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Digital Factory Alliance:
Transforming Manufacturing Together

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Foreword

BREAK | CONNECT | INTEGRATE

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There is a widespread acceptance that AI will have a transformative impact on all economic sectors and on the United Nations Sustainable Development Goals. The AI impact will be driven by:

1. Productivity gains from manufacturing automating processes.
2. Productivity gains from manufacturing augmenting existing labour force with human-centred AI technologies (assisted and augmented intelligence).
3. Increased consumer demand resulting from the availability of personalised and/or higher-quality AI-enhanced products and services.

In 2018, under the Boost 4.0 initiative, a number of digital and manufacturing leaders, as well as key European associations, machine builders and top research centers joined forces with the ambition to define and develop highly replicable big data solutions to address the ***Zero-X Manufacturing Excellence Challenge***; - a digital factory 4.0 that is capable of manufacturing process optimisation through holistic and widespread use of data and AI to drive design, service and operations towards manufacturing excellence in terms of zero time to market, zero errors, zero accidents, zero incidents, zero defects, zero waste, zero supply chain breaks, zero unplanned breakdowns or zero net energy operations. In this context, these industrial and digital companies were confronted with 3 main barriers to unveil the promised economic and societal potential of human-centred AI manufacturing; namely:

1. **Breaking** the manufacturing data silos
2. **Connecting** with sovereignty and trust the industrial data end-points along the digital thread.
3. **Integrating** seamlessly data pipelines, digital manufacturing platforms & services for digital twin operation across the product and process lifecycle

Addressing these 3 barriers from a value driven perspective has resulted, in significant factory internal data-driven transformations. On the other hand, it has resulted in notable foundational achievements to establish embryonic cross-factory and supply chain data-driven disruptions.

In 2019, this effort to address the Zero-X Manufacturing Excellence Challenge from a data-driven perspective, was seconded and augmented by a second lighthouse initiative, Qu4lity, with the ambition to enable the so called "digital continuity" to unveil the power of zero defect manufacturing autonomy and enable innovative processes.

It is in 2021 that we now hold compelling evidence that such data-driven transformation of our factories can in fact be achieved with significant benefits under realistic, measurable, and replicable conditions based on open, certifiable and highly standardised and transformative shared Factory 4.0 models and exploiting trusted digital infrastructures.

The methods, knowledge, digital products and industrial transformations achieved deserve to be sustained, enlarged and leveraged beyond the duration and the scope of the particular initiatives that saw them being realized in the first place. A group of companies, with the support of the European Commission, decided to take the initiative to set the Digital Factory Alliance (DFA).

The DFA is born as an international community with the mission to bring the remarkable results achieved so far in the realm of data-driven digital factory transformation further by means of:

1. creating reference bodies of knowledge that empower the manufacturing industry with the knowledge to address the Zero-X Manufacturing Excellence Challenge,
2. fostering trusted data-driven digital manufacturing product and platform integration,
3. facilitate building together new business opportunities increasing the base of industrial companies that can benefit from the emerging digital solutions and platforms; and
4. further motivate the overall community to become early adopters of data-driven AI-powered digital technologies to leverage industrial competitive advantages; and doing so on the basis of European digital, industrial and societal values.

Let´s welcome the DFA.

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Digital Factory Alliance (DFA)

Transforming Manufacturing Together

Carmen Polcaro
DFA Steering Board
Innovalia Association

The Digital Factory Alliance (DFA) is an international trusted community for digital factories stakeholders to foster knowledge sharing and industrial collaboration to achieve data-driven digital transformation.

GIVE | TAKE | MULTIPLY

Over the last few years, many factories have individually undertaken or are going through an Industry 4.0 pilot purgatory. Industry is slowly and painfully learning that Industrial Internet, AI and big data can bring business value to factory operations. However, the replication of such pilots to other factories is still a very limited; complex, time consuming and expensive process.

In 2021, three companies Innovalia, AtoS Research and Innovation and Engineering Ingegneria Informatica S.p.A encouraged by the European Commission decided to set the Digital Factory Alliance, building on best practices and lessons learned during the implementation of two of the largest European partnerships set by digital and manufacturing lighthouse industries to trial at scale big data-driven solutions for Industry 4.0 process optimisation (Boost 4.0, Qu4lity).

Progressing faster through the pilot 4.0 purgatory with better pilot replicability

These two lighthouse initiatives evidenced that Industry 4.0 lacks from a common global knowledge platform that facilitates the community to learn from and with the best; accelerating digital transformation leverage.

In fact, excellence in data driven factory transformation is not a simple digital technology procurement exercise. Excellence in data-driven transformation demands access to an open community where factories, manufacturing and digital industries can see and can be seen, where they get to know and are known. Manufacturing industry cannot afford that most significant digital capabilities and product pass unattended. Still for manufacturing industry remains difficult (cumbersome and time consuming) to find common frameworks that support them in identifying the value provided and replicability of such innovations and digital transformation in their specific factory and manufacturing contexts and value chains.

Through adoption of shared models and pilot 4.0 practices, in the medium and long-term, individual piloting activities will result in collective benefits such as better alignment between digital infrastructures and digital manufacturing platforms, more cost-effective system and factory integration and a much larger economies of scale for big data powered and AI-driven manufacturing 4.0 processes implementation.

Collective shared value generation for individual shorter times to profit

The DFA mission is to take care that such community is nurtured, that such common foundations for data-driven factory transformations are set, shared and maintained and that successful big data driven pilots can leverage higher profits to industry in much shorter time scales.

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Individual factories can achieve their pilot goals faster building upon and adopting DFA best practices and principles. At the same time, their success contributes to the DFA collective knowledge to shape better digital infrastructures and platforms for sustained shorter times to market, increased revenues and profit.

DFA acknowledges *"by design"* the individuality of each factory and the need to develop unique competitive advantages. Yet, also recognizes the need to profit globally from data-driven transformations faster and at lower costs. This implies that factories should not work alone. Precisely, DFA firmly believes on the need of such individuality to define a set of shared principles that can leverage excellence in data-driven transformation, faster digital value leverage and a successful implementation of resilient and sustainable global production value chains.

Transforming Manufacturing Together: Addressing the Zero-X Manufacturing Excellence Challenge

The DFA foundations are set to address the need to accelerate the implementation of a data-driven digital transformation and modernization of manufacturing factories and supply chains to cost-effectively realize Zero-X manufacturing processes. The DFA is born to put digital solutions to work for advanced Zero-X manufacturing processes. No matter which process is addressed. The DFA model should facilitate gradual digital solution adoption. Thus, industry can freely and reliably continue evolving, enhancing and scaling their engineering, manufacturing and servicing strategies at the pace of their business's needs. The DFA activities are based on 4 pillars:

- Promotion the development of **Lighthouse Initiatives** of collective manufacturing interest to be the first to **try** and **transform**.
- Access to a **Body of Knowledge (BoK)** for DFA members (large industries and SMEs) to be the first to **know** and realize with excellence digital Zero-X manufacturing processes.
- Cultivate a **Business Network** for business development and access to certified interoperable digital products and platforms. DFA members are the first to **profit** from cost effective and future proof digital solution **adoption** by the partners they trust.
- Steer an **Innovation Campus** through collaboration with best of breed digital and advanced manufacturing hubs and innovation and sectorial associations. The goal is for DFA members to be the first to be **inspired** for early adoption of digital solutions and incubation of manufacturing innovation initiatives.

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DFA Lighthouse Initiatives

SEE | PARTCIPATE | TRANSFORM

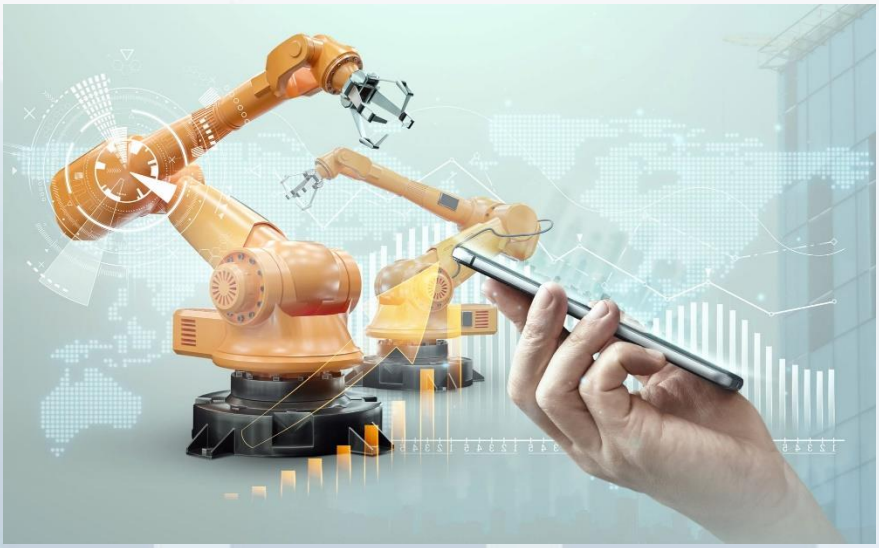
Stefano Ierace
Chief Operating Officer
Consorzio Intellimech

The Digital Factory Alliance Lighthouse Initiatives are initiatives that are of common interest to the DFA industrial and digital community. The DFA Lighthouse Initiatives in collaboration with key European and National networks address specific challenges, e.g., manufacturing excellence, manufacturing resilience that are of high impact to manufacturing industry competitiveness.

The DFA Lighthouse Initiatives bring together the most relevant factories (large industries and SMEs) with the most compelling pilots and large scale trials under a common model of representation. The Lighthouse initiatives allow for fast assessment and understanding of the pilot context, achievements, relevance and replication potential by other DFA members and general industry at large.
The DFA has already set 3 Lighthouse Initiatives:

1. Zero-X Manufacturing Excellence Challenge
2. Manufacturing Global Response Challenge
3. Network of Lighthouse Factories

The goal of the DFA lighthouse initiatives is to provide equal visibility of advanced manufacturing capabilities of leading industrial stakeholders as well as to the digital manufacturing leaders and service providers and the digital products empowering factories 4.0 with such advanced capabilities.



DFA Body of Knowledge (BoK)

LEARN | APPLY | LEAD

Prof. Dimitris Kiritsis
ICT for Sustainable Manufacturing.
École Polytechnique Fédérale de Lausanne, Lausanne (EPFL)

In the post-pandemic era, the manufacturing industry is changing, and so is the way we organize our companies. We're in the middle of another industrial revolution. Industry 4.0 is making the world of manufacturing more global, faster, more digital, and more connected at an unprecedented rate. Digital manufacturing is also enabling more trustworthiness and more inclusiveness through trusted data and knowledge sharing, as companies are seeking to satisfy and increase the well-being of their stakeholders as well as the interests of their shareholders.
But this isn't the first time that we've changed the way we work on the shop floor, and it certainly won't be the last. The DFA Body of Knowledge (BoK) goal is to democratise access to that practical knowledge that can represent the most for the digital transformation of manufacturing companies to effectively address sustainability, resiliency and Zero-X manufacturing challenges they face: zero-emissions, zero-waste, zero-defects, zero-breakdowns, zero-accidents, ...

The DFA BoK spans a focused set of activities, generates reference guidelines, allows interactive pilot knowledge navigation and connects the DFA community with the most suitable vocational and formal learning and training platforms; as well as with the cutting-edge industrial associations and knowledge and innovation communities, so the DFA community remains competitive at large.

The DFA BoK addresses 2 main areas of knowledge and leadership in data-driven digital transformation with a focus on needs from manufacturing businesses in general but particularly small and medium enterprises:

- 4Resilience
- 4Excellence

The goal is to be better prepared as a community to provide a global response to future manufacturing challenges, industrial value chain disruptions and outbreaks in increasingly connected global manufacturing networks while preserving and improving the well-being of all involved stakeholders.

DFA Business Network

NETWORK | PARTNER | GROW

Cosmas Vamvalis
Managing Director
Atlantis Engineering

With digital transformation of manufacturing industry, we are witnessing an exploitation of the digital product offer present in many marketplaces. Such offer could become sometimes overwhelming for manufacturing industry. Moreover, the integration of such products is increasingly complex, time consuming and expensive for the customer impacting negatively on the digital transformation experience and digital market growth.

The DFA Business Network goal is precisely to address such product/service integration inefficiencies to grow the market facilitating:

- **Networking** and access to a community of **business partners**, which sharing a common model
- **Certified product integrations** with well-established standards and open APIs based on the DFA reference digital service/product integration models.
- **A meta-marketplace for DFA products/services** that can be deployed under the DFA digital service integration model.
- **Business opportunities** for digital **product and service;** e.g., digital integrated offers and presence in markets through partnerships and joint agreements.
- **Business development** activities to enable collaboration with DFA business network partners for expansion, establishment and operation of digital products and services in international markets

The DFA Business Network will allow your digital product to become immediately visible to the digital factory community. The Business Network will allow your company to develop your digital business through partnerships and collaboration to enrich and enlarge your business offer.

The DFA Business Network will provide your digital factory with access to a set of integrated solutions ready to be tailored to meet your specific Zero-X manufacturing challenge. Increase the value of your digital investments and modernize your factory with shorter times for your Return of Investment (ROI).

DFA Innovation Campus

INSPIRE | CREATE | INNOVATE

Silvia de la Maza
Chief Innovation Officer
Innovalia Association

The best way to predict the future is to create it. The DFA Innovation Campus is designed for those companies that need to be part of the transformation and cannot stand to be mere spectators of the digital revolution.

The DFA innovation campus offers a number of activities to empower and prepare digital and manufacturing industries for engagement in current and future digital value chains. The DFA Innovation Campus goal is precisely to facilitate motivate, steer and drive the DFA partners to make sure that their innovation activities make a difference, to them and to the sector.

The DFA Innovation Campus provides access to an Innovation Catalogue and the resources facilitated by the European Factories of the Future Research Association to inspire DFA partners into the implementation of new digital solutions and services. Equally, the DFA Innovation Campus also provides support in the realization of each digital business. For the DFA there is no small digital dream for your factory or product. The connects the DFA partners with a selected network of Experimental Factories and Digital Innovation Hubs that to enable comprehensive technical and business experimentation of digital solutions to address the specific Zero-X manufacturing challenge or need.

The DFA Innovation Campus as an open innovation ecosystem provides partners with visibility of current and emerging digital value chains trends and innovations. How will circularity, autonomy, sustainability influence the value chains in the different sectors? The DFA Innovation Campus facilitates a platform to engage with sectorial and cross-sectorial communities in an active dialogue to shape such value chains or simply to benefit from its outcomes.

Become part of the digital future and be prepared to make the most profit out of it.

Up to the Zero-X Excellence Manufacturing Challenge

Thanasis Poulakidas
Senior R&I Manager
Intrasoft International

Angelo Marguglio
Head of Smart Industry and Agrifood" Unit.
Engineering Ingegneria Informatica S.p.A

Over the last few years, the potential impact of IIoT, big data and AI for manufacturing industry has received enormous attention. However, although digital technologies have become a trend in the context of manufacturing evolution, there is not yet sufficient evidence on how and if they will leverage such impact in practical terms. New concepts in the area of Industry 4.0 such as digital twins, digital threads, augmented decision support dashboards and systems, simulation-based commissioning system rely significantly on advanced engineering and operation of AI and big data techniques and technical enablers. The emergence of data-driven techniques to increase data visibility, analytics, prediction and autonomy has been immense. However, those techniques have been developed in many cases as individual efforts, without the availability of an overarching framework making the transfer of such applications to other industries at scale cumbersome. Moreover, the development of such big data applications is not necessarily realised in context with reference architectures such as the European Reference Architectural Model Industry 4.0 (RAMI 4.0), which serves as reference in the sector for Industry 4.0 digital transformation. Big data promise to impact industry 4.0 processes at all stages of the product life-cycle.

The DFA provides a unified reference model to address the Zero-X manufacturing challenge and to accelerate the adoption of industry 4.0 big data powered and AI-driven intensive smart manufacturing services through highly replicable lighthouse activities that are intimately connected to current and future Industry 4.0 investments, resolving the smart connected product and process data fragmentation and leveraging the Factory 4.0 data value chain. To facilitate the replicability of the Zero-X manufacturing lighthouse trials and big data powered AI-driven solutions piloted, the DFA relies on the alignment and harmonisation of three reference models:

- **A Big Data Pipeline RA.** The DFA model is fully aligned with ISO 20547 to drive Industry 4.0 big data pipeline and process engineering and operation. The goal is to ensure universality and transferability of trial results and big data technologies as well as economies of scales for big data platform and technology providers across sectors.

- **A Manufacturing Data Space RA.** The DFA model adopts the DIN27070 International Data Spaces Association (IDSA) Reference Architecture, which has been recently adopted by Gaia-X Federated European Industrial Data Cloud RA. DIN27070 is compatible with Hyperledger distributed ledger RA and SOLID. The goal is to ensure sovereignty and trust in manufacturing data sharing spaces and connected digital value chain processes.

- **A Manufacturing 4.0 Digital Service Integration RA.** The DFA model applies a Digital Service Integration Reference Architecture (DSI-RA) fully compliant RAMI 4.0 and IIRA. The goal is to ensure a perfect alignment between big data processes, platforms and technologies with overall digital transformation and intelligent automation efforts in Zero Factories and connected supply manufacturing networks.

Incubating Growth with Open Source and APIs

Chief Technology Officer (CTO)
FIWARE Foundation

The use of data has become essential for decision-making and the automation of processes across both the public and private sectors. Data sharing is becoming increasingly important and offers numerous benefits, helping SMEs all over Europe to save valuable time and money as well as engaging in development of innovative services with other players.

FIWARE drives the definition and encourages the adoption of open standards — implemented using Open-Source technologies and smart data models — that ease the development of smart solutions across multiple domains. The FIWARE Context Broker, as integral part of the FIWARE EIDS CIM REST Connector, supports effective data exchange among parties by using the standard NGSI-LD API. With our contribution to the Boost4.0 project we aim to break down 'data silos' through the sharing, re-use and trading of interoperable data assets, boosting the creation of innovative services in different sectors.

We plan to incorporate the FIWARE EIDS CIM REST Connector as an incubated FIWARE Generic Enabler and explore its adoption by the wider FIWARE Community and Ecosystem. As such, it would become a part of the security chapter of the FIWARE Catalogue of Open-Source software components so it can be optionally included as component in the various domain specific reference architectures to support trusted exchange of data between different organizations.

Due to its alignment with IDS specifications, it would help to strengthen the position of smart platform/solutions "powered by FIWARE" in the context of coming IDSA and GAIA-X scenarios.

Thanks to the new B2B European Industrial Data Space and data sharing ecosystems, SMEs will work more efficiently and cost-effectively as well as collaborate with other parties to build innovative services around data value chains. This will improve the competitiveness of Industry 4.0 and will pave the way for a sovereign data economy in Europe and globally.

Breaking the Data Silos: Big Data Reference Architecture

Thanasis Poulakidas
Senior R&I Manager
Intrasoft International

One of the main challenges Industry 4.0 faces when designing their big data solutions, is to effectively address the design & development of high-performance big data pipelines for advanced data management, analytics and visualization. Then, the challenge lies on how to successfully integrate such big data pipelines in the digital factory engineering & production frameworks.

The DFA-adopted Big Data Reference Architecture is composed of 4 main layers:

1. Integration Layer, which facilitates management of data sources, infrastructure and data ingestion
2. Information and Core Big Data Layer, which include the main big data management, processing, analytics and visualization components,
3. Application Layer, where the functionality of lower layers is exposed through services with appropriate application logic that supports specific business functionalities,
4. Business Layer, which composes the application services to form the overall manufacturing business solution.

