smart Manufacturing is believed to play a critical role in maintaining the competitiveness of organisations, by supporting them at different levels such as process optimisation, resource efficiency, predictive maintenance and quality control. Nevertheless, AI technologies which are currently and rapidly penetrating industrial sectors at those levels remain essentially narrow AI

systems. This is due to the lack of self-adaptiveness in the AIs capability to assimilate and interpret new information outside of its predefined programmed parameters. This mean that AI systems are tailored for solving specific tasks on a specific predefined setting and changes in the underlying setting usually requires system adaption ranging from fine-grained parameter adaptations to fully-fledged re-design and re-development of AI systems.

TEAMING_AI project aims at a human AI teaming framework that integrates the strengths of both, the flexibility of human intelligence and scale-up capability of machine intelligence. Human AI teaming is equally motivated to meet the increased need for flexibility in the maintenance and further evolution of AI systems, driven by the increasing personalization of products and service, as well as tackling the barriers of user acceptance and ethical challenges involved in the collaborative environments where artificial intelligence will be used, in order AI can be considered as "teammate" rather than as a threat.

The TEAMING.AI project will be run over 36 months with a work plan divided into 9 Work Packages. Work Packages from 1 to 5 are devoted to the development of new technology to enhance the interaction between human and machine. Furthermore, Work Packages 6 and 7 wrap the development of 3 use case scenarios. Finally, two final Work Packages (8 and 9) will work respectively on the dissemination, exploitation of results and coordination of the project in a transversally way to the above mentioned WPs.

TEAMING.AI will start in January 2021, with 15 participants and coordinated by SOFTWARE COMPETENCE CENTER HAGENBERG GMBH

7.8 XMANAI project for Explainable AI for Manufacturing

Despite the indisputable benefits of AI, humans typically have little visibility and knowledge on how AI systems make any decisions or predictions due to the so-called "black-box effect" in which many of the machine learning/deep learning algorithms are not able to be examined after their execution to understand specifically how and why a decision has been made.

The inner workings of machine learning and deep learning are not exactly transparent, and as algorithms become more complicated, fears of undetected bias, mistakes, and miscomprehensions creeping into decision making, naturally grow among manufacturers and practically any stakeholder

In this context, Explainable AI (XAI) is today an emerging field that aims to address how black box decisions of AI systems are made, inspecting and attempting to understand the steps and models involved in decision making to increase human trust.

XMANAI aims at placing the indisputable power of Explainable AI at the service of manufacturing and human progress, carving out a "human-centric", trustful approach that is respectful of European values and principles, and adopting the mentality that "our AI is only as good as we are". XMANAI, demonstrated in 4 real-life manufacturing cases, will help the manufacturing value chain to shift towards the amplifying AI era by coupling (hybrid and graph) AI ""glass box"" models that are explainable to a ""human-in-the-loop"" and produce value-based explanations, with complex AI assets (data and models) management-sharing-security technologies to multiply the latent data value in a trusted manner, and targeted manufacturing apps to solve concrete manufacturing problems with high impact.

XMANAI just started in November 2020, with 15 participants and coordinated by TXT.

7.9 EU-Japan.AI project in EU-Japan AI knowledge exchange for manufacturing

Artificial Intelligence technology is already having a great impact in many areas, especially including the manufacturing sector. The integration of AI with advanced manufacturing technologies and systems makes it possible to exploit the full potential in the manufacturing industry by achieving a higher level of adaptability, efficiency and robustness. At the same, such systems will be human centric and promote the inclusion and cooperation with humans during planning and execution which can help to improve the quality of products and processes.

Both the EU and Japan have recognised these new development trends and their importance. In order to widely deploy these technologies, special attention is given to international cooperation and exchange of knowledge between EU and Japan for AI-driven innovation in manufacturing. The EU-Japan.AI project is responding to this need by implementing a platform-based approach to connect all the relevant stakeholders from EU and Japan working on AI applications for manufacturing.

This platform, beside other tools, will include an open-information hub, encouraging the exchange of information on the respective research programmes and technological results. This will be supported by distribution of topic relevant materials, information on upcoming events and matchmaking opportunities and twinning activities to establish a vibrant and connected network at the heart of the platform, where a community of practice approach will facilitate the cooperation of all the participants. Convergence workshops will help to establish how research and innovation projects should address AI for manufacturing, the needs and requirements for AI from the point of manufacturers' view as well as to address current needs and future requirements.

Overall, the project aims to establish, stimulate and support a long-term cooperation between the participants, by connecting them via the project's platform and by using modern, online-driven awareness approaches.

EU-Japan.AI will start in January 2021, with 6 participants and coordinated by MINDS & SPARKS GMBH.

7.10 Collaboration Action Plan with AI for Manufacturing ICT-38-2020

The AI REGIO contribution to the AI for Manufacturing ICT-38-2020 projects is mostly implemented in WP4 and the AI4Manufacturing toolkit in particular. New AI for Manufacturing components developed in the ICT-38 RIAs will be assessed by WP4 in the view of an overall integration into a common "AI for Manufacturing" Toolkit. In future perspective, this will also mean to actively contribute to AI4EU, creating in the platform a dedicated working space for Manufacturing.