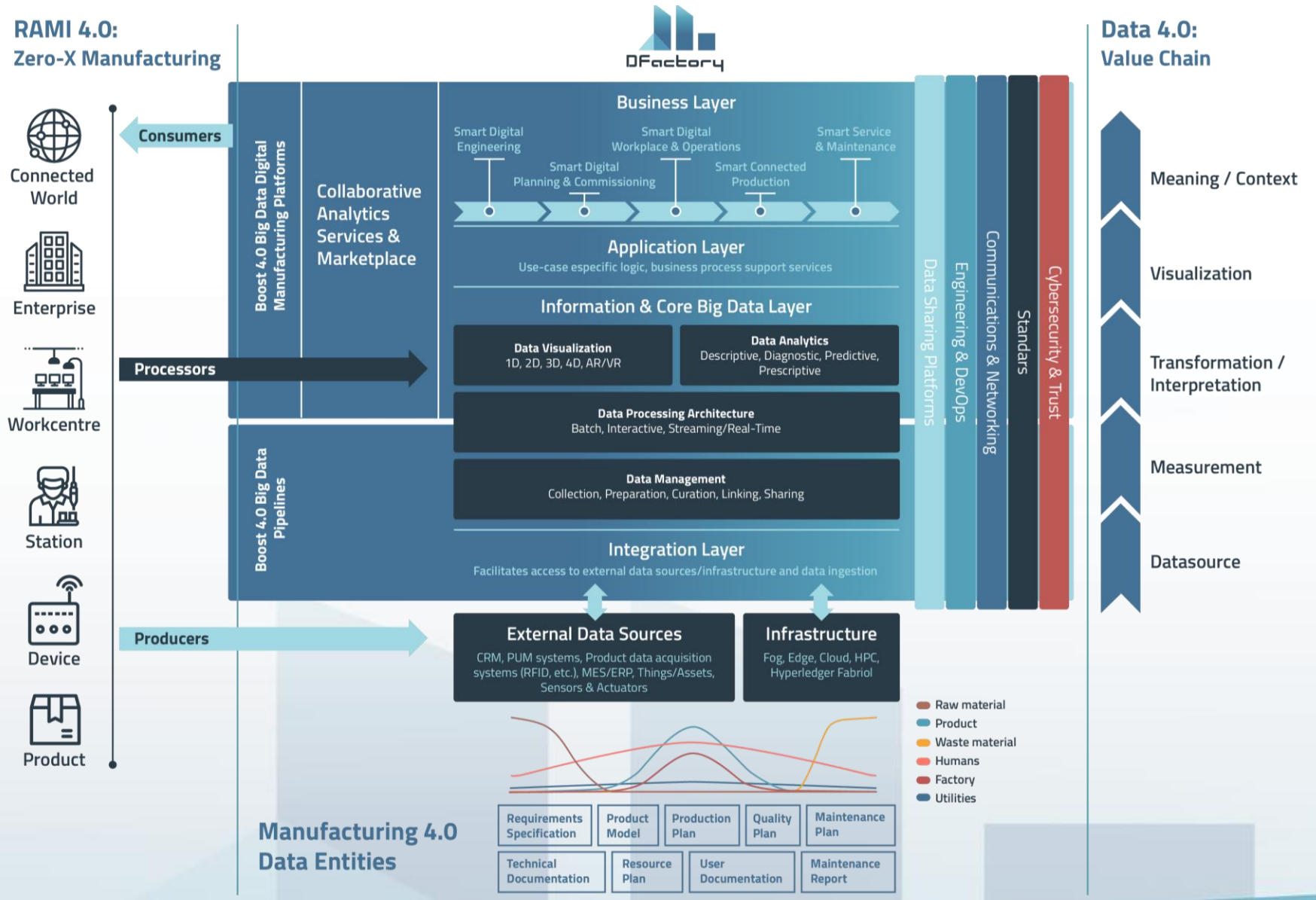
These layers are complemented by the factory dimension, which covers the integration with the factory elements, and the data end-points & entities dimension, which covers the data and their types/ontologies across the manufacturing process lifecycle.

They are also supported by a set of transversal services, in particular data sharing platforms, engineering and DevOps, communications & networking, standards and cybersecurity & trust. The whole approach is aligned with existing reference architectures and standards like RAMI4.0, IIRA, the BDVA Big Data Value Reference Model, the NIST Big Data Reference Architecture and ISO 20547 Information technology - Big data reference architecture.

This BD-RA facilitates the implementation of a big data pipeline and the integration of such pipeline in specific business processes supporting the Zero - X product, process and service lifecycle; i.e., smart digital engineering, smart digital planning & commissioning, smart digital workplace & operations, smart connected production and smart servicing & maintenance. It, thus, leverages a data 4.0 value chain that transforms raw data sources into quality data that can be interpreted and visualized providing mining and context for decision support. Such Data 4.0 value chain is developed, aggregated, integrated, processed, analysed and visualized across the Factory 4.0 layers; i.e., product, device, station, workcentre, enterprise and connected world).

ISO 20547 Big Data Reference Architecture

DFA Big Data Reference Architecture



Connecting Data End-Points: EIDS Reference Architecture

Christoph Mertens
Head of Adoption
International Data Spaces Association (IDSA)

One of the central challenges in the production environment is the handling of the data that is generated, whether it comes from sensors of machines, in planning processes or in product development. When using IT systems and platforms with a specific area of application, we often end up in one of the following situations: either data silos are formed, which easily prevents data to be exploited even for peer groups from the same company, or the so-called lock-in forces data recipients to use the same software solution to get access to the data.

The second solution currently is one of the few ways to ensure cross-company data exchange that guarantees data sovereignty for the data provider. Every company must be enabled to define rules for the use of its own data, which can then be enforced on a technical level. But what happens if those involved in data exchange cannot agree on the same platform? The consequence is the loss of interoperability and, above all, of technically enforceable data sovereignty.

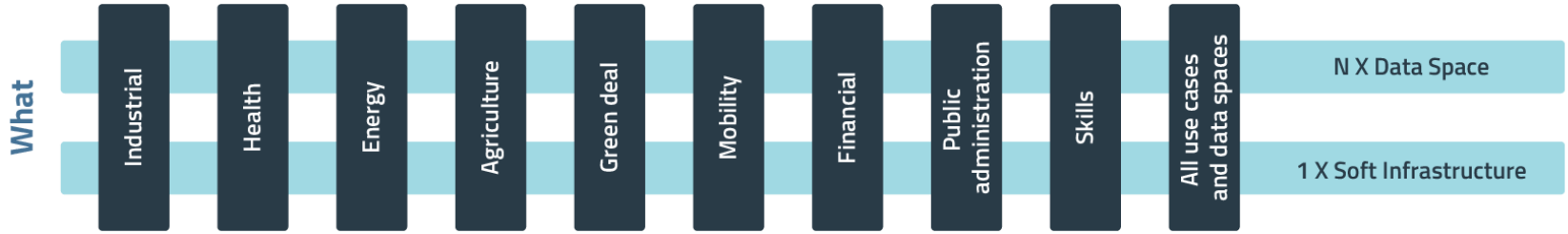
Enabling data exchange under secure and sovereign conditions is therefore of utmost importance The DFA relies on a future-oriented approach to this dilemma, which is called the European Industrial Data Space (EIDS). The EIDS is a data space based on the IDS Reference Architecture Model (IDS-RAM) developed by the International Data Spaces Association (IDSA), to bring self-determination of data usage back to industrial companies. In contrast to platform standards, the user does not create an account in the data space, but instead gains access via a so-called connector compliant with DIN SPEC 27070:2020-03 specifications.

The IDS standard, however, is not about technical requirements only. To create trust between the different participants in a data space, both the technical components (connectors, applications, etc.) and the participants (especially the operational environments) are certified according to the IDS standard. This way, it can be ensured that no "backdoors" are built into the software. Moreover, the security mechanisms are checked, as well, and they are made visible to other participants as a "trust level". Based on this information, everyone can decide whether the specified trust level of a potential partner is sufficient for their own use case or whether other partners need to be searched.

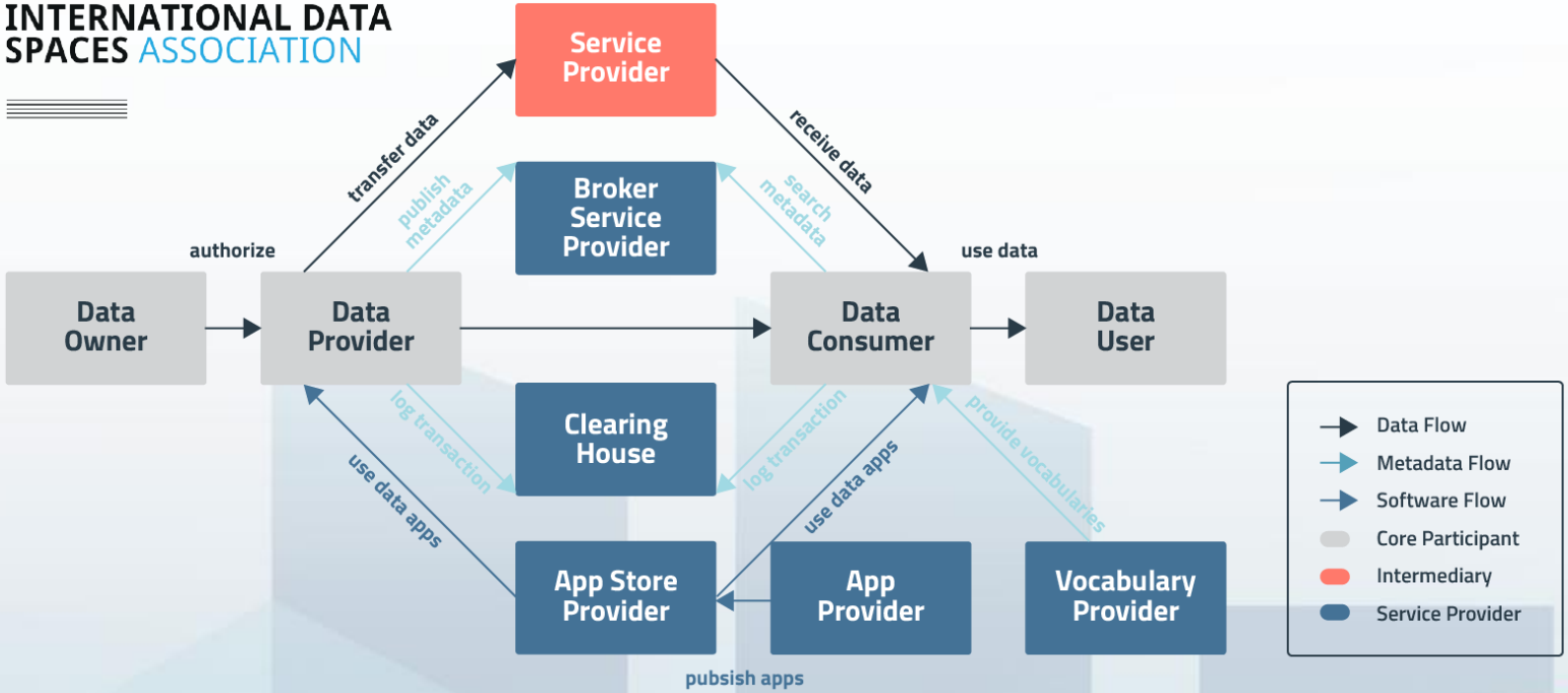
DIN SPEC 27070 Security Gateway RA for Sovereign Data Exchange

European IDS Reference Architecture

Data Spaces



"HOW": Soft Infrastructure



Integrating Manufacturing Solutions: Digital Service Reference Architecture

Angelo Marguglio
Head of Smart Industry and Agrifood" Unit.
Engineering Ingegneria Informatica S.p.A

The DFA Industrial Big Data and Data Space RA need to be articulated and instantiated with the support of specific platforms, solutions and infrastructures, so that the big data-powered AI-driven manufacturing processes can actually be realized. To facilitate replicability and transferability of digital factory solutions, the DFA provides the Digital Service Integration RA (DSI-RA), which ensures a broad industrial applicability of digital enablers, mapping the digital technologies to different areas and to guide technology interoperability, federation and standard adoption.

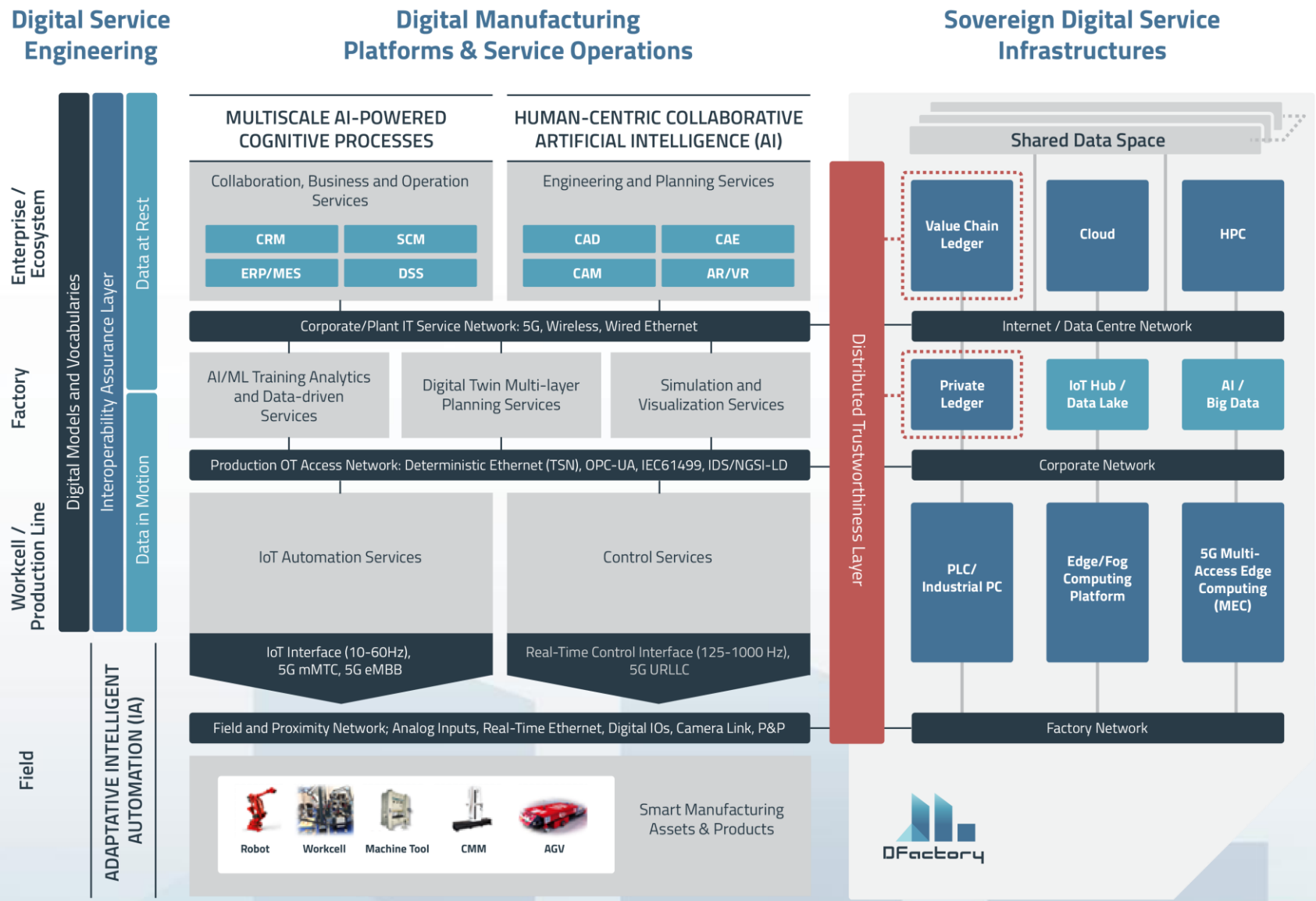
The DFA DSI-RA design complies with ISO/IEC/IEEE 42010 architectural design principles and provides an integrated yet manageable view of digital factory services. In fact, DFA DSI-RA integrates functional, information, networking and system deployment views under one unified framework. The DFA DSI-RA address the need for an integrated approach to how (autonomous) services can be engineered, deployed and operated/optimized in the context of the digital factory. The DFA DSI-RA is composed of three main pillars:

1. Digital Service Engineering.
2. Digital Manufacturing Platforms & Service Operations
3. Sovereign Digital Service Infrastructures.

The DFA RA is aligned with ISO 20547 Big Data Reference Architecture and DIN SPEC 27070 Security Information Gateway RA. Moreover, The DFA RA integrates the 6 layers of the RAMI 4.0 IEC 62264 and IEC 61512 Hierarchy Layers (product, field and control devices, station, work-centre, enterprise and connected world). The RA is composed of four layers that address the implementation of the 6 big data "C" (Connection, Cloud/edge, Cyber, Context, Community, Customisation) required for implementation of data-powered AI-driven digital manufacturing processes. These 4 layers map to the four intelligence levels considered by the Zero Factory; i.e., smart asset functioning, reactive reasoning, deliberative reasoning and collaborative decision support).

ISO/IEC/IEEE 42010 Architecture Description

DFA-Digital Service Integration Reference Architecture



European Industrial Data Space (EIDS) Under Test

Begonia Laibarra
CEO
Software Quality Systems (SQS)

Data security and data sovereignty are the fundamental value propositions of the EIDS. Any organization or individual seeking permission to access the EIDS must certify the core components, like connectors, to securely exchange data with any other party which is part of the data space. The EIDS components are based on the International Data Space Reference Architecture V3.0, which also defines a certification criteria catalogue. Both data spaces, IDS and EIDS are referring to the same criteria catalogues. The catalogue is split into three thematic sections,

1. IDS-specific requirements.
2. Functional requirements that are taken from ISA/IEC 62443-4-2.
3. Best practice requirements for secure software development.

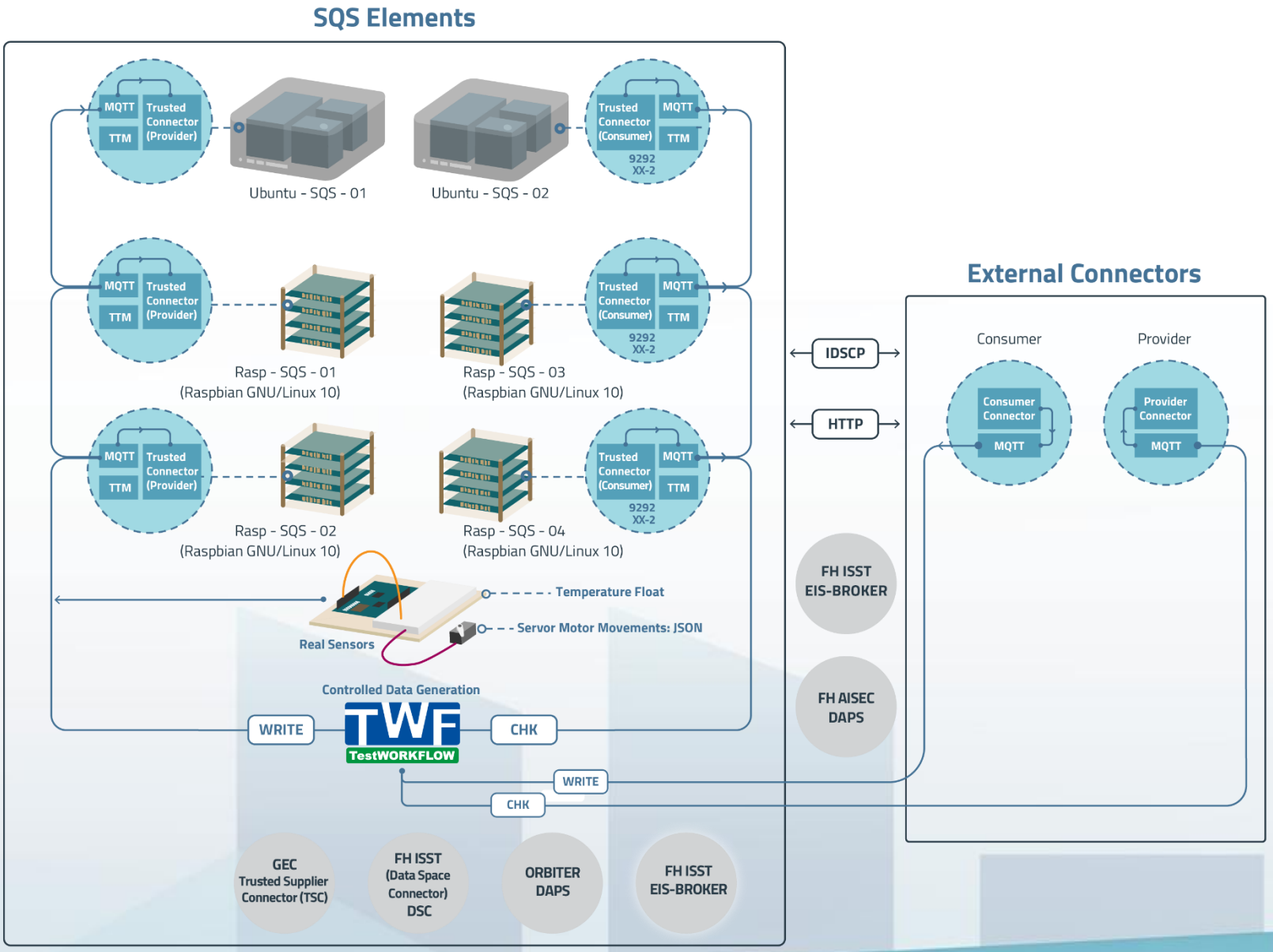
The EIDS core components must provide the required functionality and an appropriate level of security. Therefore, the IDS certification scheme defines three security profiles for the core components

- Base Security Profile
- Trust Security Profile
- Trust+ Security Profile

DFA is providing access to the SQS Integration Test Camp (ITC), a remotely accessible facility where IDSA architecture can be assessed with real IDSA components; with the goal of having a full IDSA environment. The architecture was first built with the minimum components needed to test the interoperability of connectors, base of IDSA environment, and it is in constant evolution, including more components (i.e., DAPS, Broker, APP Store), building an open environment where every IDS component can be tested.

ISO 17025
Integration Test Camp (ITC): Validating EIDS Component Compliance

IDSA Integration Test Camp (ITC)



The Birth of a Network of Lighthouse Digital Factories

Jesus Alonso
Innovation Manager
Innovalia
Association

The individual navigation of the digital factory pilot purgatory can become a frustrating and costly experience. The Network of Lighthouse Digital Factories is a collective industrial effort to jointly develop digital transformation pathways towards the Zero-X Manufacturing Excellence vision with complementary evidences deriving from individual large-scale trials of advanced manufacturing 4.0 processes under a common and holistic framework.

In 2018, 10 of the most competitive European factories and digital platform leaders decided to join forces to provide unequivocal evidences of big data and digital technologies business value, boost their manufacturing 4.0 processes and break the information silos in a shared vision towards Zero-X manufacturing processes.

The stakeholders in the Network of Lighthouse Digital Factories shared the same need for collaboration. The goal was the implementation of cutting-edge data-driven digital transformation trials that could indeed leverage significant manufacturing competitive advantages and high business value at scale.

Manufacturing industry was and is still undergoing a digital manufacturing pilot purgatory. The Network of Lighthouse Digital Factories offers a guideline to speed up the navigation of the pilot purgatory. It provides increased visibility and awareness of the most advanced Zero-X manufacturing 4.0 processes delivered by leading manufacturing industries and SMEs.

Data-driven digital transformation pilots with a context and a holistic framework can boost digital adoption by Industry 4.0, accelerate pilot purgatory navigation and increase digital resilience of industrial value chains.

However, visibility in itself, while valuable, is not sufficient if not delivered within a common context. This common context is crucial for an informed establishment of digital transformation strategies, to boost adoption, replication and transfer of digital solutions. Ultimately, the large-scale trial context ensures a successful navigation of the pilot purgatory.

Aligned with global standards, the Digital Factory Alliance (DFA) Network of Lighthouse Digital Factories provides such common big data reference framework to build unique data-driven digital factory transformations. The DFA framework is fully integrated in a shared Zero-X manufacturing process digital service deployment model aligned also with the key Reference Architectures for Manufacturing Industries and Industrial Internet.

Beaconing a Resilient Digital Transformation

Over the last few years some companies have achieved remarkable competitive advantages with the adoption of digital technologies to power up their manufacturing processes, while others, up to 70% according to the latest data from the World

Economic Forum (WEF), have fallen behind and are still stuck in the "pilot purgatory".

Data-driven transformations have been accelerating the modernisation and digitisation of next generation factories and even complete manufacturing supply chains and business networks across industries and sectors. Moreover, such transformations have been accompanied by a reimagination of workplaces, the very same nature of the work to be performed and the strategies for workforce up-skilling and re-skilling[1].

The DFA digital service integration framework for the Zero-X Manufacturing Excellence is shared across the Network of Lighthouse Digital Factories and provides the common grounds for collaboration and replication yet respecting Intellectual Property and the individual ability to develop unique competitive advantages.

Digital transformation of manufacturing industry towards smart, intelligent connected factories and supply chains had been usually steered by the need to boost 4 main business drivers, namely time to market (speed), flexibility, quality and efficiency. However, with the recent world events, most notably the COVID-19 pandemic, manufacturing and global industry at large have suffered significant disruptions at unprecedented scales in the recent past. This has resulted in a growth for and acceleration of the demand for digital transformation to adapt quickly during disruption, while remaining viable and operational. Hence, additional business drivers such as agility and customer centricity, supply chain resilience, speed and productivity or eco-efficiency become drivers of transformation.

This level of agility and resiliency sits at the core of data-driven digital transformation and innovation. Digital transformation assets have proof critical levers during this unexpected adversity period reducing the impact of turmoil and increasing the appreciation for the digital qualities and capabilities that have enhanced a faster adaptation recovery and sustained activity.

Thus, it is in this period of transformation acceleration that lighthouse factories should become the beacons and models for digital adoption of more resilient production systems. These companies are already leading the way towards modernized and digital operations for the next normality. It is in this context that beyond individual tangible factory competitive advantages and achievements, the ultimate value of the Network of Lighthouse Digital Factories has emerged. The ability to frame the large-scale pilots and trials under the shared common design principles for industrial data spaces and to integrate those in the Zero-X digital service integration model provides a unique opportunity. Moreover, the value precisely resides in providing such shared grounds for collaboration yet being able to fully respect IP and individual competitive advantage development. The DFA lighthouse pilot and trial framework provides a most needed guidance for better preparedness, acceleration and successful digital transformation through solution replication and customization; wherever or whenever they decide to engage in their digital pathways.

The DFA Lighthouse Manifesto: Principles for Excellence and Future Resiliency in Data-driven Digital Transformation.

[1] Skills for the Future of Manufacturing, World Manufacturing Forum 2019 Report

Digital Transformation is at the core of current and future manufacturing transformation and is gaining momentum as an enabler for increased growth, profitability, flexibility, resilience, efficiency, quality and time to market.

With the impact of global outbreaks such as COVID-19 on business continuity and operations, manufacturing industry is witnessing an acceleration in the adoption of digital technologies. We face both a critical milestone but also a unique opportunity that could define the future capabilities and competitiveness of our manufacturing industry. Manufacturing industry calls for the opportunity to integrate the digital technologies that will fulfil their most immediate needs today without having to sacrifice or compromise their future digital growth and sustainability. Moreover, in current turbulent times irrespective of the stakeholder size this needs to be done, more than ever, with tight and well dimensioned budgets.

How digital technologies will be adopted and integrated by industry and how platforms and ecosystems will be shaped by digital industries will determine future individual business opportunities, collaboration patterns across industry and the resilience of manufacturing value chains. Manufacturing industry cannot afford to be simply presented with the next digital innovation unfolding. Manufacturing industry needs to proactively and openly collaborate to shape together industry 4.0 products, platforms, spaces and ecosystems to facilitate economies of scale, resilience, sustainability.

The DFA manifesto represents the principles for future resiliency and excellence, with the vision of building a win-win scenario for digital and manufacturing industries that will accelerate adoption of digital technologies, lower acquisition and operational costs, enable a balanced digital transformation at the speed of business growth and leverage freedom of choice for best in class and best in value digital solutions.

1 DIGITAL IS EVERYWHERE, EVERY FACTORY IS UNIQUE.

Digital transformation is a mandatory call for every factory in Europe whatever its size and location. But every factory is a unique combination of people, product, services, processes and business models, and has reached a certain station on the path to digital transformation. The Digital Factory Alliance welcomes every company, wherever they are on their digital travel and will walk with you towards your destination. You are not alone in your trip.

2. THE DIGITAL OFFER IS INFINITE OUT THERE, BUT DON'T LET THIS OVERWHELM YOU

What does a factory need to start, improve or complete its digital transformation? Sensors, actuators, software, specific algorithms, robots, telecom or computing infrastructures? Moreover, it's not only about machines, it's also about people, especially about people, your workforce needs just-in-time, just-in-place, hands-on training. The market offer is tremendous and the choice is not easy. The Digital Factory Alliance with its team of honest brokers, neutral reference models, open international standards, labelling programmes and the experience gained over years of experimentation will guide you through this ocean of solutions.

3. INTEROPERABILITY BY DESIGN AND STANDARDS INSTEAD OF LOCK IN

Being tied to a single provider is not a convenient solution for most factories and especially for SMEs which require greater flexibility and a tailored solution to stick to a tight budget. The Digital Factory Alliance is all for customised solutions to

address unique challenges: we are collecting existing standards and promoting the definition of new ones to guarantee the interoperability of composable and modular systems that gather best of breed and best in value solutions, so you can make them work in your preferred way.

4. DEFINE YOUR GOALS AND RESOURCES AND LET DIGITAL WORK FOR YOU

Which is the next station on your digital path? Where do you want to get? When do you need to get there? This is your homework as a member of the Digital Factory Alliance, but getting there is a trip we are going to do together. Our digital decisions today should not be compromising the future of our manufacturing companies in terms of digitalisation costs, growth, collaboration or circularity. Being part of the Digital Factory Alliance will allow you purchase products and engage in platforms and ecosystem with the tranquillity that they have gone through the labelling programmes we endorse and that they respect the principles and interoperability guidelines adopted by the Digital Factory Alliance.

5. BUILD YOUR DIGITAL FUTURE WITH THE PROVIDERS YOU TRUST

Walking along your digital path does not mean that you will need to do so with strangers. Being part of the Digital Factory Alliance will allow you to do so with those partners that have supported us to bring our business where they are today. However, the Digital Factory Alliance will allow us to invite new trusted partners, which share our vision for digital transformation, with innovative ideas, knowledge or products to enrich or accelerate our trip. The choice is ours and the path to take to our destination open. We are in control of our decisions.

6. DEVELOP INCREASED MANUFACTURING AUTONOMY LEVELS THROUGH EXPERIMENTS AND EVIDENCE

The investment needed to bring factory shopfloor either to the next level of digitalisation and automation or to extend the useful life of your major capital investments and large industrial equipment is huge. Such investments cannot be afforded without a reasonable level of assurance that the integrated system is the adequate response to the objectives of the factory. Being part of the Digital Factory Alliance will allow you to engage in an active digital transformation dialogue, to learn from lighthouse factories, to become one and to access to a large network of experimental facilities specialised in a large portfolio of technology. They will allow you to test all the technologies you need and more importantly to do it at the speed of light to reduce the risk of new technology integration; so, they work together flawlessly in your shopfloor.

7. DEVELOP YOUR DIGITAL & MANUFACTURING CAPACITIES AT THE SPEED OF BUSINESS

Digital transformation is not only about technology, is about change and people, because a company is made by people. The evolution of your digital factory requires the evolution of your employees, their upskilling to operate in this advanced environment. Discover which are the skills and capacities that industry is nurturing and do not allow your factory to lag behind. The Digital Factory Alliance will provide you access to a rich offer of training courses and training factories close to you. With the access and support from the largest Global networks of Advanced Manufacturing and Digital Innovation Hubs, the Digital Factory Alliance will support your company to design and engage with the up-skilling and re-skilling programmes you need, to put your new manufacturing process in action; be it zero defect manufacturing, predictive maintenance.

8. LET DATA AND HUMAN-CENTRIC AI DRIVE YOU TO PROFIT

Data is a key factor in the development of human-centric collaborative artificial intelligence, enhanced decision support and value creation. Inside the Digital Factory Alliance, we have the opportunity of collectively design the principles to set our data assets, engage in the development of our industry commons and adopt shared data vocabularies and spaces to ensure that your factory is not left behind or apart from future data and intelligence economies and digital value chains.

9. MASTER THE VALUE OF THE ZERO-X MANUFACTURING VISION

Be zero defect manufacturing, zero unplanned breakdowns, zero net energy factories, supply chains or zero waste manufacturing, the value of zero is at the core of future manufacturing competitiveness. The Digital Factory Alliance firmly believes that our ability to design, ramp-up, operate and service Zero-X processes will define both our factory competitiveness and uniqueness. It is crucial to accelerate the adoption of Zero-X processes across the complete value chain. Through the Digital Factory Alliance initiatives, we can support your company to master the implementation of ZDM, predictive maintenance solutions over common digital infrastructures, industrial data spaces and manufacturing assets.

10. DIGITAL FOR ALL

The Digital Factory Alliance believes in the need to develop resilient digital value chains and that there is no small digital dream to be left behind. The Digital Factory Alliance is there to nurture with manufacturing champions and SMEs their new digital value chains. We are here to support your factory in a soft digital landing and onboarding processes, so your factory is always fit for and never late to engage with these emerging digital value chai

Boosting Digital Factories Competitiveness Together

Boost 4.0 Lighthouse Factories and Big Data Large Scale Trials

Some of the most competitive factories, from three strategic economic sectors that drive not only European manufacturing economy but also are driving the IoT/smart connected market development (i.e., automotive, manufacturing automation and smart home appliance sectors) have joined forces to set up 11 lighthouse factories and 2 replication factories, that are a coherent, complementary and coordinated big data response to the 5 EFFRA Factory 4.0 Challenges;

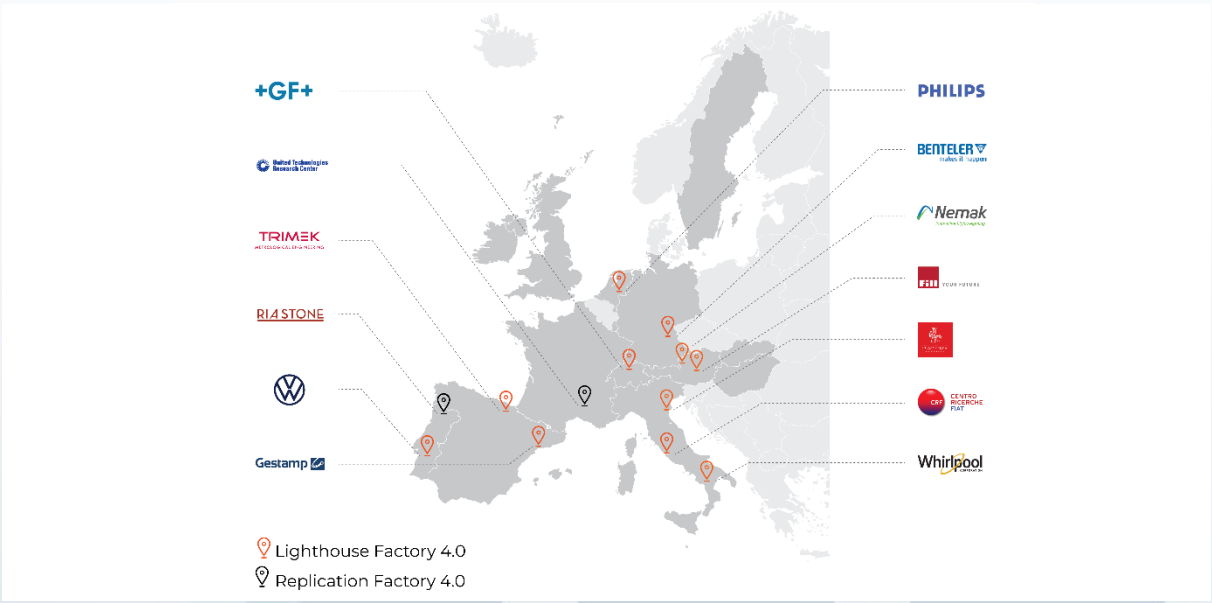
- Lot size one distributed manufacturing,
- Operation of sustainable zero-defect processes & products,
- Zero break down operations,
- Agile customer-driven manufacturing value network management
- Human-centred manufacturing.

The Network of Lighthouse Digital Factories leverages 5 widely applicable big data transformations

1. Networked commissioning & engineering,
2. Cognitive production planning,
3. Autonomous production automation
4. Collaborative manufacturing networks
5. Full equipment & product availability;

The 5 transformations are seamlessly implemented and delivered across each of the 5 key product and process life-cycle domains to deal with the Zero-X Manufacturing Excellence Challenge:

1. Smart Digital Design 4.0 and Engineering 4.0,
2. Smart Digital Production Planning 4.0 & Commissioning 4.0,
3. Smart Digital Operations and Digital Workplace,
4. Smart Connected Digital Production and Logistics 4.0,
5. Smart Digital Maintenance 4.0 and After-sale Services 4.0.



Engineering A Weightless Casting Digital Transformation

Factory: Nemak GmbH, Linz, Austria

Smart Engineering 4.0

With more than 22.000 employees at 38 production sites Nemak has been driving the development and production of innovative aluminium components for the automotive industries. The Nemak production site in Linz focusses on the production of high-quality automotive cylinder heads. Nemak is entering new market segments by intensifying activities regarding the manufacturing of structural components and components for e-mobility. These casting parts come with different challenges (high complexity of casting parts, smaller production volumes, etc.).

The existing production concepts of former high volume casting parts have to be adapted for future parts. In modern casting manufacturing processes quality control is the end of the process. Faulty parts are therefore only detected after casting, machining and heat treatment. The majority of manufacturing flaws occurs during the casting process, which is at the start of the manufacturing chain. A significant part of the production costs is incurred in later production stages (machining, heat treatment).