Collaboration Item	Action Plan
Joint Dissemination	YES through the new AI Partnership and AI4EU
Synergies with Projects	YES identification of DIHs inside the AI for Manufacturing projects
Link to innovation networks	YES through the CF2 and OPEN DEI CSA
Common Marketplace	YES through AI4EU and the AI4Manufacturing Toolkit
Cluster Meetings	YES participation to AI for Manufacturing Cluster meetings and workshops
Mentoring Activities	YES synergies with the AI for Manufacturing training initiatives

Digital Innovation Hub Catalogue	NO not relevant here

8 Manufacturing and AI Partnerships and Associations

AI REGIO needs to direct its efforts towards creating win-win relationships with both the Manufacturing and the ICT domains under the new challenge of "AI for Manufacturing". The following two paragraphs describe our approach in either domain.

8.1 Partnerships and Associations in Manufacturing

8.1.1 The EFFRA PPP in H2020 2018-2020

Inside EFFRA (European factories of the Future Research Association) and its Innovation portal, some projects' clusters are quite close to Innovative AI Applications. This refers to ZDM cluster, but also to PdM (Predictive Maintenance) cluster.

8.1.1.1 The Zero Defect Manufacturing Cluster

Since 2011, the **4ZDM** cluster has cooperated, made different joint arrangements and worked on exploitation possibilities between the projects in this area of expertise. It aims to promote the adoption of ZeroDefect production and quality control systems by industry. 4ZDM currently represents:

- **FP7** Projects, MIDEMMA, MUPROD, IFACOM, MEGAFIT focused on ZDM at workpiece / fixturing level, machine level, process level.
- **5 H2020** running projects (under topic FoF-03-2016) that have recently finished or are about to finish (ForZDM, ZAero, Z-Factor, GoodMan, Stream-0D), focused on ZDM at production system, multi-stage shopfloor level.
- **2 H2020** running projects (under topic FoF-08-2017) that are facing the completion (SmartLine, Citcom), focused on ZDM at in-line measurement for micro-nano enabled high-volume manufacturing
- **2 H2020** running projects (under topic DT-ICT-07-2018) in progress around the midterm (QU4LITY, ZDMP), focused on ZDM at Digital Manufacturing Platforms for Connected Smart Factories.

The ZDM related topics are implemented in WP18-20 by the **DT-FoF-11-2020** (Quality Control in Smart Manufacturing), which are implemented starting from beginning 2021.

- **I4Q Industrial Data Services for Quality Control in Smart Manufacturing**. i4Q Project aims to provide an IoT-based Reliable Industrial Data Services (RIDS), a complete suite consisting of 22 i4Q Solutions, able to manage the huge amount of industrial data coming from cheap cost-effective, smart, and small size interconnected factory devices for supporting manufacturing online monitoring and control. (CERTH coordinator).
- **Dat4Zero Data Reliability and Digitally-enhanced Quality Management for Zero Defect Manufacturing in Smart Factories and Ecosystems.** DAT4.ZERO is a Digitally-enhanced Quality Management System (DQM) that gathers and organizes data from a Distributed Multi-sensor Network, which, when combined with a DQM Toolkit and Modeling and Simulation Layer, and further integrated with existing Cyber-Physical Systems (CPS), offers adequate levels of data accuracy and precision for effective decision-support and problem-solving - utilizing smart, dynamic feedback and feed-forward mechanisms to contribute towards the achievement of Zero Defect Manufacturing (ZDM) in smart factories and their ecosystems. (SINTEF coordinator).
- **InterQ Interlinked Process, Product and Data Quality framework for Zero-Defects Manufacturing.** The EU-funded InterQ project is using artificial intelligence tools to assure

optimised quality in smart factories. Specifically, it will focus on the process, product and data, so that quality can be traced across the supply chain. The project will also use digital twins to predict the final quality of the processes. As regards the reliability of the data collected, this will be checked in real time and based on historical and statistical analysis. (IDEKO coordinator)

- **OPTIMAI Optimizing Manufacturing Processes through Artificial Intelligence and Virtualization.** The EU-funded OPTIMAI project will strive to strike an optimal balance between fast, cheap and reliable production choices that have a big impact on the competitiveness of an industry. To this end, the project will develop smart instrumentation of production with AI-enabled sensors for quality inspection and monitoring. Using AI models, collected data will be analysed for the early detection of defects, the identification of upstream deficiencies and the reconfiguration of production parameters. (CERTH coordinator)