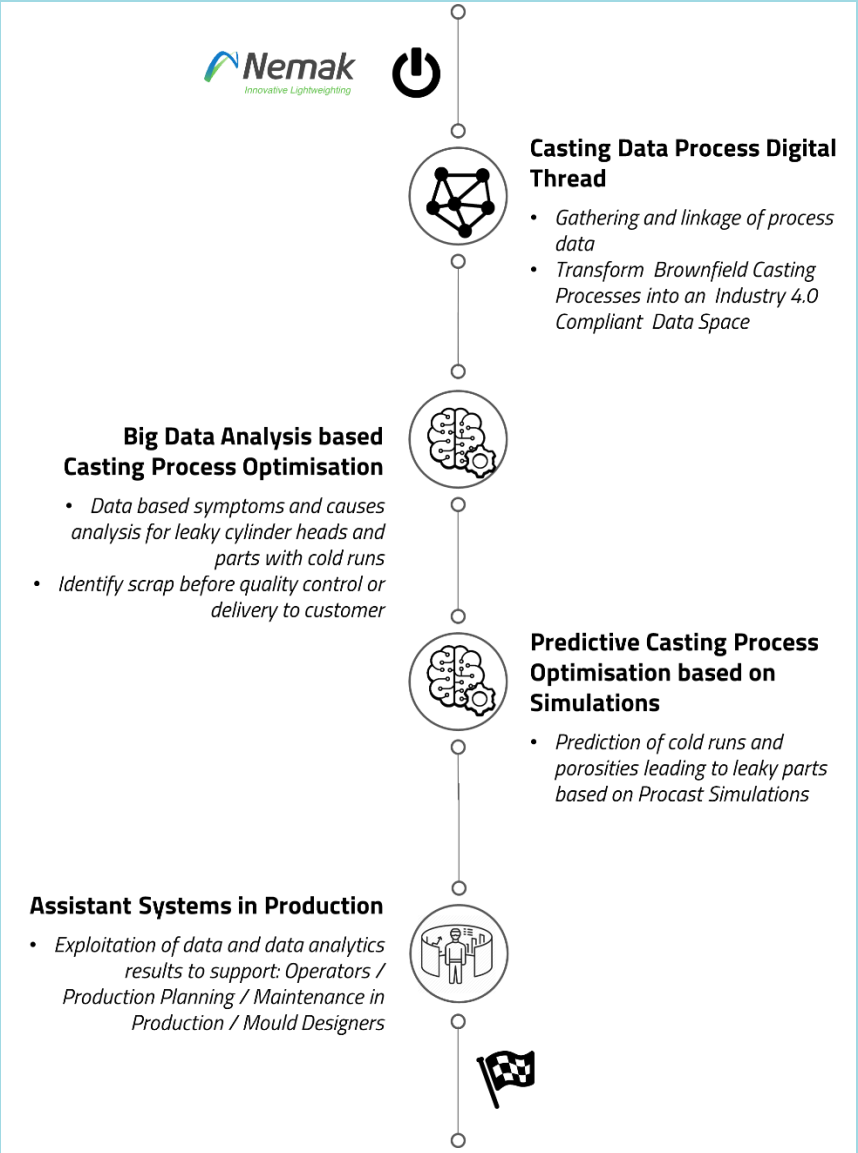
Nemak Linz large scale trial goal is to implement an AI-powered predictive quality of casting parts e.g., cylinder heads, electrical drives housing and light weight structural components. The early detection of flawed parts corresponds to a huge cost saving potential. Not only would such an early detection reduce the production costs of Nemak, it also enables to reduce its ecologic footprint (reduced resource consumption, resulting in lower CO_2 emissions).

Photo source: Nemak GmbH

Predictive Quality for Automotive Part Casting

Deployment and evaluation of a predictive quality engineering framework for gravity casting processes at Nemak:

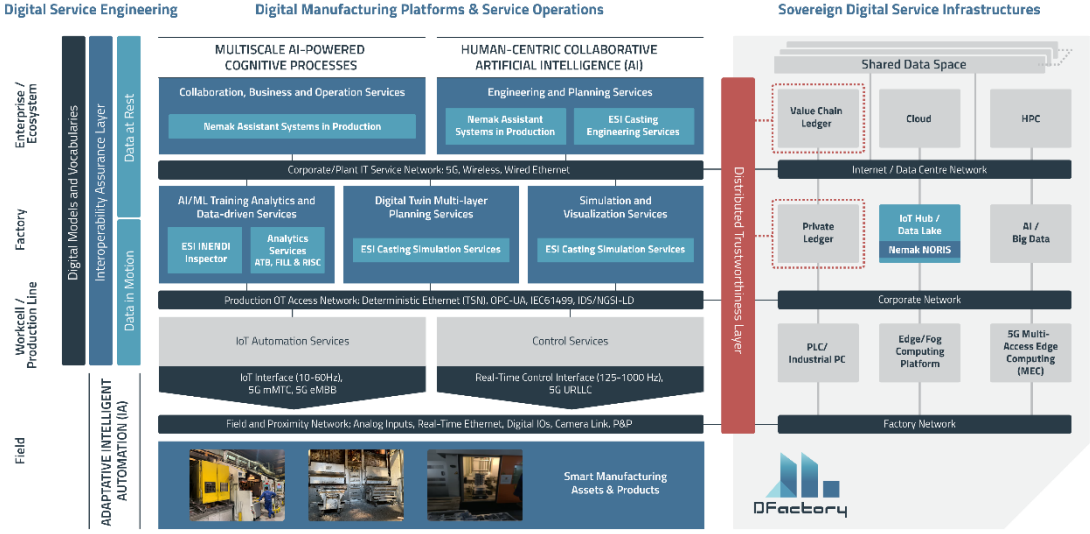
- ICT infrastructure transformation towards an Industry 4.0 compliant data space.
- Increase data exploitation and process traceability by linking melt shop data to specific cast parts
- Predictive analytics by big data analysis and hybrid simulation models to identify symptoms, causes and solutions for high scrap rates caused by leaky parts and cold runs on specific products.
- Data exploitation by Nemak Assistant Systems in Production to support human actors' decisions involved in casting processes in their daily tasks.



Key Facts & KPIs

Increase in identification of leaky parts	↑61%
Reduction in manual XCT inspections	↓22%
Rework reduction due to	
Cracked sand cores	↓88%
Data points coverage increase in simulation	x12
Process monitoring Increase	↑33%
Variables per casted part increase	↑17%

Digital Factory Alliance (DFA)
Digital Service Integration Reference Model



Digital Solution Providers

Big Data Casting Engineering

Clemens Grillberger,
PDC Sr. Manager SPM,
Nemak Linz GmbH

BOOST 4.0 was an enabler for Nemak Linz GmbH regarding the power of big data analysis for optimizing casting processes

Daniel Obreiter
General Manager,
ATB – Institut für angewandte Systemtechnik Bremen GmbH

In BOOST 4.0 ATB was able to significantly expand its knowledge around Big Data and data economics and successfully developed validated casting process data analysis models which will expand ATBs portfolio in form of services for the casting industry.
As a research institute, ATB was able to further expand its personal network and will additionally share the knowledge gained to initiate new research projects build on the results of BOOST 4.0.

Vincent Chaillou
Group Board Member and Chief Operating Officer (COO)
ESI Group

The BOOST 4.0 project enables ESI Group to tackle the challenges of the transformation of the Manufacturing Market in particular the brownfield light metal casting processes into an Industry 4.0, combining the Virtual prototype testing (physics-based simulation) for the Casting with the Data, AI and data analytics, embedded in the ESI Hybrid TwinTM platform. These services are provided as assistant systems in production and Implementation, in real time by controlling sensors data and optimization of the process and then the delivery of Scalable Solutions for our customers.

DI Wolfgang Freiseisen
Managing Director
RISC Software GmbH

Since its foundation by Prof. Bruno Buchberger, RISC Software GmbH has been operating in the interaction area between mathematics and computer science. Our goal is to connect research and economy and to help companies generate benefits from the research results. In very general terms, we are responsible for technology transfer by means of software, i.e., we develop professional software for our customers and R&D partners from the research fields. The methods of mathematics are our basis even in times of artificial intelligence and the vehicle for technology transfer is the professional software engineering, i.e., computer science. This combination together with our domain know-how built up over many years, especially in industry, logistics and medicine, generates the economic value for the partner companies.

The Machine Tool Cybernetics Revolution

Factory: FILL GmbH, Gurten, Austria

Smart Engineering 4.0

FILL as key machine tool provider delivers in the order of 100 production systems per year to around 50 customers worldwide. 90% of FILL machines and systems are exported to automotive, aerospace, sports, construction and housing and renewable energy sectors. Zero defect production demands that machines cost-effectively and flexibly adapt to optimum production configurations. Therefore, machine tools are increasingly customized and customisable (lot-size 1 production scheme).

Rigid engineering processes designed for mass production are not able to optimize smart connected machine tool lot-size 1 engineering and fail to incorporate external operational data to optimise machine self-configuration & adaptation features**.**

The goal of FILL large scale trial was to evaluate an innovative approach to networked lot-size-1 machine tool engineering capable of exploiting distributed and real time data across suppliers and customers, i.e., the so-called cybernetics solution. As a machine tool builder, the challenge was to leverage big data continuity across the machine tool product lifecycle and stakeholders.

The trial has adopted an agile V development model. A metadata representation approach has been integrated to define the structure and the relations (i.e., the connections) between the various data sources across the full machine tool engineering, manufacturing and operation process lifecycle. The smart digital engineering large scale is evaluating the adoption of a model-based engineering process, a model repository (1) for trusted digital twins using big data (2) for better service design (3) and to create product-service-systems (PSS) (4) across the life cycle.

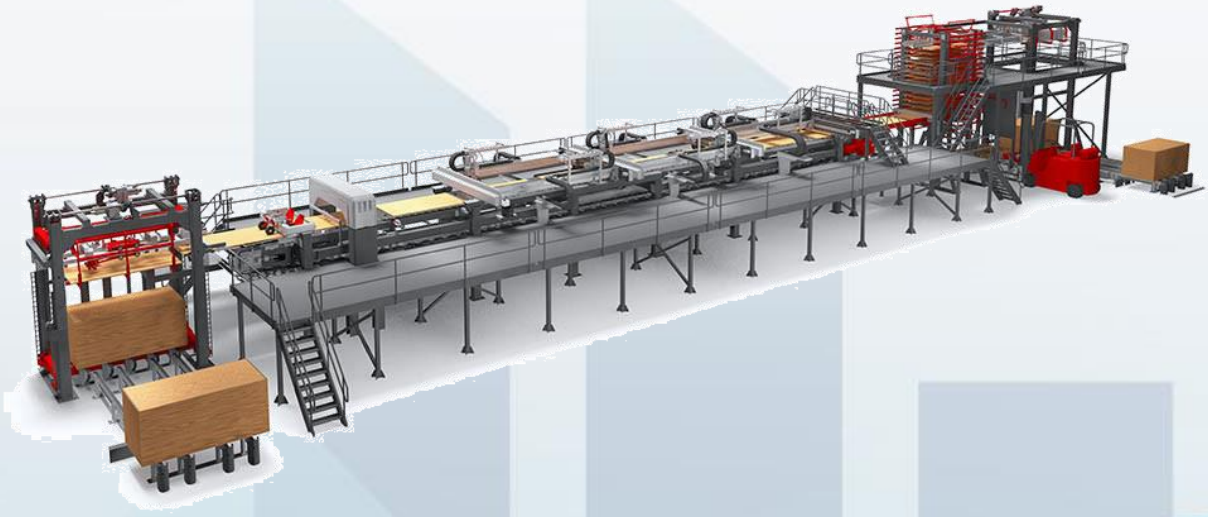
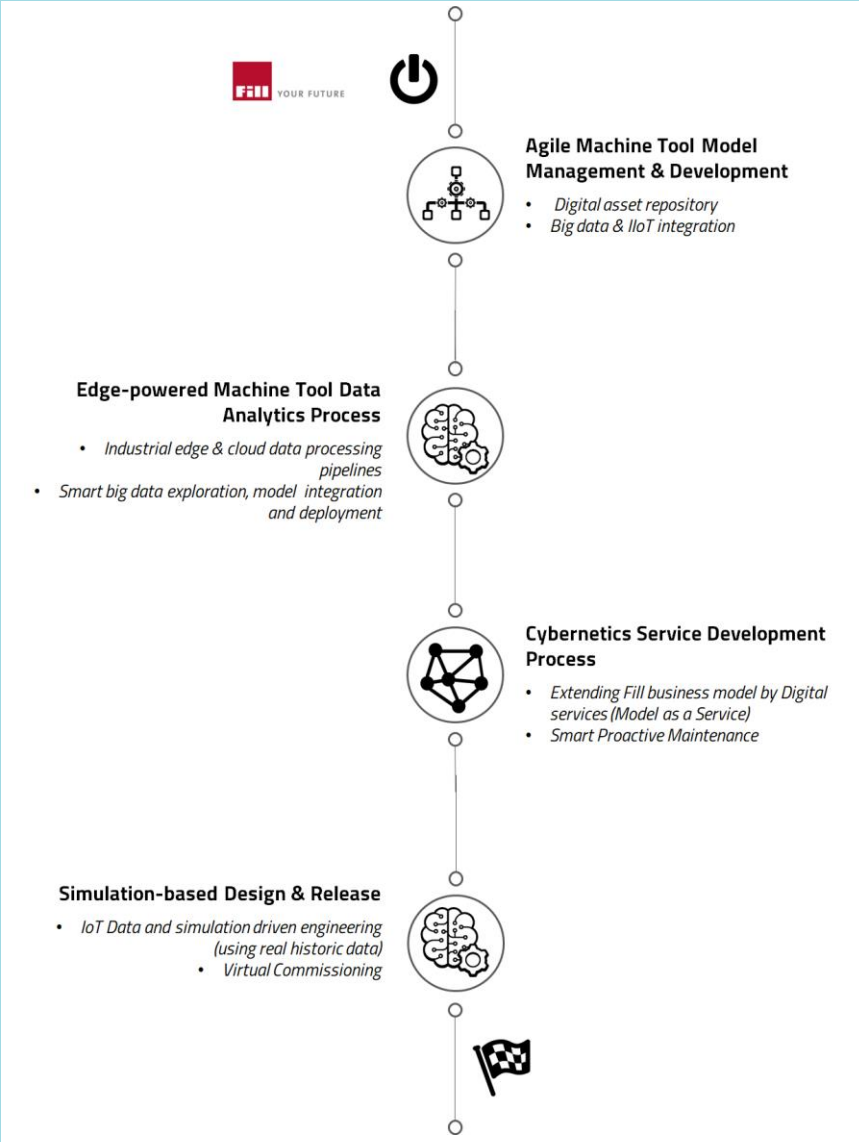


Photo source: FILL GmbH

Closed-Loop Machine Tool Customisation Engineering

Deployment and evaluation of a smart digital engineering framework for machine tool design and commissioning at Fill:

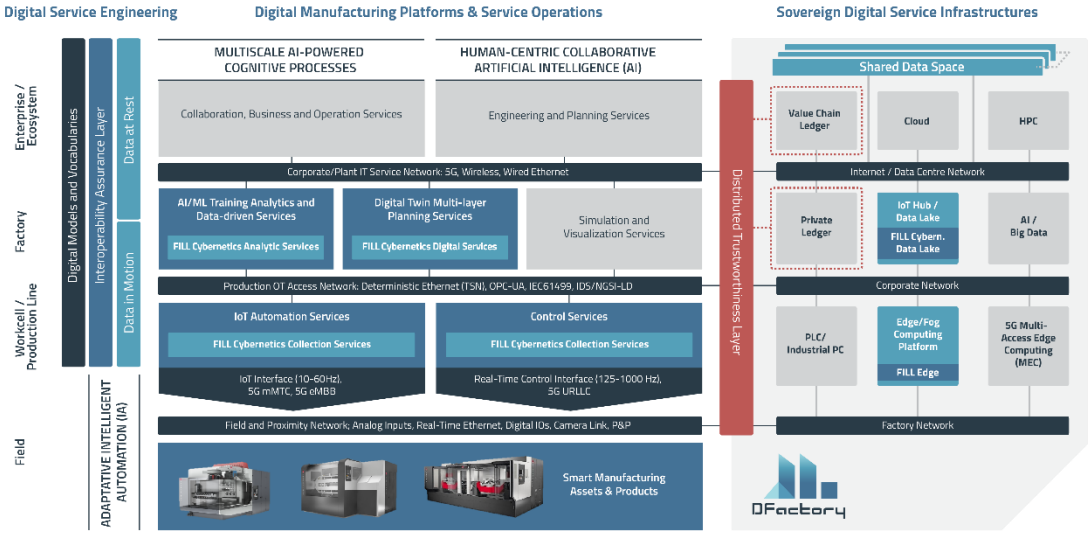
- Model-based and big data-driven engineering process with digital asset repositories.
- Extending Fill business model by digital services (Model as a Service).
- Machine and process models optimization engine relying on big data processing pipelines.
- Machine big data logger and exchange platform.
- 3D production simulation and virtual commissioning relying on integrated IoT data and simulation driven engineering.



Key Facts & KPIs

Reduction of engineering lead time	↓27%
Reduction of engineering errors	↓ 21%
Unplanned breakdowns reduction	↓ 21%
Service costs reduction	↓19%
Reduction of commissioning time	↓15%

Digital Factory Alliance (DFA)
Digital Service Integration Reference Model



Digital Solution Providers

VISUAL COMPONENTS

RISC Software GmbH

TTTech Ensuring Reliable Networks

TTTech industrial

Alois Wiesinger
CTO
Fill GmbH

Fill is a grown family-owned company and focused on its customers success. The new approach of closing the information gap by digitalisation between customers and the Fill engineering leads to a better fulfilment of customer requirements. By end of the large-scale trial, we already noticed a higher level of customer satisfaction. In addition, the high availability of industrial data across companies enables digital, agile and self-controlled production and value-added networks. Besides the facts and figures of the measured KPIs, it is about the working people and their motivation. I think the digitalization and its approach is mandatory, but to benefit from it, it is about the mindset to see digitalization as a chance and not a threat. With this newly created transparency on the process and the trust we have built up with our partners and customers we are best prepared for the factory of the future!

Juha Renfors
Vice President for Products
Visual Components

The achievements reached at the BOOST 4.0 project have demonstrated in large-scale pilots the importance of the management of big data in a standardized and secure way. The utilization of 3D Simulation technologies during the engineering release process, connecting the digital models securely with the big data enabling the Digital Twin, has accelerated the system's design and commissioning while the design and operation errors have been reduced to zero, pushing productivity to the higher levels. Our experience in the BOOST 4.0 project has been very fruitful by developing new products that will reach the market soon and also strengthens the relations with the project partners.

Dr Wolfgang Freiseisen
Managing Director
RISC Software GmbH

Although no project is like the other and there are always new challenges in the R&D environment, we rarely work "from the scratch", but mostly build on our own frameworks, on our knowledge. Within Boost4.0, RISC Software GmbH enhanced its data analytics framework, AnnaLyze, by making it suitable for future Big Data projects. Secondly, on a meta-level, the knowledge exchange, the communication and the dissemination activities within Boost4.0 have helped us to expand our know-how and opened the door for further cooperative research activities with companies from other industries.

Dr Thomas Berndorfer
Member of the Executive Board
TTTech Industrial Automation AG

Within the Boost4.0 project, we acquired a broad insight into how potential customers utilize Big Data technologies and data analytics services to foster European manufacturing's digital transition. By providing Nerve Blue as edge computing technology for the pilot installation at FILL, we, as TTTech Industrial Automation AG, were able to develop novel features and demonstrate the benefits & capabilities for real-time data aggregation and deployment virtualized analytics services worldwide. Nerve Blue offers an out-of-the-box experience, with an intuitive user interface and edge computing features that allow users to collect, store and analyse machine data, consolidate multiple functions on one device, and remotely manage software.
By the end of Boost4.0, we adapted our understanding of the market needs in a broader Big Data ecosystem, with edge computing as a key enabling technology. We demonstrated that machine builders are able to reduce system complexity and cost by using our Nerve Blue platform while improving machine performance and offering innovative new services to customers. The achieved developments for our Nerve Blue product line enable us to address a broader customer base by providing cutting-edge technologies for manufacturing enterprises, pushing the digitization of the European's industry.

Realising the Zero Defect Factory 4.0

Factory: GF Machining Solutions, Biel, Switzerland

Smart Planning & Commissioning 4.0

A critical issue for manufacturing in Switzerland for GF is the resulting machine cost with respect to main competition in Asia; differences can be partially compensated by the product quality and offer in terms of precision and productivity, but puts a high pressure on development, supply chain and operations. In particular, it is necessary to improve the assembly and test of different machine functional groups (mechanical, electrical, electronic) and processes, but also be able to provide to the market innovative features in shorter times than the usual 2-3 years cycle for the upgrade or development of a new device.

This involves a leap in data management and communication from the engineering stages towards the production stages during the pre-series phase, where a faster feedback should be implemented in order to adjust the product quality and enable the series deployment. In terms of assembly, even if some components supplies are enabled to a just-in-time operation through automated communication of stocks, around 80 of machine component remain highly linked to human operations and databases which are not standardised across different production sites.