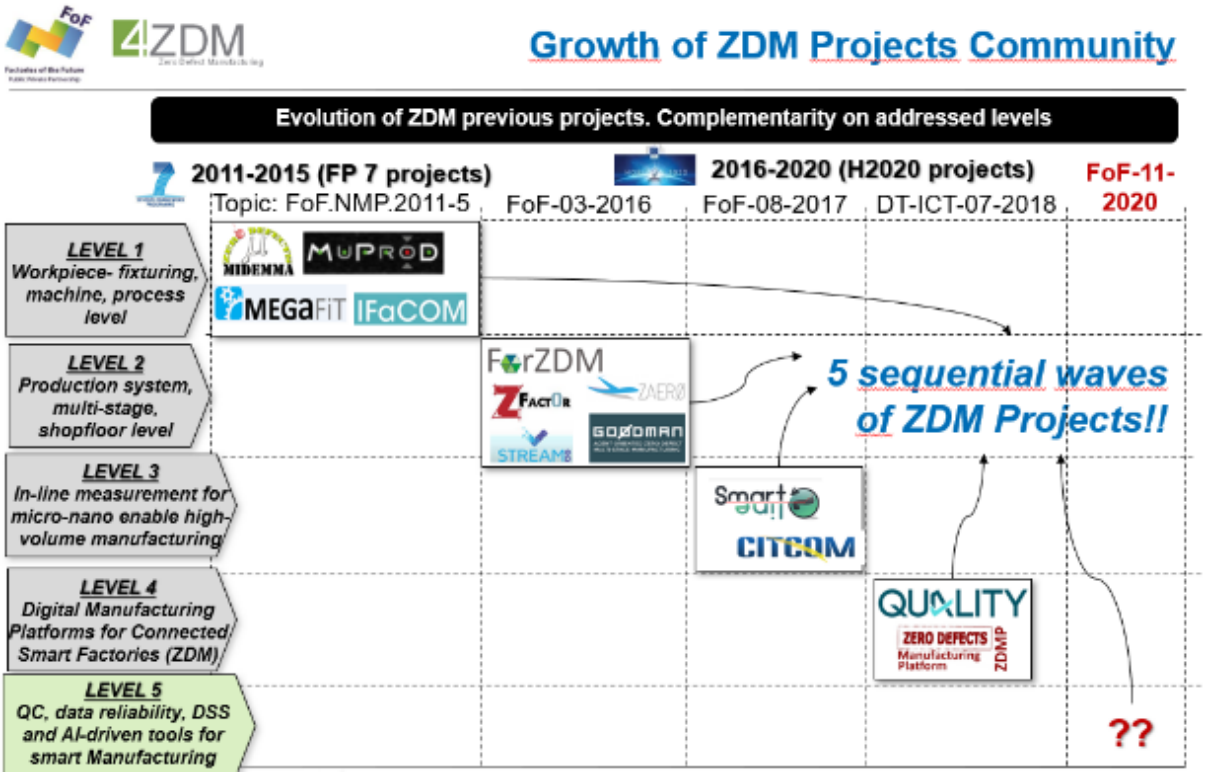

Fig 1: 5 sequential waves in ZDM project community

Additionally, projects accepted under topic DT-FoF-11-2020 (Quality Control in Smart Manufacturing) will be also invited to the cluster from early 2021 on. They will be located in the fifth level where data reliability, and IA tools among others are gaining importance. The interaction of the AI REGIO project with the 4ZDM cluster, will benefit the exchanges with the 4ZDM community, sharing vision and priorities of the participants. The main objectives of the cluster are

- Provide pro-active support to disseminate the projects' tangible outcomes to support industrial exploitation and take-up within the clusters.
- Review the state of the art and formulate future FoF priorities.

8.1.1.2 The Predictive Maintenance Cluster

The **ForeSee cluster** (European cluster for Sustainable Predictive Maintenance Solutions in the Factories of the Future) aims to develop sustainable predictive maintenance solutions for the factory of the future. The cluster consists of **six European projects**, which are funded under the EU H2020 FoF-9 call – Novel design and predictive maintenance technologies for increased operating life of production systems.

- **PROPHESY** is a platform for rapid deployment of self-configuring and optimised predictive maintenance services.
- **PROGRAMS** is a prognosis based reliability analysis method for maintenance scheduling.
- **Z-BRE4K** is a novel predictive maintenance platform for zero-unexpected-breakdowns.
- **PRECOM** is a predictive cognitive maintenance decision-support system to improve preventive maintenance.
- **SERENA** is a versatile plug-and-play platform that enables remote predictive maintenance.
- **UPTIME** is a versatile and interoperable unified predictive maintenance platform for manufacturing industry.

Bearing in mind that **ForeSee** is a predictive maintenance cluster and that some **AI REGIO** partners have actively participated in projects of this cluster, different aspects have been taken into account to continue developing innovations based on that knowledge. AI based applications for PdM can be integrated into the WP4 AI4Manufacturing Toolkit, especially those coming from the new FoF-11 projects.

8.1.2 The EIT MANUFACTURING Initiative

EIT Manufacturing is one of the Knowledge Innovation Communities within the European Institute of Innovation & Technology (EIT) – like EIT Digital – that connects the leading manufacturing actors in Europe. Fuelled by a strong interdisciplinary and trusted community, EIT Manufacturing will add unique value to European products, processes, services – and inspire the creation of globally competitive and sustainable manufacturing.

EIT Manufacturing vision is that the global manufacturing innovation is led by Europe. EIT Manufacturing's approach is designed to immediately and forcefully address specific economic and societal challenges, leveraging opportunities to maximise the impact for a successful European manufacturing[63].

8.1.2.1 The EIT MANUFACTURING Flagships

EIT Manufacturing will use Flagships and Innovation Hotspots to guide its efforts in Innovation, Education, and Business Creation towards high potential innovation and entrepreneurship. Innovation hotspots are the intersection between a current or emerging industry need, and one or more enabling technologies that could help meet this need. Strategic innovation hotspots that have particularly high social, environmental and economic impacts and need a sustained effort to build capacity in Europe, will be designated as Flagships. EIT Manufacturing has selected four initial Flagships:

1) **People and Robots for Sustainable Work** - Industrial robots is a smart enabling technology capable of collaborating and interacting with humans to support us. Collaborative robots will help society to achieve human wellbeing and spectacular manufacturing performance. Effective human-robotic systems have high positive social impact and provide attractive challenges in manufacturing for young people;
2) **Additive Manufacturing for Full Flexibility** - Additive manufacturing of multiple material combinations enable high-value personalised products and advanced servitization. This flagship promotes enabling technologies, e.g. additive manufacturing technology in highly flexible manufacturing systems, radically increasing precision and flexibility, while exponentially reducing time to produce final products. Dynamic value networks providing "supply-and-produce-on-demand" will be developed for new industry sectors. Example enabling technologies are multi-material printing, one-step printed sub-assemblies, and automated surface finishing;

[63] https://eit.europa.eu/sites/default/files/eit_manufacturing_factsheet.pdf

3) **Waste-free Manufacturing for a Circular Economy** - Waste-free manufacturing enables Circular Economy deployment. Deploying new technologies, processes, and digital tools to minimise waste and resource use along entire product lifecycles is crucial for reaching climate goals. Digital twins facilitate eco-design, boosts dematerialisation, and reduces process waste even further. Skills, mind-sets and behaviours must be changed alongside technology to switch to and environmentally sustainable production patterns;
4) **Platforms for Digitalized Value Networks** - Value networks for digitalised manufacturing need strong digital platform bases to enable an efficient digital marketplace, flexibility, and reactivity to market changes for Europe. This flagship will support the use by manufacturers, integrators, and their value chains of digital platforms to create high-value manufacturing value networks for Europe.

These Flagships add value to European manufacturing and address multiple strategic objectives. All flagships involve several programmes that cover a complete range of activities, training and up-skilling, and novel business models. The 2020-2021 EIT MANUFACTURING Innovation Activities will be monitored for synergies, in particular the AI.Sov project about Data Sovereignty for AI innovative applications.

8.1.3 The A.SPIRE and SPIRE-06 call

A.SPIRE[64] is the European Association which is committed to manage and implement the SPIRE Public-Private Partnership. It represents innovative process industries, 20% of the total European manufacturing sector in employment and turnover, and more than 150 industrial and research process stakeholders from over a dozen countries spread throughout Europe. SPIRE brings together cement, ceramics, chemicals, engineering, minerals and ores, non-ferrous metals, steel and water sectors, several being world-leading sectors operating from Europe. The mission of A.SPIRE is to ensure the development of enabling technologies and best practices along all the stages of large scale existing value chain productions that will contribute to a resource efficient process industry.

The following six projects have been funded in SPIRE-06.

CAPRI (https://www.capri-project.com/ Cognitive Automation Platform for European PRocess Industry digital transformation), AI REGIO beneficiaries POLIMI ENG. Innovative cognitive automation for the European process industry. The EU-funded CAPRI project will establish, test and demonstrate an advanced cognitive automation platform (CAP) for process industry digital transformation. The platform will help the sector increase its flexibility of operations and improve performance through different indicators and cutting-edge quality control of products and intermediate flows. The CAP will be modular and scalable, allowing the development and integration of advanced applications that address manufacturing challenges in significant process sectors such as **asphalt, steel-making and pharma**.

COGNITWIN (https://www.sintef.no/projectweb/cognitwin/ Cognitive Plants through Proactive Self-Learning Hybrid Digital Twins), AI REGIO beneficiary NISSATECH. The EU-funded COGNITWIN project will investigate how today's plants can learn from historical data and adapt. It will partner with numerous industries and research groups from around Europe to create a platform that includes a sensor network for monitoring and collecting data from various plant processes. The platform will include IoT, Big Data, AI, smart sensors as well as automatic learning and communication technologies.

COGNIPLANT (https://www.cogniplant-h2020.eu/ Cognitive Platform to Enhance 360° Performance and Sustainability of the European Process Industry). Technological boost for Europe's production process industry. Process industries turn to advanced technology to improve production and quality control and limit unplanned negative occurrences. Advanced data control and analysis combined

[64] https://www.spire2030.eu/spire/the-association

with the Digital Twin concept offer substantial benefits to production plants. The EU-funded COGNIPLANT project will supply plants with a ranked supervisory control solution that offers an inclusive observation of the production process and its energy and resource needs. The project will be performed by four SPIRE industries. A chemical plant in Austria, an aluminium refinery in Ireland, a concrete production plant in Italy and a metal manufacturer in Spain. COGNIPLANT will increase operation performance, boost quality control of the final products, speed up response time to unplanned incidents and reduce CO2 emissions.