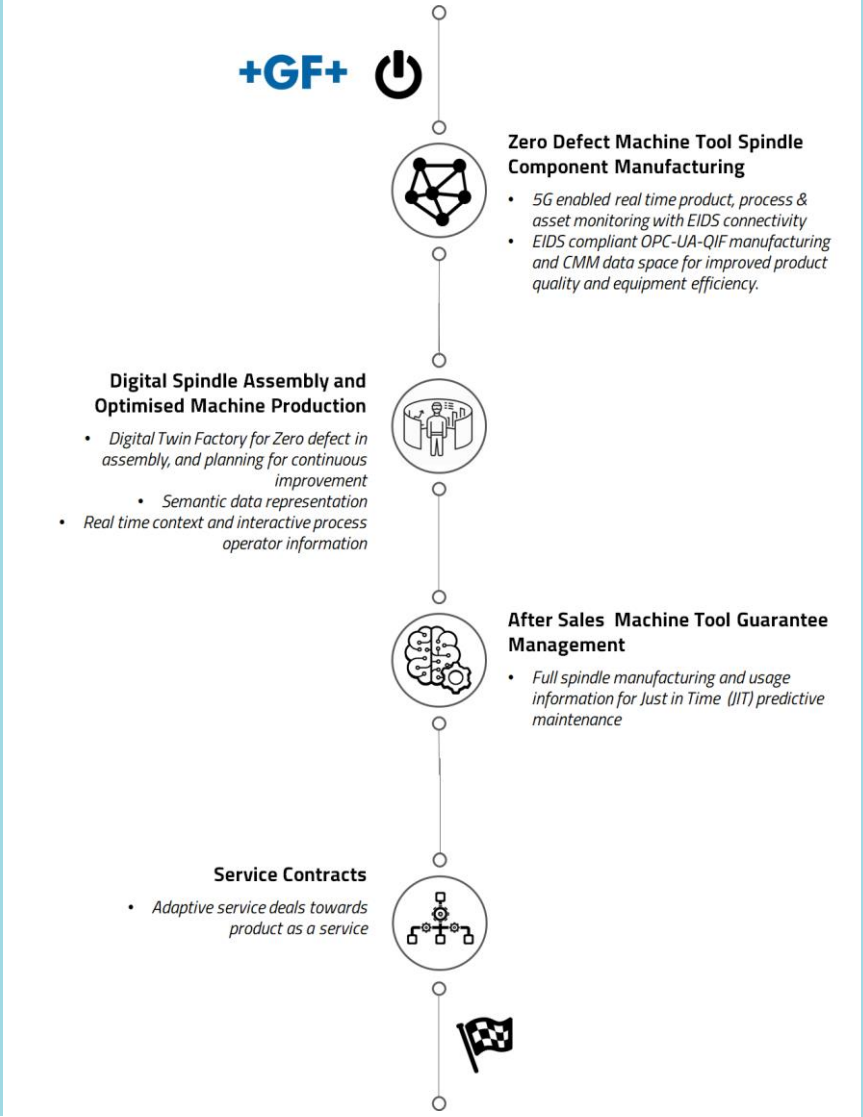
The +GF+ large scale trial goal was to optimize the GF spindle's component production efficiency combining machine tool predictive models and part quality control data. The aim was to improve spindle manufacturing lead time and quality towards zero rework and no scrap operations with the development of a digital and connected assembly. Ultimately, the large-scale trial unfolded and exploited an intelligent factory data management and planning system for zero defect spindle manufacturing and device operation.

Photo source: GF Machining Solutions

Cognitive Digital Thread for Zero Defect Spindle Production

Deployment and evaluation of a semantic digital factory framework for zero defect spindle and machine tool manufacturing at +GF+:

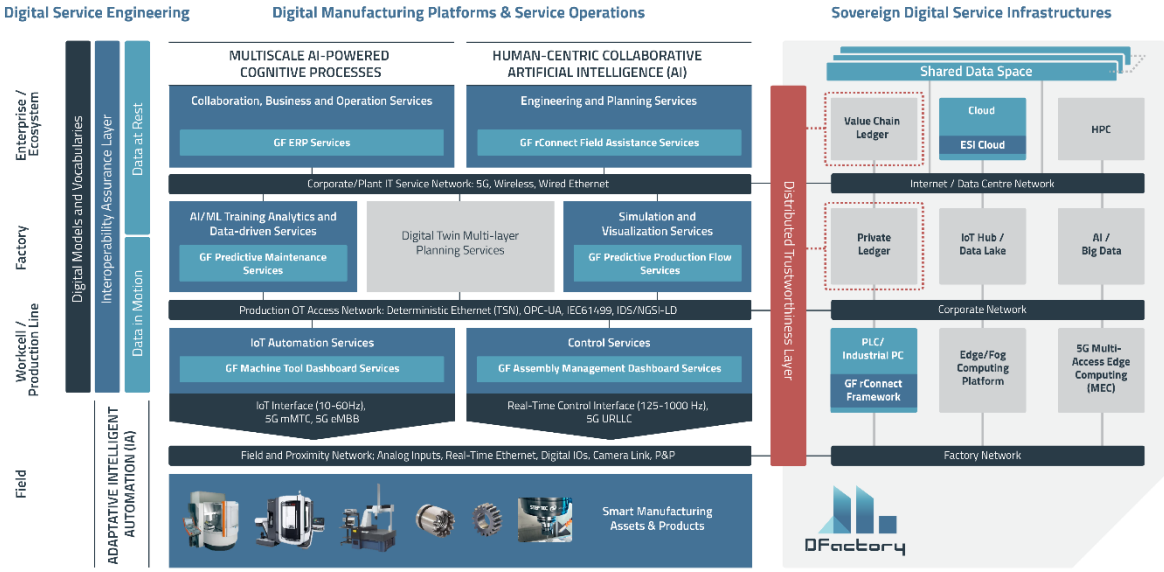
- Standardised big data sourcing and aggregation pipelines across the manufacturing line and usage phase
- Semantic digital thread model and digital factory twin services.
- Factory IIoT KPIs monitoring and analytics tools for real-time production flow diagnostics
- Machine learning for machine tool predictive maintenance
- Smart planning system for optimum spindle manufacturing



Key Facts & KPIs

Part reworked (reduction)	↓10%
Parts returned to production after operational tests (reduction)	↓10%
Mean test iterations after assembly	2
Spindle recovery from client	3%
Spindle returned under warranty	5%

Digital Factory Alliance (DFA)
Digital Service Integration Reference Model



Digital Solution Providers

esi get it right®

CAPVIDIA

EPFL

Andreas Rauch,
Head Digital Business, Board Member
GF Machining Solutions

The Boost 4.0 +GF+ pilot has successfully analysed, integrated, and evolved a disparate process already existing in our Spindle factory shop floor towards a continuous digital solution which is truly connected to people, defining a competitive, sustainable business framework for the company, and outreaching the machine products and our customers with a scalable data and analytics approach. On top, the solution is perfectly aligned with the GF future standard platform, cloud infrastructure and digital services strategy.

Vincent Chaillou
Group Board Member and Chief Operating Officer (COO)
ESI Group

The BOOST 4.0 project was a perfect opportunity for collaborative development to prove the value based of the solution based on an operational demonstrator in a close to real industrial conditions, using the machine-learning-based foundry to monitor and to improve the production outcomes

Tomasz Luniewski
President
Capvidia

Boost 4.0 participation was an excellent playground for testing emerging MBD technologies and verifying the level of their market acceptance. Capvidia's CAD agnostic MBD approach based on industry standards (ISO/ANSI) proves to be correct to support the most complex engineering data types across various industrial segments. Standard data formats based on semantically defined ontology allow for effective and intelligent data exchange. Automation of both downstream and upstream processes resulting in cost and time savings up to 40% compared with traditional engineering approaches. Better control and increased product quality come as additional benefits. Tests with industrial partners proved reduction of documents number from twelve to one, total elimination of transcription errors and faster process overall. The MBD based concepts prove its efficiency in the race for cost savings, better product quality (zero defect product), better process control and stronger competitive advantage.

Prof. Dimitris Kiritsis
ICT for Sustainable Manufacturing.
École Polytechnique Fédérale de Lausanne, Lausanne (EPFL)

In the +GF+ BOOST 4.0 large scale trial we implemented an Extract-Transform-Load pipeline to collect data from heterogenous sources, enriched-it by adding semantics, and stored it as linked data, using the Azure platform. We used an ontology for the semantical model, in order to standardize data and ensure that data is expressed using one common model all across the factory. The semantically enriched data could then be queried, visualized and used to implement a Machine Learning algorithm to deliver Predictive Maintenance services. Through this pilot, we demonstrated the possibilities that the combination of ontologies and a modern software architecture can offer in terms of asset digitalization, meaningful data standardization and data analytics, indicating a path towards Factory 4.0.

Fine-Twinning Next Generation Intralogistics Processes

Factory: Volkswagen Autoeuropa, Palmela, Portugal

Smart Planning & Commissioning 4.0

Volkswagen Autoeuropa (VWAE) belongs to an automotive manufacturing industry located in Portugal (Palmela) since 1995 and is a production plant of Volkswagen Group. VWAE competitiveness relies on increased efficiency in intralogistics processes. Currently the logistics process is heavily reliable on manual operations and in addition to that, the operation is performed inside the factory, where space is limited. On the receiving area trucks are traditionally unloaded by a manual forklift operation, and then the unit loads are transported to the warehouse where they will be stored either in shelve or block storage concept. System wise there is one database to control the parts coming from each truck and then a separate database, which registers the unloading, transportation and storing of the material in the warehouse. The data silo-based architecture did not provide basis for monitoring and optimization of the overall logistics process

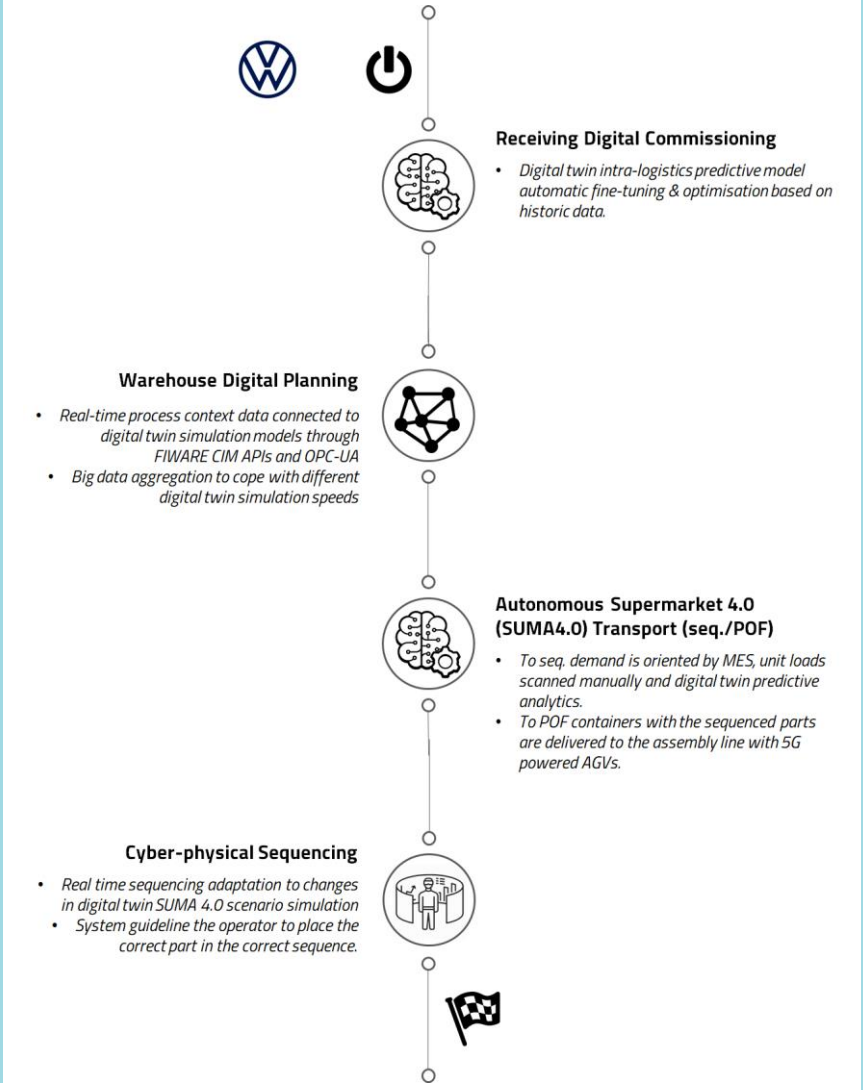
WW Autoeuropa large scale trial ambition was the implementation of a data-driven autonomous warehouse that translates into financial benefits for the Volkswagen Group, increase in flexibility (which is key specially during the introducing of a new model), minimization of human dependency for manual operations and thus an increase in the process efficiency. The automation and control of the process through a Big Data architecture enables a business intelligence approach to the warehouse system. The planning & commissioning of advanced intra-logistics 4.0 processes therefore presented clear big data challenges in the velocity (real-time warehouse data streaming), veracity (accuracy of digital twin simulations), variety (breaking intralogistics information silos) and volume (data deluge) dimensions.

Photo source: Volkswagen Autoeuropa

Supermarket 4.0 Intralogistics Smart Planning

Deployment and evaluation of a supermarket 4.0 intralogistics planning optimisation framework powered by simulation at VW Autoeuropa:

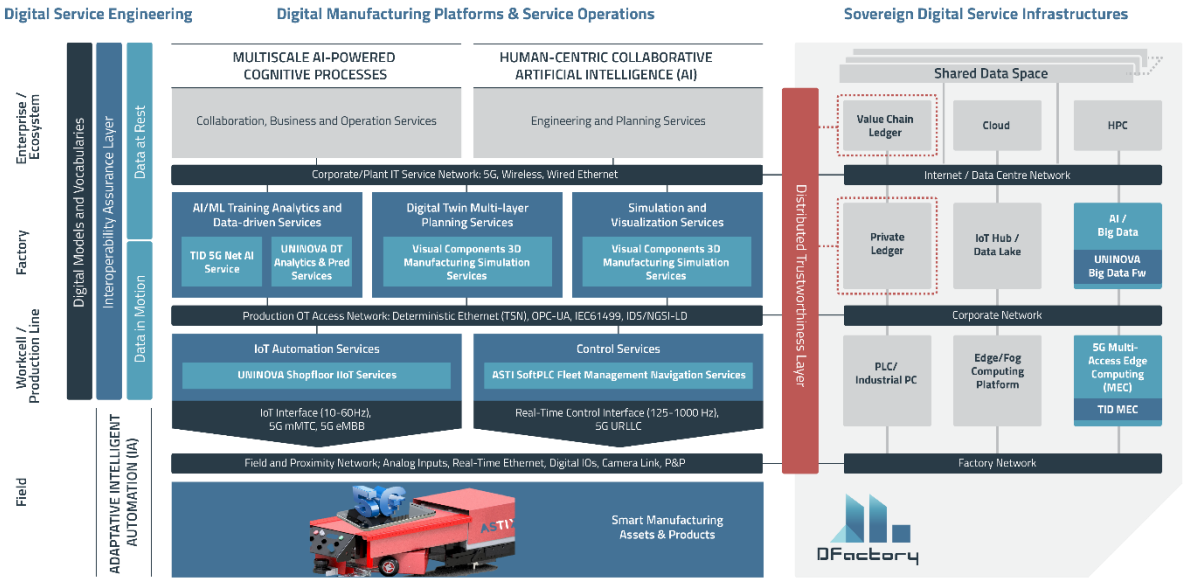
- Big Data and machine learning technologies to aggregate real-time logistics operations' data, perform prediction over the data and enable predictive and adaptive features.
- Real-time big data pipeline interconnection with simulation environment.
- Increase efficiency and flexibility by simulating on a digital twin multiple scenarios before SUMA 4.0 intralogistics process optimisation.
- Analytics and machine learning techniques used in order to analyse key performance indicator data returned by the simulation environment to establish the optimal logistics ecosystem.



Key Facts & KPIs

Idling time reduction	↓10%
Stock ownership reduction	↓ 10%
Time to market reduction	↓15%

Digital Factory Alliance (DFA)
Digital Service Integration Reference Model



Digital Solution Providers

VISUAL COMPONENTS

ASTI

Telefónica
Telefónica Investigación y Desarrollo

UNINOVA

The Boost 4.0 large scale trial ties with the Volkswagen brand's TRANSFORM.TOGETHER production strategy. The TRANSFORM.TOGETHER production strategy with its eight central action areas lays down the roadmap for leveraging existing efficiency potential and achieving a sustained increase in productivity. This strategy has defined eight main action areas containing concrete measures to drive the progress of the production strategy at all Volkswagen sites: productivity, team of the future, rework-free products and processes, sustainable structures, stable sales order process, ramp-up excellence, low-expenditure factories of the future and Think Blue. Factory

Mika Anttila,
Vice president of Product Development
Visual Components

The current production demands require more flexible production technologies, which could allow reduce the time to market and adapt to lean production, reduce overheads, cut errors, and reach ZDM. In the BOOST 4.0 project our 3D Simulation technologies have been further developed to be ahead of the current production demands and open new perspectives to our customers. Standardized management of big data sets is crucial to ensure productivity. Data sets are securely connected to the virtual environment that enables the Digital Twin. In the virtual environment, provided by the Digital twin, several layers of big data sets, from a simple actuator to the entire factory, are merged to analyse productivity, detect errors, and test and validate new production configurations. Our experience in the BOOST 4.0 project has been beyond our initial expectations. The large-scale pilots have opened new development perspectives which have successfully accomplished, tested, and validated in the project pilots and will become available in our commercial products during 2021.

Jesus Folgueira,
Global CTO
Transport and IP Networks,Telefonica

BOOST4.0 has opened an opportunity to demonstrate how 5G infrastructure and services and a common industrial framework can improve internal processes in companies involved on Industry 4.0 paradigm. Open collaboration in BOOST 4.0 with partners from different companies and expertise areas has been very enrichment for our innovation goals

Ricardo Jardim-Gonçalves
Director
Uninova

BOOST 4.0 was a landmark in UNINOVA's mission to pursue excellence in scientific research, technical development and education. It enabled to unleash the potential of Big Data technologies, combined with Digital Twins, creating value in Portuguese automotive industry

Moulding the Digital Control of Shopfloor Performance

Factory: Philips Consumer Lifestyle B.V., Drachten, Netherlands

Smart Production & Supermarket Intralogistics 4.0

Philips Consumer Lifestyle (Philips CL) wants to grow to become a key player in health and wellbeing by constantly delivering relevant and meaningful innovations. Philips CL in Drachten (Philips Drachten) is a principle site of electric rotary shaver manufacturing, occupying over 50% market share of a € 1 billion market. Philips Drachten encompasses a large suite of highly automated processes used during the manufacturing of electric shavers. Of these manufacturing processes, injection moulding is of particular importance, as this is used during the fabrication of plastic components for electric shavers. Injection moulding, however, is a competitive market, making it essential for Philips Drachten to continuously improve on quality, production performance, and costs where this process is concerned.

All of these plastic parts are manufactured onsite at Drachten, requiring approximately 80-90 moulding machines of multiple vendors, models and generations. For large manufacturing sites, generalization is key to deploy data driven solutions. It is simply not feasible to develop a specialized solution for each machine in the machine park.

Philips CL large scale trial ambition was to lower the amount of time required to enable analytic capabilities for each machine and develop big data scalable solutions for shopfloor operation optimization; along with seamless connectivity in the manufacturing process. This has resulted in efficient ramp-up times between different moulds, along with full traceability along the process chain all the way to the customer.