FACTLOG (https://www.factlog.eu/ Energy-aware Factory Analytics for Process Industries). Digital twins are a virtual simulation of real-world objects. One of the main expectations of the use of digital twins is to provide the capability to observe and monitor the behaviour of their respective physical twins. The EU-funded FACTLOG project will develop a real-time processing layer where observations, knowledge and experience interoperate to understand the control behaviour of a complex system (cognition). It will enable the realisation of the **cognitive factory** as an ensemble of independent but intertwined European Credit Transfer (ETC) systems that can self-learn and detect and react to anomalies and disruptions. The 20-member consortium will bring related knowledge and innovation, organising different pipelines of machine learning and analytical tools.

HyperCOG (https://www.hypercog.eu/ Hyperconnected Architecture for High Cognitive Production Plants). A digital boost for cognitive manufacturing. Increasing production and decreasing environmental damages is a key target in the digital transformation of production plants. The EU-funded HyperCOG project proposes an advanced industrial cyber-physical system (ICPS) that will increase production performance, limit emissions and energy consumption, and offer lifelong training in digitalisation for workers. The system is built on technological advances accessible in the market. It offers a hyper-connected network of digital nodes that can receive considerable streams of data in real-time. As a result, it can supply industrial plants with awareness and cognitive reason. The impacts of the system on productivity and environment will be verified on three use cases included in the SPIRE scope – in the steel-making, cement and chemical sectors.

INEVITABLE (http://inevitable-project.eu/ Optimization and performance improving in metal industry by digital technologies). Manufacturing looks to smart monitoring technologies. Producing metals has always been at the heart of civilisation – right from the Bronze Age and Iron Age, this transformation continues. Today, digitalisation presents remarkable opportunities for how steel and other non-ferrous metals are produced. The EU-funded INEVITABLE project is looking into the future. The aim of this project is to optimise manufacturing processes by fully digitalising monitoring technology. Real-time machining process control at shop floor can significantly improve machining efficiency and the quality of finished parts. It will also reduce resource consumption and CO2 emissions for a more competitive and sustainable metallurgic industry.

AI REGIO will set up collaborations with SPIRE-06 projects about cognitive technologies and solutions, leveraging on common beneficiaries with CAPRI and COGNITWIN projects

8.2 Partnerships and Associations in Digital Technologies

Regarding Digital Technologies partnerships and associations, we believe that the AI4EU platform (§8.2.1), the BDVA Partnership and its evolution to AI, Data, Robotics Partnership (§8.2.2), the AIOTI alliance and its Smart Manufacturing WG11 (§8.2.3) and the IDSA association (§8.2.4) should be considered as a priority for AI REGIO. AI, Big Data, Industrial IoT and Data Spaces communities will be our four privileged dissemination targets in the Digital Technologies domain.

8.2.1 The AI4AU AI-on demand Platform

Artificial Intelligence is a disruptive technology of our times with expected impacts rivalling those of electricity or printing. Resources for innovation are currently dominated by giant tech companies in North America and China.

To ensure European independence and leadership, we must invest wisely by bundling, connecting and opening our AI resources, **AI4EU will efficiently build a comprehensive European AI-on-demand platform** to lower barriers to innovation, to boost technology transfer and catalyse the growth of start-ups and SMEs in all sectors through **Open calls** and other actions.

The platform will act as a broker, developer and one-stop shop providing and showcasing services, expertise, algorithms, software frameworks, development tools, components, modules, data, computing resources, prototyping functions and access to funding. Training will enable different user communities (engineers, civic leaders, etc.) to obtain skills and certifications.

The AI4EU Platform will establish a world reference, built upon and interoperable with existing AI and data components (e.g. the Acumos open-source framework, QWT search engine) and platforms. It will mobilize the whole European AI ecosystem and already unites 80 partners in 21 countries including researchers, innovators and related talents.

Eight industry-driven AI pilots will demonstrate the value of the platform as an innovation tool. In order to enhance the platform, research on five key interconnected AI scientific areas will be carried out using platform technologies and results will be implemented. The pilots and research will showcase how AI4EU can stimulate scientific discovery and technological innovation.

The AI4EU Ethical Observatory will be established to ensure the respect of human centred AI values and European regulations. Sustainability will be ensured via the creation of the AI4EU Foundation. The results will feed a new and comprehensive Strategic Research Innovation Agenda for Europe.

AI REGIO, under the coordination of CARTIF (AI4EU beneficiary) is organising a set of Ambassadors to oversee the various AI4EU activities and task forces. In particular, we are interested at developing an "AI for Manufacturing" section of the platform, leveraging on the current Industry vertical and extending it with AI REGIO services and assets.

8.2.2 The BDVA PPP in H2020 2018-2020

The **Big Data Value Association** (BDVA), is an industry-led organization representing large businesses, small and medium-sized enterprises (SMEs), and research organizations in Europe. It represents the private part in the contractual Public Private Partnership (cPPP) on Big Data Value with the European Commission, that represents the public side. The overall goals, main technical and non-technical priorities, and a research and innovation roadmap for the BDV PPP is represented by the Strategic Research and Innovation Agenda (SRIA)[65] defiled over the last years and published by the BDVA.

The availability of powerful data analytics techniques and tools has enabled a massive improvement in the availability of raw data, on one side, and has intensified, in general, all the activities around the Big Data aspects and related Value.

Looking at the EU data market, over the period 2016–2020, the International Data Corporation (IDC)[66] estimated a compound annual growth rate (CAGR) up to 15.7% for the EU data market, considering the most favourable scenario. In other words, the size of the data market in Europe is estimated to double (and even more) by 2020 reaching a total amount of 107 billion EUR.

[65] http://bdva.eu/sites/default/files/BDVA_SRIA_v4_Ed1.1.pdf

[66] http://datalandscape.eu/study-reports

It is worth to note how the BDV PPP is also aligned with the Digital Single Market Strategy, promoted by the European Commission, especially in the specific pillar about "**Developing the European Data Economy**". The DSM Strategy, in order to manage the digital transformation of our economy (and society) has identified four main dimensions to focus on: Digital skills; Start-ups and the digitization of all industry and service sectors; Digital innovation for modernising public services; Stepping up investments in digital technologies and infrastructures.

8.2.2.1 The SMI Working Group and its 2020 White Paper

In the context of the Big Data Value Association, the working group on Smart Manufacturing Industry (SMI) is analysing the digital transformation of the Manufacturing domain that, the increasing adoption of Big Data, is producing.

In a structured approach, the SMI group is analysing the Smart Manufacturing Industry along three main dimensions (also referenced as Grand Scenarios) where Big Data applications have their main focus in a B2B model.

1. **Smart Factory**: Applications for better information within the factory. In the Smart Factory, data is generated inside the production lines and (both batch and real time) data analytics (safety, optimization and diagnosis) is needed for the plant and for the (blue collar) workers.

2. **Smart Supply Chain**: Applications to connect suppliers and producers in the manufacturing value chain. In the Smart Supply Chain, data is generated by subjects such as suppliers, providers, distributors and retailers while data analytics are designed, for example, for logistics optimization, closed loop manufacturing collaborations among engineers and managers.

3. **Smart Product Lifecycle**: Applications producing product or service related data. In the Smart Product Lifecycle, data is directly generated by the product (or the service) throughout its lifecycle. Product data collected and analysed in this way, is relevant for new product design, condition monitoring, preventive and predictive maintenance as well as for re-use and re-cycling purposes as in a circular economy perspective. The Smart Manufacturing Industry group published two papers. The first one (2018) is mostly focused on Big Data technical challenges and in the alignment with the Factories of the Future (EFFRA) community. The second one (2020) extended the scope complementing the technical challenges with non-technical ones and including perspectives from other research and innovation communities (euRobotics, IDSA, AIOTI).

Starting from the technical priorities identified in the first version of the paper (56 in total), the second version presented a consolidation of them, still grouped by grand scenario. Those aspects more relevant to be addressed in the Smart Factory scenario are represented by *Data Integration* (companies still have issues in extracting data from internal silos); *Secure Data Analytics* (derived from the distributed nature of the computational systems, from the edge to the cloud); *AI and Knowledge extraction* together with *Analytical Infrastructure* (strictly related to the secure data analytics challenge) and *Natural Language Interaction* (due to the increasing human-machine relation that can be established in a manufacturing workplace).

For what regards the Smart Product Lifecycle scenario, the most relevant challenges are:

- *Product, Data and Service Interoperability*, to enable the servitization trend;
- *Secure Product Data Processing Architectures*, to enable the data integration among different stakeholders and systems, all part of a complex long-living product;
- *Product Lifecycle Data Models* and *Asset Administration Shells*, as digital transformation instruments;
- *Personal and Product Digital Twins*, for digital modelling integration between Products/Services and Humans in view of new ways of collaboration inspired by Artificial Intelligence.

Finally, for the Smart Supply Chain scenario, the identified challenges are:

- *Vertical Data Integration*, as accessing to data produced by different and distributed actors, in the supply chain, is the very first step to achieve;
- *Traceable and Trusted supply chain*, as a direct consequence of the first integration step;
- *AI-driven Models*: the use of AI to improve the forecasting processes, self-optimization.

Looking at the non-technical priorities, the paper presents how EU legislation, principles and values have to drive Data Technologies for the Smart Manufacturing Industry for a proper compliance alignment, for example considering a human-centric approach and "ecosystem of excellence", together with "ecosystem of trust" as EU objectives to achieve. From the business perspective, the two main points are represented by the successful growing of servitization and the new market opportunity represented by the Data (Platform) Economy.

Given the increasing interest on the benefits enabled by the data economy, it is expected that the manufacturing companies (and the B2B in general) will invest more in the exploitation of new business model based on data assets. The third non-technical priority is represented by the need of properly skilled and trained people that work in the manufacturing value chain. This can be achieved by creating EU international degrees and masters as part of a European competence framework in big data and artificial intelligence topics, together with training-on-the-job programmes supported by a multi stallholders (industry-research-education-government) collaboration.