These new autonomous modes of manufacturing have leveraged new actionable production insights, business cases for production customization with frequent product changeover and smaller batch sizes and deployment of cloud-enabled scalable general predictive maintenance and process control solutions.

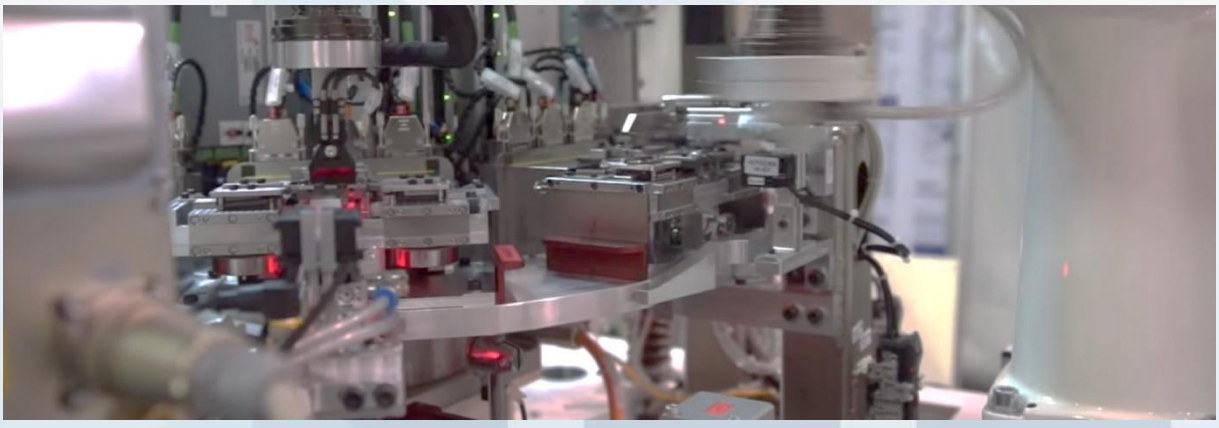
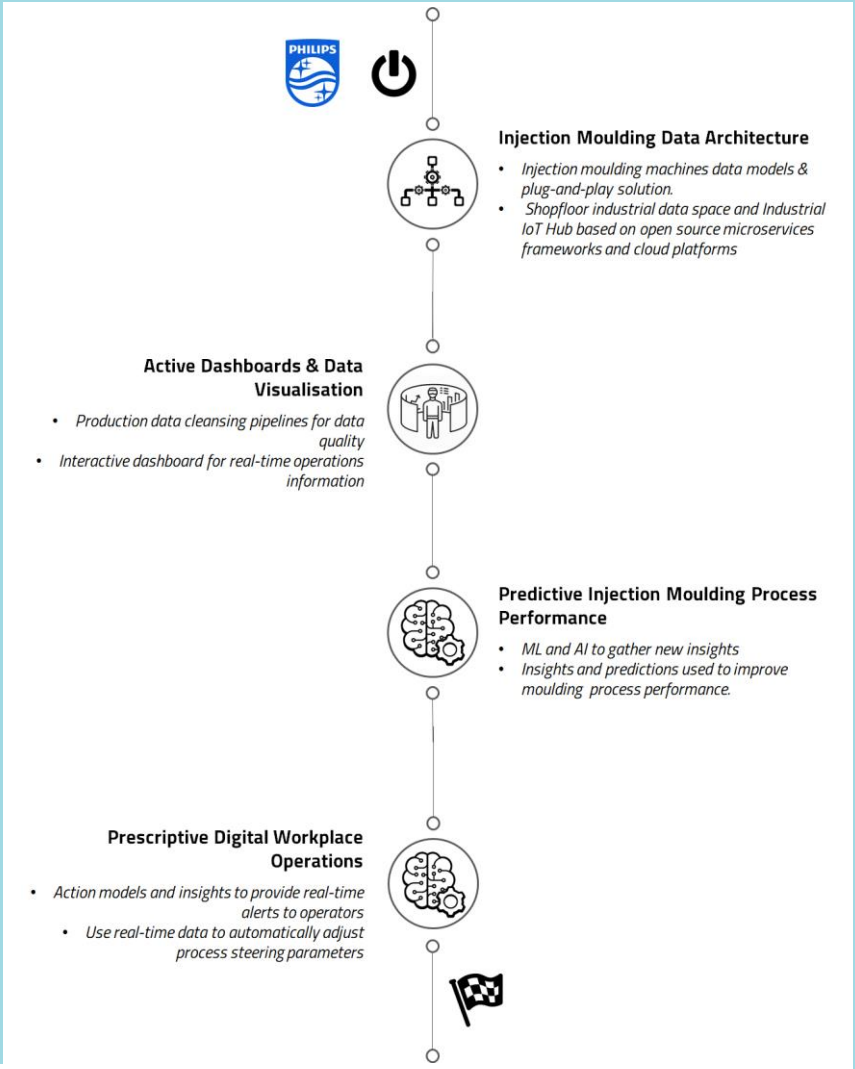


Photo source: Philips Consumer Lifestyle B.V.

Quality Analytics Automation for Injection Moulding

Deployme-nt and evaluation of a real-time shopfloor optimization, decision support and control framework for injection moulding lines at Philips:

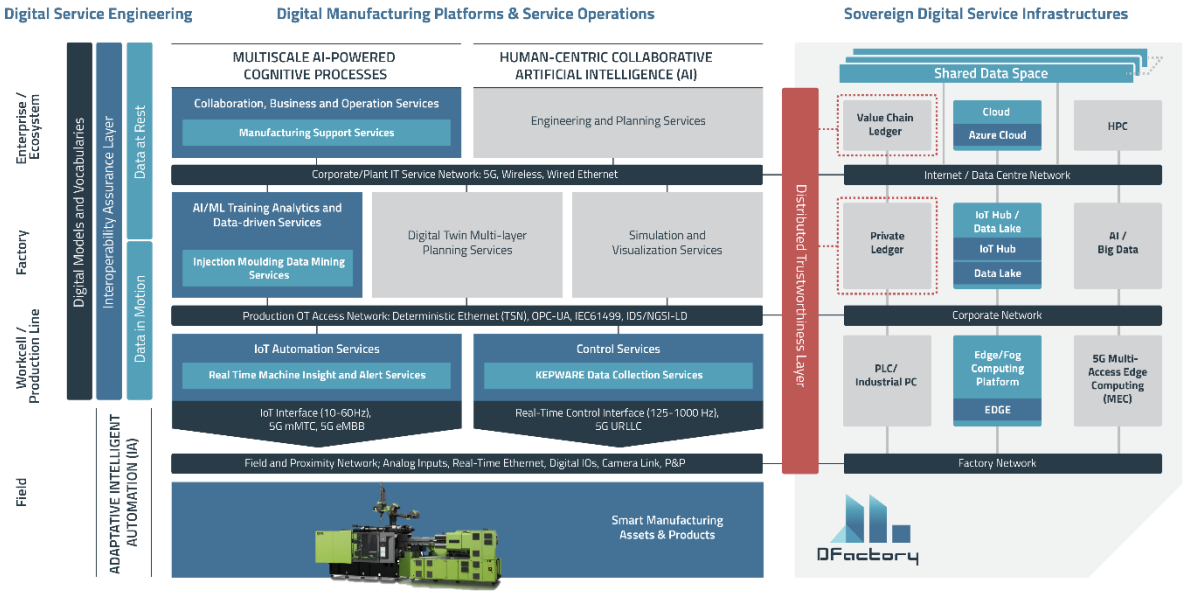
- Automation of process data gathering across the brownfield and greenfield machine park.
- Connect multi-variate (predictive) analytics and ML algorithms with production insights to action process improvements
- Use real-time data to automatically adjust process steering parameters in human-centred dashboards



Key Facts & KPIs

Fall-off rate reduction	↓10%
Downtime reduction	↓9%
Process data availability.....	... from 20 min to rt
Number of parameters monitored per machine per cycle	from 10 to 80
Time to connect machine to real time (rt)t platform.....	from 2 weeks to 4 hours
(Non)valuable & unnecessary operator control actions reduction.	↓70%

Digital Factory Alliance (DFA)
Digital Service Integration Reference Model



Digital Solution Providers

PHILIPS Research

imec

The vision is to have a unified strategic goal: managing all data sources on a modern and centralized platform, starting with injection moulding

Jaap ten Have
Operations Manager
Philips CL

The Boost 4.0 pilot is contributing to great results on the quality performance of the injection moulding machines, as well as providing breakdown on the process parameters and improving the interaction between the operator and the machine. With the Boost 4.0 pilot we wish to go about and implement across the entire factory for the injection moulding machines. We will shortly have new moulding processes for Mother and Childcare in place, which will give us the opportunity to further build on the great results achieved so far.

Jan Eysermans
(Former) Site Manager Drachten
Philips CL

It is a strategic goal to increase efficiency of Injection Moulding (IM) processes by at least 10% to keep Drachten attractive for Philips.

Rogier du Pau
Global Engineering Manager
Philips CL

The moulding department is one of the largest within Philips and increasing. Therefore, the Boost 4.0 pilot is an important project for us as a site as well as for Philips. The aim of the pilot is to create transparency within our manufacturing process and use that for improvement in quality and yield on our machines and equipment.

Prof. Bruno Volckaert
IMEC

For IMEC, the Boost4.0 project allowed academic innovation in terms of micro-service driven IoT data handling backends to be evaluated thoroughly in an operational industry4.0 setting, where reliability and production readiness are of the utmost importance. A new focus on software robustness arose, especially given current complex distributed ecosystems where data from different manufacturers speaking heterogeneous protocols all needed to be integrated and delivered to a machine learning backend.

Assembling an Autonomous Automotive Production Line

Factory: FCA | Centre Research Fiat, Melfi, Italy

Smart Production & Supermarket Intralogistics 4.0

Traditional automotive linear production process presents different criticalities e.g., saturation of processing stations and logistic equipment, space shortage at the lineside. The evolution is moving towards autonomous and flexible production lines.

FIAT Chrysler Automobiles (FCA) has implemented a large-scale trial of an autonomous production and welding cell, which assembles components for a middle size commercial truck, with high complexity and high variability (roughly 6 to 10 vehicles per hour). CFA is introducing the concept of autonomous production, where the traditional linear process is removed and Mobile Robots such as Automated Guided Vehicles (AGVs) and Collaborative Robots with vision capabilities among others are included.

These mobile robots have duties related to logistics (e.g., replenishment, preparation of components, etc.) or manufacturing (e.g., carrying work in progress). The control of fleets of such AGVs and their availability and reliability to respect cycle time and lead-time is crucial to ensure the stability and throughput of the production systems.

Planning and control of the mobile robots and monitoring and maintenance of the mobile robots became crucial as prior to the trial there were no specific approaches to store and analyse data related to the missions of the vehicles, their wear-out and availability (impact of lead time for delivery, uncertainty with human operators' interactions).

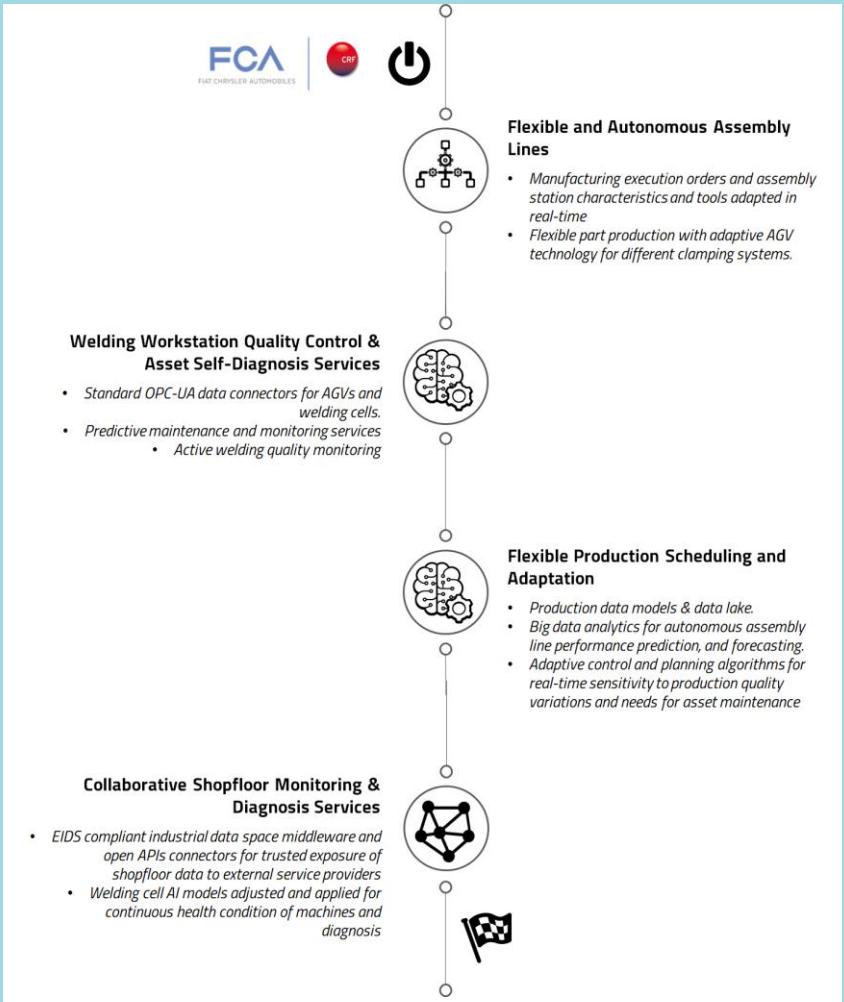
The ambition of the autonomous digital production line trial was to gather evidence about (1) the digital solution to deliver flexibility to potential changes in the demand or to issues/delays/changes in the logistics or productive systems (2) over-dimensioned fleet of robot's reduction; and (3) business continuity robustness to avoid business interruption (e.g., stock-out, unwanted waiting or idle time for the machine), delays and reduction of throughput. Moreover, the large-scale trial has also demonstrated that FCA can deploy a trusted data space solution for data sharing among the whole value chain (providers, maintenance services, etc.) to ensure availability not only of mobile robots but also of the manufacturing assets; autonomous welding cells in this case. This is crucial to transfer the autonomous production concept to the rest of the plants of FIAT Chrysler Automobiles Group.

Photo source: FCA

Autonomous Production and Welding Line Operation

Deployment and evaluation of a predictive framework for maintenance and control of autonomous production lines at FCA:

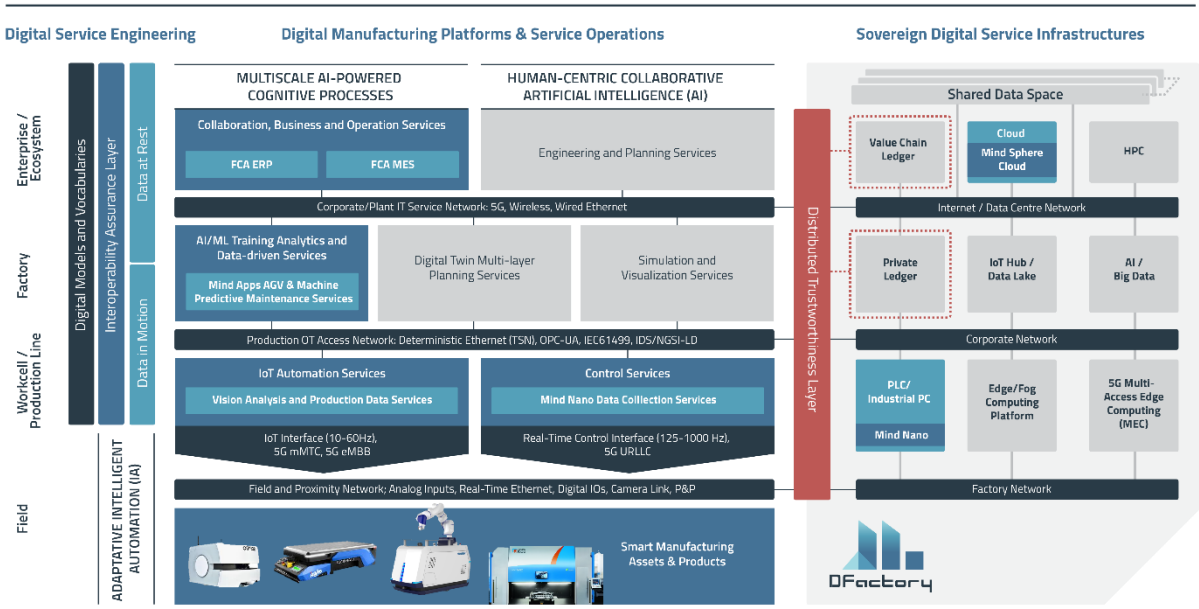
- Enable optimal production mission planning and adaptive management of incoming events.
- Develop a predictive analytic platform which, based on the continuous data flow coming from the shopfloor can determine the planning of maintenance activities.
- Standardised procedure to deal with the huge amount of product and process data and build contextual decision support systems



Key Facts & KPIs

WIP increase	↑2%
Intralogistics costs reduction	↓13%
OEE increase	↑10%
Maintenance cost reduction	↓8%
AGVs efficiency increase	↑25%
AGVs saturation	92%
Job throughput increase	↑20%

Digital Factory Alliance (DFA)
Digital Service Integration Reference Model



Digital Solution Providers

SIEMENS

PRIMA INDUSTRIE

POLITECNICO MILANO 1863

Giuseppe Sellitto
Responsible for WCM
Campus Melfi, CRF | FCA

The Boost 4.0 large scale trial at FCA CRF Melfi represents a powerful occasion to import a new concept of industrial production in the automotive field and to inquire and implement big data analysis techniques in order to increase the system performances using and matching data which are often already generated and available in the company environment. Starting from the implementation of the project pilot. We are planning to extend its approach and contents to other company plants.

Paolo Calefati
Vice President and Head of Innovation
Prima Industrie SpA

The Boost4.0 project has taken the exploitation of Big Data analysis to a higher level in our company, especially on the creation of business value. Thanks to this greater awareness on this topic at a higher corporate level, Prima Power has consolidated its membership in the Mindsphere World IoT Community.

Pasquale De Leo
Head of Customer Services
SIEMENS

MindSphere is the leading industrial IoT Platform designed for every business application, from SMEs and Start-ups to big Corporation, and it is a driver for the industrial digitalization. MindSphere is not only able to collect and analyse all kinds of sensor data in real time, but also it is an operating system equipped with an open interface that can be used to develop a new business model approach for OEMs and Developer team to allow them to sell their cloud applications.
In the scope of the Boost4.0 project, the industrial experimentation intends to demonstrate how different data streams coming from the automation level can be captured and used to extract added value using the big data IoT platform. The experimentation also exploits how this cloud platform can integrate domain specific applications in order to enrich the prototype with the value introduced by digitalization.
Data Flow, availability, security and analytics are the main challenges in this industrial experimentation.

Sergio Gusmeroli
Research Coordinator
Politecnico di Milano

The BOOST4.0 FCA / PRIMA Industrie / SIEMENS industrial pilot, operated by SIEMENS Mindsphere Industrial IoT platform and enabled by powered-by-FIWARE Open-Source components, represented a unique opportunity on how high value Data Sets, secure Industrial Data Platforms and configurable multi-stakeholders' business and innovation models could become an embryonic Data Space for the Automotive industry. The Italian IDSA Hub and the MADE competence centre initiatives supported by POLIMI could further amplify the impact of this industrial pilot"

TRIMEK
METROLOGICAL ENGINEERING

Metrology 4.0 Under Control for All Dimensions

Factory: GESTAMP Automotive Smart Factory (ASF), Boroa, Spain
Motor Sport Institute (MSI), Madrid, Spain

Smart Manufacturing & Logistics 4.0

Trimek is a Coordinate Measurement Machine builder part of Innovalia Metrology. Innovalia Metrology is a strategic alliance between Trimek, Datapixel and Unimetrik – three Innovalia Group companies that have joined forces to offer manufacturing sectors with best-in-class metrology solutions. Innovalia Metrology offers metrology solutions that integrate traditional metrology with the latest technological developments, from laboratories to production lines. Innovalia Metrology is a pioneer of virtual metrology and 3D scanning technology for metrology. Through the M3 dimensional metrology 4.0 platform, Trimek delivers a unique traceability workflow to guarantee measurement accuracy for parts and components that are vital to the manufacturing process, and to enable the achievement of higher levels of productivity and efficiency in production processes.