The SMI working group is led by ENG and POLIMI and its evolution towards the AI Partnership will bring more value to a collaboration with AI REGIO.

8.2.3 AIOTI WG11 Sustainable Manufacturing

AIOTI **Working Group 11** 'Smart Manufacturing' main focus has been the application of the Industrial Internet-of-Things for Smart Manufacturing, addressing both discrete and process industrial interests. The Industrial Internet-of-Things (IIoT) denotes to the industrial subset of the Internet-of-Things; it refers to interconnected sensors, actuators, instruments, and other devices networked together with computers' industrial applications (Wikipedia contributors, 2020).

Such infrastructure allows for data collection, exchange, and analysis, enabling the generation of insights that facilitate improvements in productivity, efficiency, quality, safety and much more.

These days, **Artificial Intelligence** (AI) is the most disruptive digital enabler of the Industry4.0 era. AI's innovation potential is currently propelled by advances in parallel hardware and scalable software systems which have enabled the development of advanced machine learning frameworks and novel algorithms that are suitable for large scale problems in realistic settings. In the manufacturing sector, advanced AI technologies enable solutions to large scale optimisation and control problems. Applications areas include: Prescriptive Maintenance, Predictive Quality Management, Smart/Autonomous Control, Smart Robotics, Human-Robot collaboration, Smart Logistics Management, Agile Production, Generative Product Design, Zero-Defect Manufacturing, etc.

As such, the AIOTI Working Group 11 is working to contribute to merging the Industrial Internet-of-Things with Artificial Intelligence – the so-called **Artificial Intelligence of Industrial Things (AIIoT)** – in a safe, trusted and effective manner to enable further outstanding transformational possibilities in manufacturing. Ensuring the safety and reliability of AIIoT systems is key for deploying them at scale and for fully leveraging the benefits of AI in manufacturing. One can think of the IoT as the digital nervous system while Artificial Intelligence is the brain of a system (Marr, 2019). In a like manner, the Artificial Intelligence of Industrial Things connotes the join of Artificial Intelligence with the Industrial Internet-of-Things to create a truly cognitive system that enables further outstanding transformational possibilities in industry.

UNPARALLEL Innovation (AI REGIO partner) is leading the AIOTI Working Group 11 linking to the developments of the AI REGIO project particularly in respect to IIoT & AIIoT cases and solutions for quality management and zero-defect manufacturing.

8.2.4 IDSA International Data Spaces Association

International Data Spaces e. V. (IDSA) is an international association under German law with legal seat in Berlin, German, and its head office in Dortmund, Germany. The IDSA pools the requirements on International Data Spaces (IDS), organizes the knowledge exchange between research and business and develops guidelines for the certification, standardization and utilization of the results emerging from the different IDS related research projects on European and national level.

IDS enables a reliable exchange of data with common rules for all companies – based on an open reference model. With the establishment of the IDSA, business and industry take an active part in designing the architecture of the IDS. Currently the IDSA has round about 115 members who shape the data sovereignty topic and bring the results to standardisation organisations.

The German DIN SPEC 27070 is already published and details IIoT security requirements and offers a reference architecture for secure gateways for the exchange of industry data and services. International standards are in preparation.

Research projects like AI REGIO help the IDSA to check existing and collect new requirements. Furthermore, reference implementations of IDS based components with intense feedback loops between the project and the working group "Architecture" and "Certification" of the IDSA help to increase the maturity and therefore the TRL of IDS components.

Furthermore, IDSA community for industry partners (IDS-I) was launched just recently. This community is a great interface between IDSA members' companies from industry, since the community's mission aims at collecting and refining requirements from the industry domain.

Thanks to liaisons with international organisations, IDSA is in frequent contact with a whole variety of companies and institutions with different backgrounds. Amongst these liaisons there are often representatives from the manufacturing industry that are also interested in solutions like developed in AI REGIO.

The IDSA has liaisons with iSHARE, Robot Revolution & Industrial IoT Initiative (RRI), Industrial Value Chain Initiative (IVI), Big Data Value Association (BDVA), Plattform Industrie 4.0, Data Market Austria, Industrial Internet Consortium (IIC), OCEAN, FIWARE, OPC Foundation.

The so-called IDS Launching Coalition, which is coordinated by the IDSA aims at bringing IDS based products to the market until November 2020. The already developed standards, proofs of concept and MVPs are taken one step further by members of the IDSA and will lead to competitive offerings at the market for all kinds of industries. Partners from IDSA's research projects can take this as motivation for their very own pilot implementations and use experiences gained in the Launching Coalition to their advantage.

In order to disseminate results from projects IDSA is organising two large events annually – the IDSA Summit in Summer and the IDSA Winterdays at the end of each year. These events are ideal networking events to foster the exchange of experience between research and industry. Both events attract more than 400 participants every year.

Due to COVID-19 live events and other activities that require personal attendance are paused and IDSA is organising a row of digital formats for different purposes. A virtual booth was created, that was the ideal platform for IDSA members, IDS based use cases and research projects with IDSA involved to present their work. This virtual booth was followed by a row of virtual live sessions and expert talks. All our members and research projects are invited to contribute and use these events to create attraction and inform the broader public.

AI REGIO sees IDSA as a privileged partner for its dissemination and exploitation activities.

8.3 Collaboration Action Plan with Manufacturing and AI Partnerships

The AI REGIO contribution to the Manufacturing and AI Partnerships and Associations is mostly implemented in WP7 and WP8. This concerns the dissemination and exploitation of AI REGIO outcomes to both the communities and in particular to EFFRA, BDVA and the new DAIRO partnership, AIOTI and AI4EU.

Collaboration Item	Action Plan
Joint Dissemination	YES through the EFFRA Innovation Portal and the AI Partnership
Synergies with Projects	YES identification of DIHs inside the Manufacturing and AI communities
Link to innovation networks	YES through the CF2 and OPEN DEI CSA
Common Marketplace	YES through DIH4INDUSTRY (Digital Accelerator)
Cluster Meetings	NO no specific cluster meetings here
Mentoring Activities	YES synergies with the Manufacturing and AI training initiatives
Digital Innovation Hub Catalogue	YES specifically for DIH4INDUSTRY

9 Conclusions and Future Outlook

The present deliverable D8.1 has described the initial AI REGIO collaboration plan with seven main communities relevant for our mission and objectives:

I. In the **I4MS program**, AI REGIO is one of the Phase IV Innovation Action. The Phase III MIDIH project represents the ancestor of AI REGIO under three main viewpoints: the methods and tools for DIH management; the ICT Platform (DIHIWARE) for Innovation and Collaboration inside and between DIHs; the CPS/IoT Open Source Platform and its two implementation lanes (FIWARE and APACHE). In the I4MS Phase IV, AI REGIO expects to set-up close collaborations with KITT4SME and DIH-WORLD Innovation Actions. The I4MS4Ts CSA will support collaboration opportunities form other Phase IV projects as well.

II. In the **Support to Hub priority**, AI REGIO has identified strong opportunities of collaboration with those DIHs focussing on Manufacturing industry: some in Smart Anything Everywhere, some in Robotics domains. The relevant S4E and RODIN CSAs will facilitate this task, while the DIH4INDUSTRY platform will be the Innovation and Collaboration place for all DIHs focussing on Manufacturing. The DIHNET.eu CSA will support collaboration opportunities form other DIH projects as well, also in other but related domains, such as energy, agrifood and healthcare.

III. Other **DIH communities in the AI and Manufacturing** domains will be sought for collaboration. In particular, the Vanguard Initiative and its Efficient and Sustainable Manufacturing pilot is a community at the basis of AI REGIO; the AI DIH Network project and its mentoring and coaching program paved the way for DIH-DIH collaboration; the DIH4AI platform (based on DIHIWARE) will support an interoperability framework with AI4EU and its services.

IV. In the context of the next **EC MFF Multiannual Financial Framework**, AI REGIO will seek collaboration opportunities both in the Digital Europe and Horizon Europe programmes, by leveraging on its exploitable assets and unique value proposition. In the DEP, AI REGIO will contribute to the EDIH, Data Spaces for Manufacturing and ai TEF for Manufacturing topics. In the HEP, privileged dissemination channels will be open to "AI for sustainable manufacturing" and I4MS second generation for manufacturing sustainability in SMEs.

V. In the **Digital Manufacturing Platform** cluster, AI REGIO will participate to the working groups extended meetings (especially WG1 standardisation and WG3 impact) related to the "AI for Manufacturing" domain: reference architectures, open source implementations and standards. Collaboration with CF CSA will be sought regarding the mapping of AI REGIO cases to the three CF1 pathways and the new CF2 ones, especially the one about Data Spaces. Cross-domain interactions with agrifood, health & care, energy sectors will be implemented in the OPEN DEI CSA environment and through the activities of its TF1 about Design Principles of Data Spaces.

VI. In the **AI for Manufacturing** ICT-38 projects, AI REGIO will look for new innovative tools and solutions to potentiate and extend its AI4Manufacturing toolkit of WP4. In particular, XMANAI (coordinated by TXT) will support explainability of AI decisions, while COALA will provide advanced human-machine interaction and chatbots capabilities.

VII. In **Manufacturing and AI Partnerships and Associations**, AI REGIO will look for interesting collaborations regarding AI solutions entangled with other advanced manufacturing technologies (such as Additive Manufacturing, new Materials and Nanotechnologies) supporting different industrial sectors (such as Process and Mining industries) through liaisons with EFFRA, EIT MAN and A.SPIRE. In the domain of Digital Technologies, AI REGIO will be interconnected with the AI4EU, BDVA, AIOTI and IDSA communities as well.

For each and every community indicated above, AI REGIO D8.1 has depicted a collaboration table to be implemented along WP8 and reported in its following deliverables D8.x about communication and dissemination actions. A synthesis of such collaborations is depicted in the Executive Summary of this deliverable.