Up to now, the metrology results were usually only visualized in statistical End of Line (EoL) reports based on the Geometric Dimensioning and Tolerancing (GD&T) analysis, which is aimed only for metrology use and where few control points are considered (10-100 points). The integration of such information in industry 4.0 workflows is cumbersome, slow, costly and not amenable to automation.

New zero-defect manufacturing (ZDM) processes demand that traditional metrology laboratory processes are transformed into metrology 4.0 processes and scale up data acquisition, processing time and visualization speed various orders of magnitude. This is in accordance with the demand for more holistic, flexible and fast metrology solutions for Industry 4.0; irrespective of the geometrical complexity or size of the part manufactured.

The Trimek large scale trial has implemented a highly automated, high-speed, high-density, high-resolution dimensional analysis of automotive chassis frames, ensuring full traceability. The ambition was to leverage a generic big data pipeline exploiting international standards such as QF ISO 23952:2020 for visual analysis of massive 3D point clouds (from 10-100 million points) for very large parts in less than 30 seconds; increasing various orders of magnitude the manufacturing capabilities of the sector.

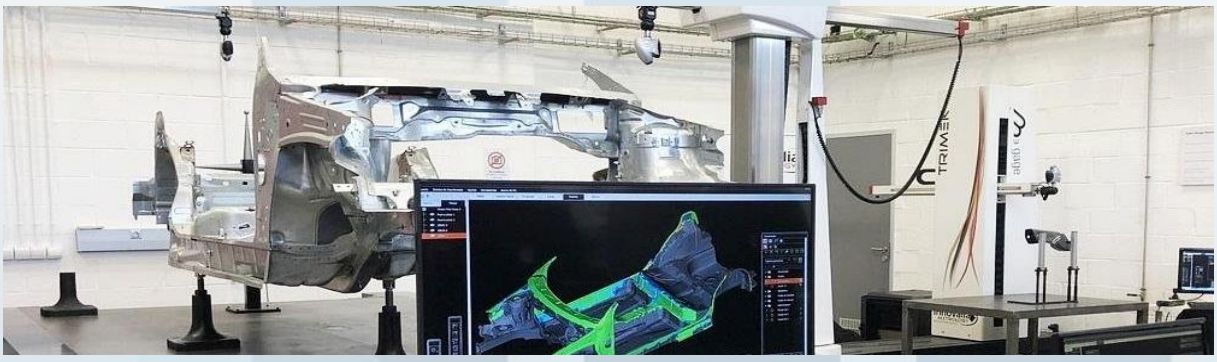
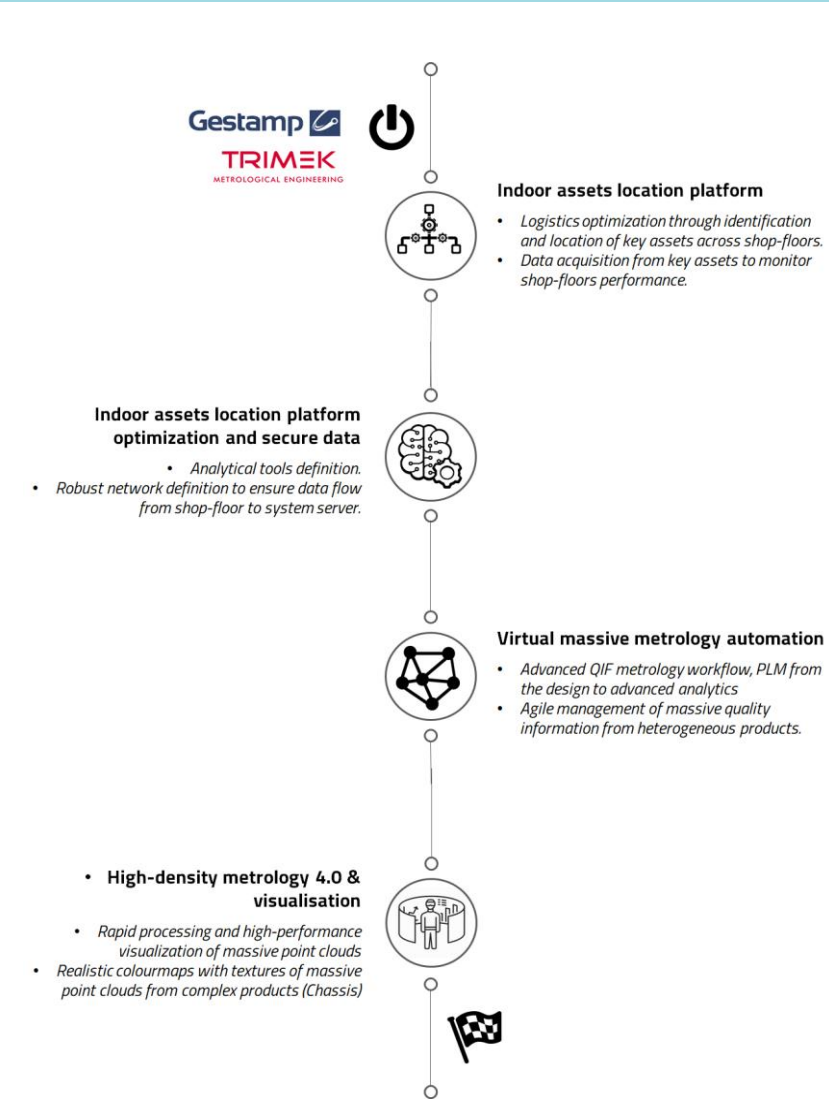


Photo source: Innovalia Metrology

Large-Scale Metrology 4.0 for Automotive Chassis ZDM

Deployment and evaluation of a metrology 4.0 3D (visual) analytic framework for quality control of large components at Automotive Smart Factory (ASF) and MSI facilities:

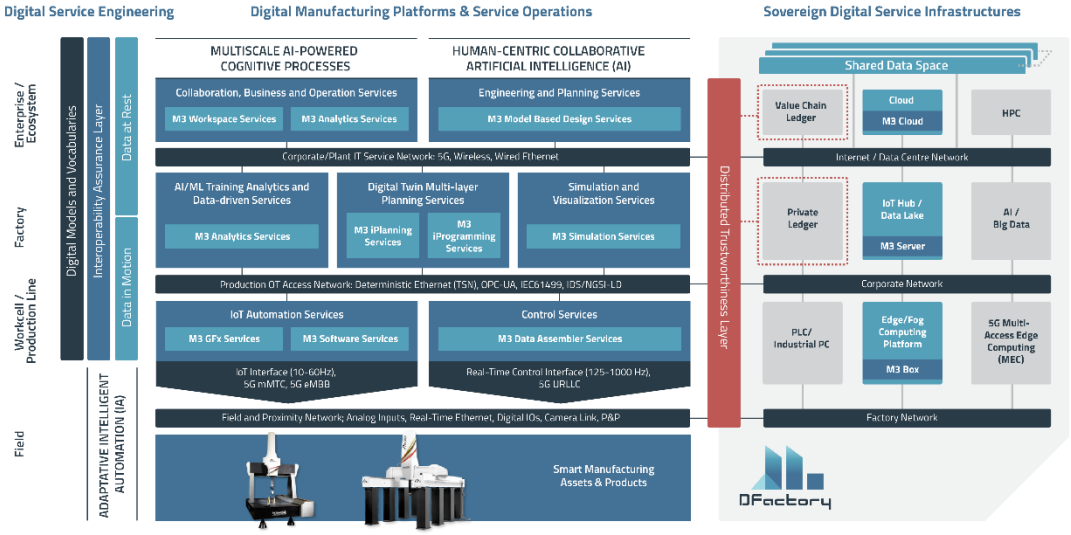
- Rapid processing and high-performance visualisation of massive and multi-sensor 3D point clouds
- Multi-purpose QIF-enabled Industrial IoT digital quality control workflows for massive digital thread product and manufacturing process information & trend analytics
- High-speed high resolution texturized colourmaps for high fidelity visual analysis of massive point clouds



Key Facts & KPIs

Measurement planning and programming times reduction	↓80%
GD&T features controlled	+600
Massive point clouds acquisition & processing time	↓73%
Increased metrology efficiency	4.5x
Products rejection reduction	↓100%
Cost reduction	↓25%

Digital Factory Alliance (DFA)
Digital Service Integration Reference Model



Digital Solution Providers

innovalia METROLOGY
eneo tecnología
innovalia ASSOCIATION

"Future metrology will be used to assess and guarantee the fit, performance and functionality of every part and support the targets of zero waste and carbon neutrality"

Rafael Garcia
Director Clio R4 Program
Motor Sport Institute (MSI)

It's impossible to build a vehicle of these characteristics without having access to this new type of reliable metrology 4.0

Laura Francos
Product Manager
TRIMEK

The Boost 4.0 large scale trial has been instrumental in adding new capabilities to our M3 metrology 4.0 platform. This bring quality control to new levels of efficiency, performance, integration and automation that are critical for our customers to be able to fully develop their Zero-Defect Manufacturing strategies. With Boost 4.0 we are bringing quality control from traditional End of Line statistical approaches to new digital approaches that put dimensional data within reach of inline quality control and digital twin solutions. With Boost 4.0 technologies the size of components is no longer a limiting factor for Industry 4.0 dimensional control solutions in the line. We can design strategies, acquire product dimensional data and compute information at unprecedented speeds, unseen accuracies and at massive scales. This is a revolution to keep manufacturing processes under control.

David Vanhoucke
CTO
ENEO Tecnología

Access, use and connection to data is critical to Metrology 4.0 solution adoption. redBorder cybersecurity big data active manufacturing network monitoring trialled in Boost 4.0 has revealed itself as a powerful tool to put your mind at ease about the security of your digital infrastructures and focus on what matters you most: your smart manufacturing process.

Alicia Gonzalez
Director Automotive
Intelligence Unit (AIC)
Innovalia Association

Digital thread continuity is critical to implement intelligent digital twin services in automotive. The Boost 4.0 large scale trials and testbeds have allowed us to build the most necessary evidences that open standards such as QIF, ProSTEP, FIWARE CIM and IDSA DIN SPEC 27070 can indeed work together and deliver the trust required to bring data across the product and process lifecycle under a European industrial data space to address Zero-X manufacturing challenges such as zero unplanned breakdowns or zero-defect manufacturing.

Manufacturing Resource Efficiency Tracking & Optimisation

Smart Manufacturing & Logistics 4.0

Factory: Gestamp S.A., Abrera, Spain

Gestamp is an international group dedicated to the design, development and manufacture of metal automotive components. The Group specializes in developing innovatively designed products to achieve increasingly safer and lighter vehicles, thereby reducing energy consumption and environmental impact. Gestamp is in more than 20 countries and has more than 100 plants worldwide.

The pilot will take place on the plant that the Group has in Abrera, Barcelona (Gestamp Abrera). This plant is one of the reference plants of the Group when we talk about Industry 4.0. In addition, there are different industrial process on this plant what make the collaboration of different assets such as: furnaces, robots, welding systems, laser, chillers, etc. The Business Case on this proof of concept is focused is some of the Industry 4.0 initiatives oriented to increase the performance and the efficiency, by reducing the waste of material, the non-quality parts, the energy consumption, etc. For that, the monitoring of the different assets that conforms the industrial process is a must.

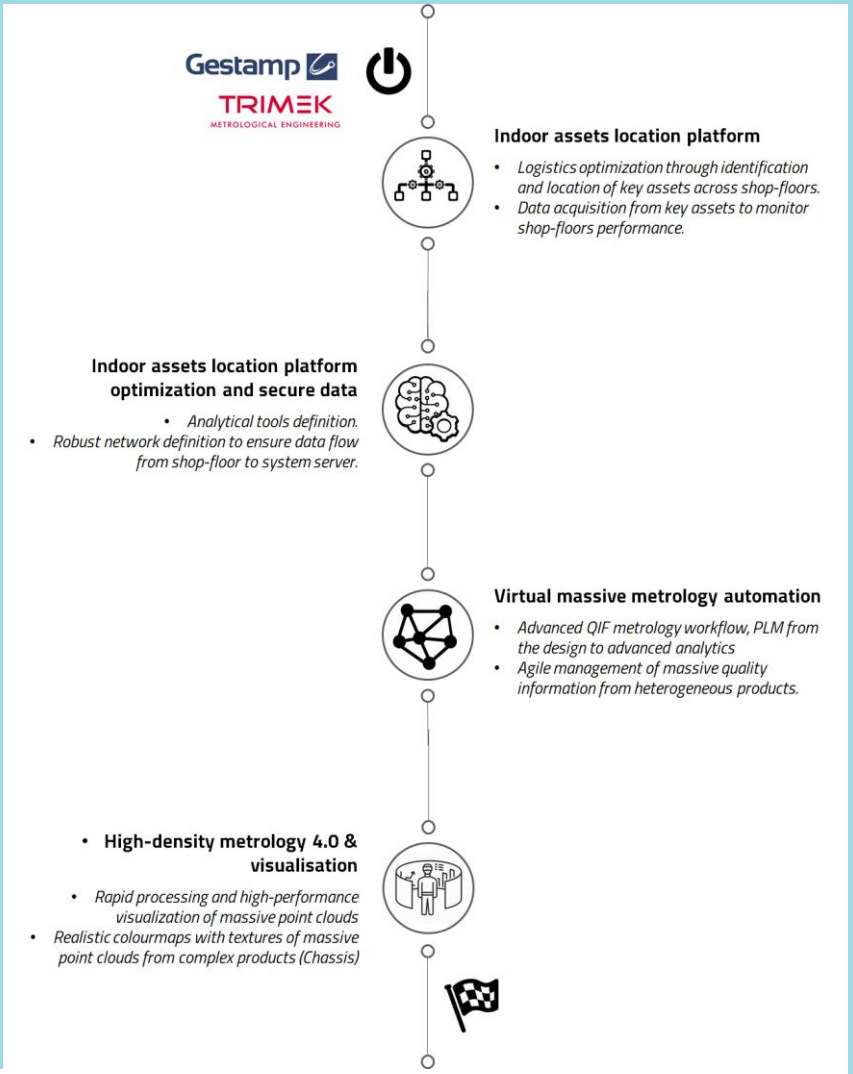
The aim of GESTAMP resources efficient factory 4.0 is to improve the energy consumption, the performance and efficiency of machines (chilling, etc.) in terms of production performance and cost, the reduction of the waste materials and defective parts.

Photo source: Gestamp S.A.

In-factory Real Time Positioning of Moving Assets & Parts

Improvement the current management of the logistics in pilot plant by localizing in real-time the main moving assets. This allows identifying current inefficiencies and areas of improvement on the logistics and production processes:

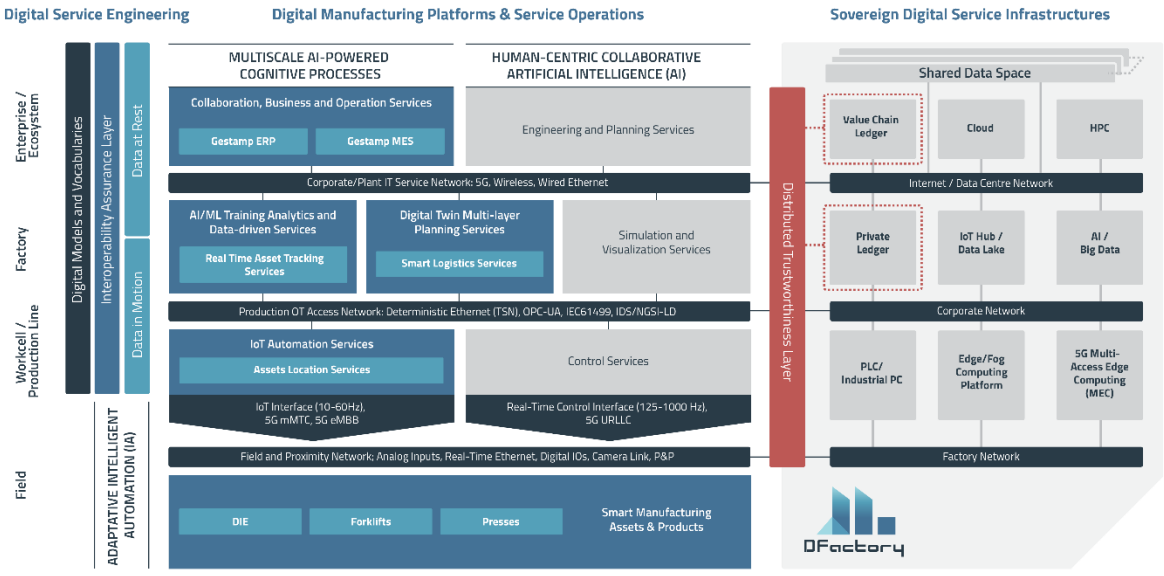
- Integration of different data sources generated by the tracked assets
- Usage RFID & UWB technologies to detect with precision the positioning of industrial assets
- Effectiveness improvement in terms of availability of shop-floor
- More dynamic and flexible allocation of resources.



Key Facts & KPIs

Storage area optimization	↑10%
Logistic route occupancy reduction	↓ 5%
Delivery preparation reduction	↓10%

Digital Factory Alliance (DFA)
Digital Service Integration Reference Model



Digital Solution Providers

i2cat

Diego Mallada
IT Digital Director
GESTAMP

Our Industry 4.0 initiatives aims create more efficient and flexible manufacturing plants and more consistent and reliable processes through the analysis of our data, by adding intelligence to the processes and getting the right information to the right people. Our trials in Boost 4.0 provide a key step in the realization of our approach to make Gestamp a digital factory leader in the automotive sector.

Dr Sergi Figuerola
CTIO, I2CAT
CTO, 5GBarcelona Alliance

The Boost Project has brought to i2CAT specific knowledge in the development and implementation of Data Spaces based on the data sovereignty model of IDS while developing systems for objects identification and positioning for industry 4.0. Thus, the project has facilitated the development of a successful pilot within the automotive sector while strengthening i2CAT's position.

From Sheep to Shop: High-End Textile Business Network Tracking and Tracing

Factory: Frateli Piacenza S.P.A., Biella, Italy

Smart Manufacturing & Logistics 4.0

Textile value chain is characterized by the production and treatment of unfinished goods in B2B business relationships. It is very fragmented and distributed in a plethora of very small5 specialized subjects, usually sub suppliers, working for a few number of relatively larger fabric producers (wool mills), of medium dimension, mid-caps mainly. Especially in the case of high-value textiles, the design of new products' catalogues (collection) has recently implied a transformation for EU textile companies into "product-service" suppliers, since even the highest quality textile production would now become empty and worthless if disjoint from a close symbiotic collaboration with the stylists of clothing, in order to personalize fabrics (exclusive textiles) and to support them with the design of extremely customized products. Piacenza is one of the few undisputed worldwide leaders in high fashion fabrics and accessories production. With an average industrial sale price around 70 Euro per meter, corresponding to more than 2.500 Euro per coat at retail price, and a design proposal of more than 1.000 new styles per year Piacenza is supplier of all leading fashion groups (Louis Vuitton, Burberry's, Gucci, Prada, Zegna, Hermès, Dior, Hugo Boss among the others), to whom it also provide a close collaboration in the definition of customized and exclusive fabrics. Based in Italian textile district of Biella, where all its production is realised, and it is one of the oldest textile industries of the world, founded in 1733 and from then on owned by the Piacenza family. Piacenza competitive strategy is focused on maximum differentiation of the product, in terms of raw material choice, style, and colour. Each year more than 1.000 designs are introduced into the market. This key competitive advantage is enforced by design know how and quick flexibility to customer requests, where the offer of new, customized and/or exclusive fabrics in close cooperation with fashion stylists. This cooperation with clothing designer has become so close that hundreds of exclusive fabrics are specifically realized for fashion leading industries every year. Piacenza strategic target is not to increase quantity but average price, enforcing market barriers based on design, know how, personalized service and sharp delivery.

Ambition:

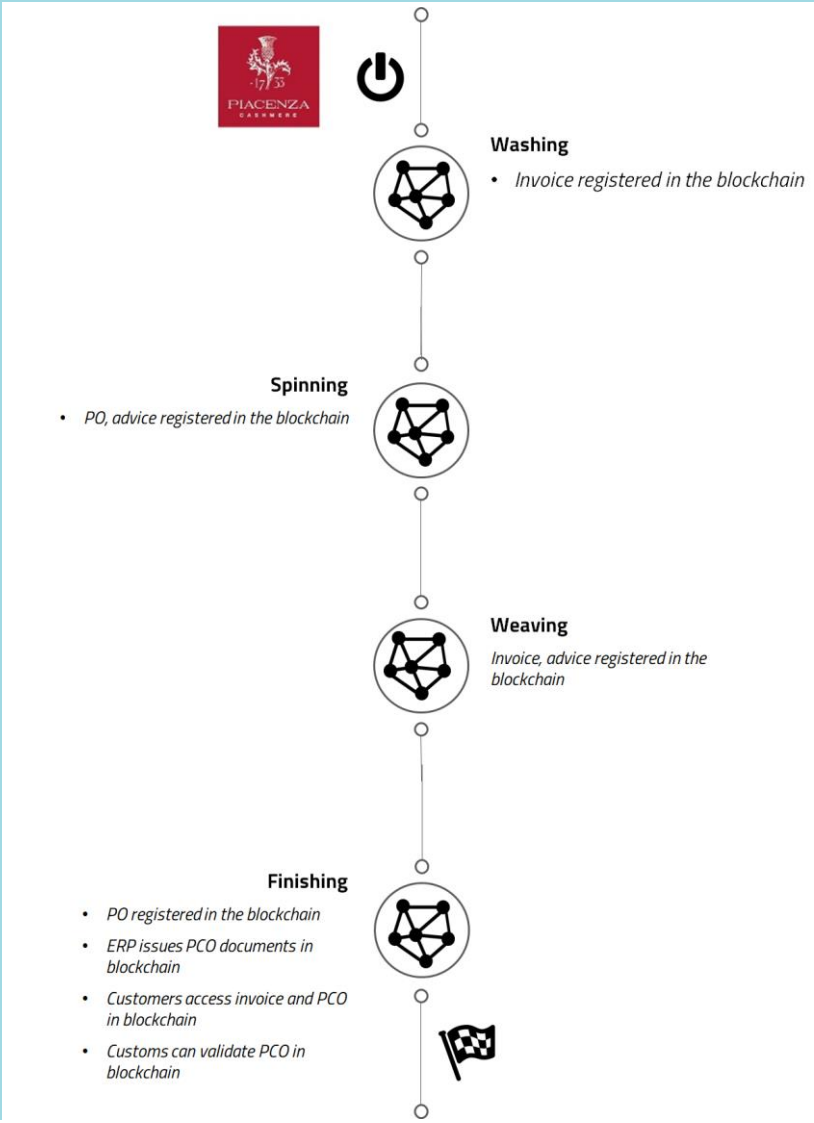
in terms of the management of the very complex and variable amount of data to manage the very erratic, unpredictable and fragmented production of hundreds of thousands of design and colour combinations in the very long textile value chain more than 70 passages) to grant clothing luxury customers an undisputed high-quality service, with a near to zero delivery delay.

Photo source: Frateli Piacenza S.P.A.

Assurance of Preferential Certification of Origin (PCO).

The garment and footwear industry has one of the highest environmental footprints and risks for human health and society. The complexity and opacity of the value chain makes it difficult to identify where such impacts occur and to devise necessary targeted actions. Key actors in the industry have identified interoperable and scalable traceability and transparency of the value chain, as crucial enablers of more responsible production and consumption patterns, in support of Sustainable Development

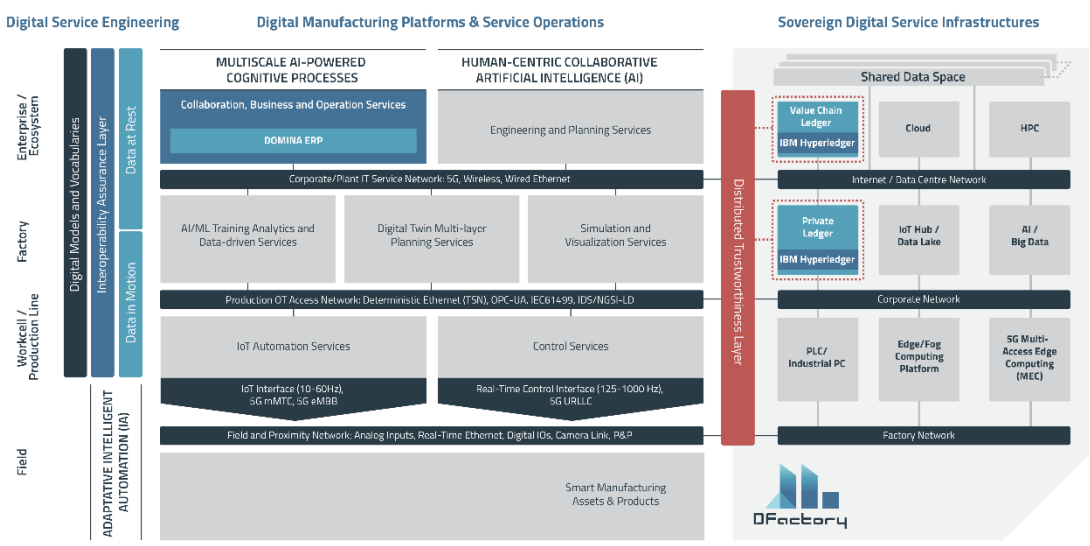
- Shared tamper-proof ledger that tracks the fabric manufacturing from source to sales
- Providing final consumers with full provenance of items and documents
- Full visibility of textile manufacturing by a non-modifiable and safe blockchain process, which prevents counterfeiting and unfair competition.



Key Facts & KPIs

Zero delay delivery improvement	↑25%
Monetary savings	↑35%
Increase of Mark Up	↑5%
Paper work reduction	↓95%
Process automation	↑95%

Digital Factory Alliance (DFA)
Digital Service Integration Reference Model



Digital Solution Providers

IBM

domina data management

Mr. Carlo Piacenza
CEO
Piacenza

"The new generations are increasingly aware and attentive to the planet and are asking us for a greater commitment to being ethical and transparent companies. Knowing the origin and the entire life of a product gives the consumer the opportunity to make conscious choices, and in the small of each of us to make an important contribution to the future both from an ethical and environmental protection point of view.
I am also very proud to testify that in our products, know-how and made in Italy play a leading role in luxury and excellence at an international level.
I am an optimist by nature and already with the advent of new generations in the company the technology and traceability project has had a new impetus, we have very ambitious goals and we are working to translate our vision into reality. Starting from Boost 4.0 project, we strongly believe in "creating a system" for traceability and for this reason we are happy that EC appreciated our commitment and approved a large project called TRICK starting in May 2021, for full implementation of textile traceability, with 29 partners covering the whole complex textile value chain, including recycling, research centres and public institutions like the nation custom agency.

Dr Asaf Adi
Senior Manager
IoT, Blockchain and AI
IBM Haifa Research Lab

"IBM Research - Haifa embarked on the BOOST4.0 project aiming to explore innovative blockchain solutions that can impact real-world use cases. Specifically, in BOOST4.0 we applied Hyperledger Fabric, the flexible blockchain framework behind the IBM Blockchain Platform, to the fashion supply chain in collaboration with Piacenza, an Italian manufacturer of high-end fabrics.

The supply chain is considered one of the most prominent fields for the application of blockchain technologies because it is a fragmented and siloed domain. Within the supply chain, there are numerous stakeholders, who are often unrelated or may even be competitors, therefore trust is a major problem in this business network. Blockchain introduces trust, security, and transparency to the supply chain. The textile industry is no different; it involves many different parties and many complex steps for the raw materials to go from 'sheep to shop'. This presented an ideal environment to work on.

We applied blockchain to build a shared tamper-proof ledger that tracks how the fabric was manufactured from source to sales — including who, what, where, when, and under what conditions. We leveraged IBM Blockchain Transparent Supply, a blockchain platform that enables companies to build their own data-sharing ecosystem with trusted supply chain partners.

I see tremendous potential in strengthening and supporting the fashion supply chain, especially now, that many consumers and fashion organizations in Europe are beginning to realize that blockchain can serve as an enabler to ensuring their supply chains are trusted, transparent, and sustainable.

Delivering a Predictive Customer Service Experience at Scale

Factory: Whirlpool EMEA, Carinaro, Italy

Smart Customer Service & Maintenance 4.0

In the Customer Service activity of a large company in White Good industry, the spare part production and management is one of the most complex and important pieces.

In fact, having to do with a large number of different product families, a huge number of different product codes, a legal duty to keep parts for all the product lifetime of about 10 years and a new product introduction cycle of 18-24 months imply a very high degree of complexity.

In particular, planning of spare parts is currently very difficult since has to deal with thousands of components for which forecast is not actually available. In fact, planning is not MRP-deterministic but mainly driven by discrete customer's orders. On the other side, a lot of different kind of datasets that could help the planning process are present in the company: long historical database of orders, claims coming from the consumers, quality and production data.

The main business competitive improvement driver for Whirlpool is to develop a forecasting technique and tool that could be used to plan the production, storage and management of spare parts, and enabling the reduction of lead time and decreasing inventory in terms of safety stock by providing visibility of orders ahead of time.

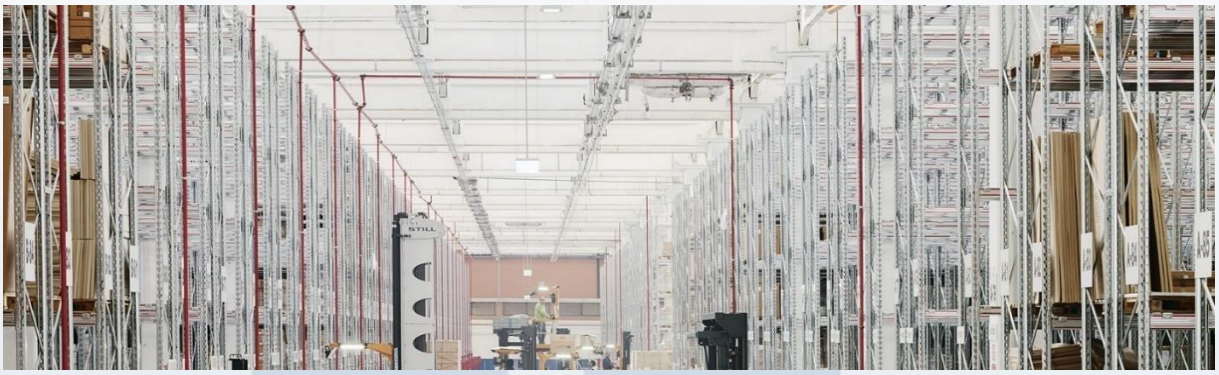
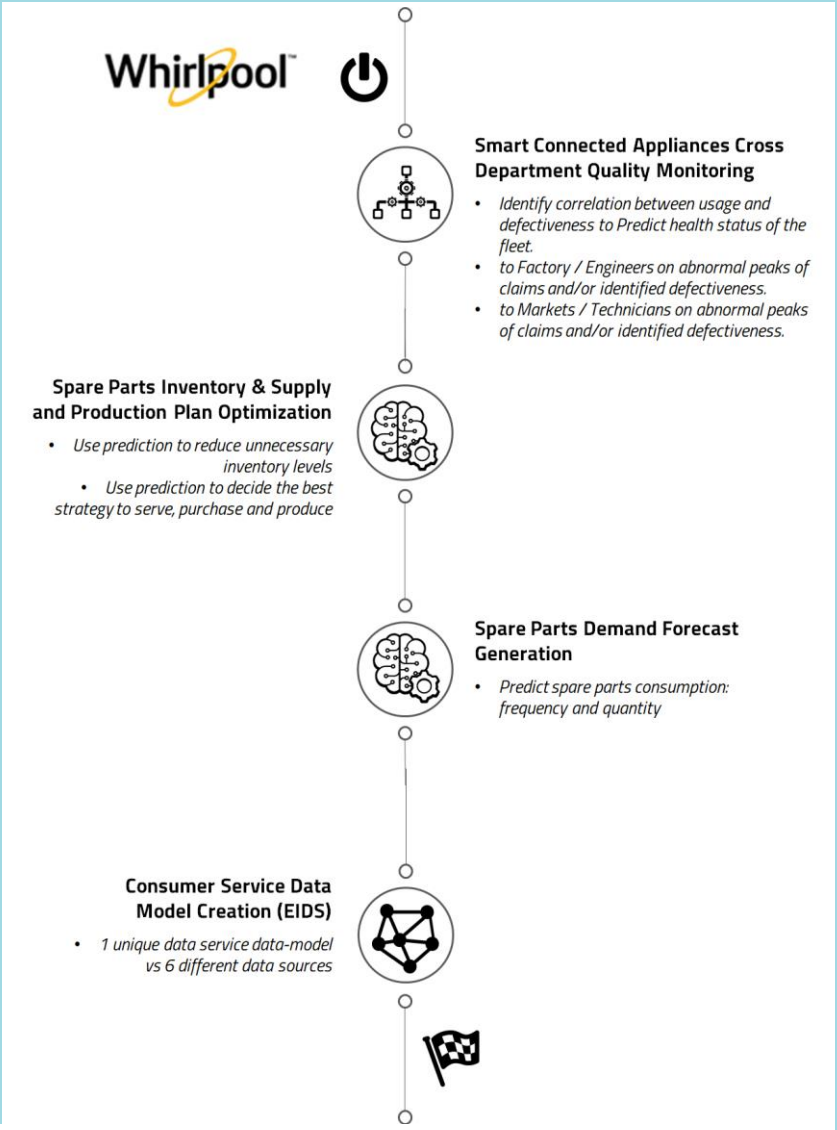


Photo source: Whirlpool EMEA

Demand Forecasting for Customer Service Planning

Deployment and evaluation of a predictive framework for spare part management at Whirlpool EMEA:

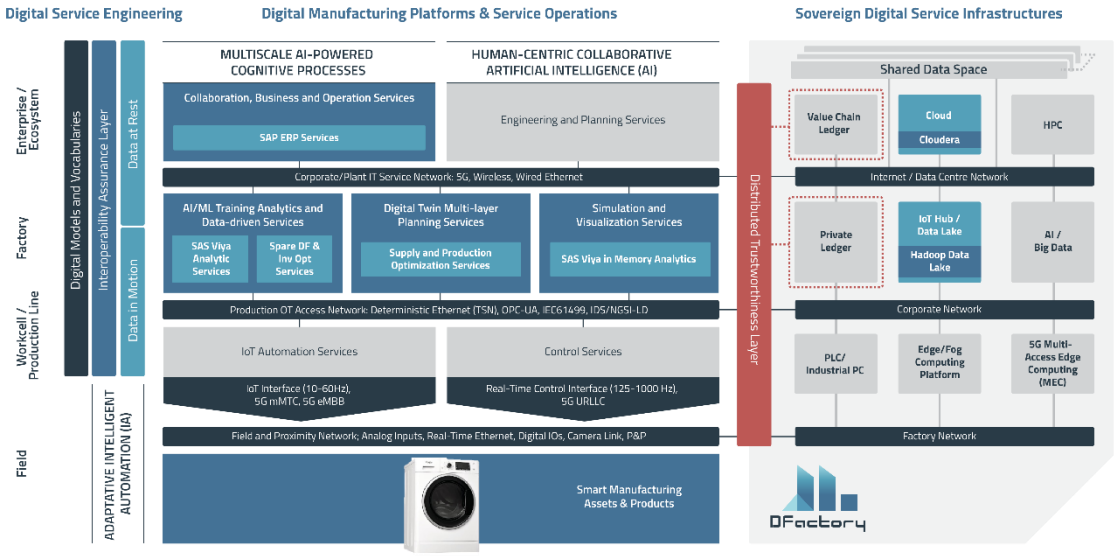
- Spare part production and distribution is one of the most complex and important challenges of the after sales services
- Field Service Engineers do have the need to rely on a central warehouse where the right parts are available at the moment, they need to make a repair
- Large number of different product families and huge number of different product codes with different components to be handled



Key Facts & KPIs

Demand forecast error reduction	↑20%
Quality of user experience	4,5 over 5
Human effort for planning improvement (hours/week)	↓15%
Spare park stock value reduction	↓26%
Spare park stock quantity reduction	↓19%
Inventory turnover	↑35%

Digital Factory Alliance (DFA) Digital Service Integration Reference Model



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POLITECNICO MILANO 1863

Lamberto Socci
Customer Service Planning Manager
Whirlpool EMEA

The potentiality of this new tool is impressive

Anetta Puzanau
Customer Service Planning Specialist
Whirlpool EMEA

With this new tool we will be able also to better manage the peaks of the market requests

Stefano Mercuri
Customer Service Planning Specialist
Whirlpool EMEA

With all the information inside this new tool, we will have a big improvement of the forecast proposal

Dr Natalie Cernecka
Head of Business Development,
TeraLab

Participating in BOOST4.0 project and contributing to the Whirlpool pilot was beneficial for TeraLab in three ways

First, the pilot helped us to mature the so-called turnkey offer of our data infrastructure platform.

Second, the pilot gave us a valuable experience serving a large international company such as Whirlpool.

And third, the pilot confirmed our expertise offering data driven solutions for manufacturing, which is among our three strategic priorities.

Sergio Gusmeroli
Research Coordinator
Politecnico di Milano

The BOOST4.0 Whirlpool / SAS industrial Pilot is a concrete demonstration of how and to what extent data-driven Digital Transformation originated from a strategic collaborative partnership between Large multi-national companies could provide a large-scale impact at local level by involving hundreds of SMEs along the Whirlpool's and SAS' value chains. This is very much in line with POLIMI education and innovation strategy for SMEs digital transformation"

Automotive: Big Data Spaces for Predictive Maintenance Services

Factory: Paderborn, Germany

Smart Customer Service & Maintenance 4.0

Reactive maintenance strategies lead to costly unplanned downtime of industrial assets. Preventive maintenance strategies, on the other hand, result in replacement of fully functional parts. Moreover, root cause analysis in case of machine failure is a bottleneck in the maintenance process.

Careful analysis is required to return assets back to production, but field engineers and service teams often lack data and insights needed to troubleshoot the underlying issues. Data-driven maintenance support and predictive maintenance strategies are an appropriate means to address these issues.

Continuous machine data means continuous analysis, risk assessment, and process coordination resulting in fewer field service calls, remote monitoring and diagnostics, and proactive (predictive and prescriptive) equipment maintenance. While the data-driven modelling techniques for predictive maintenance applications is maturing, these models and their output require careful integration into the entire infrastructure, maintenance organization and process.

The conception, selection, training and deployment of data-driven models for different assets is still a manual process, which prevents large-scale rollout of data-driven maintenance schemes. A flexible and interoperable framework, tool-chain and process is missing to boost the impact of data-driven, predictive and prescriptive maintenance appliance.

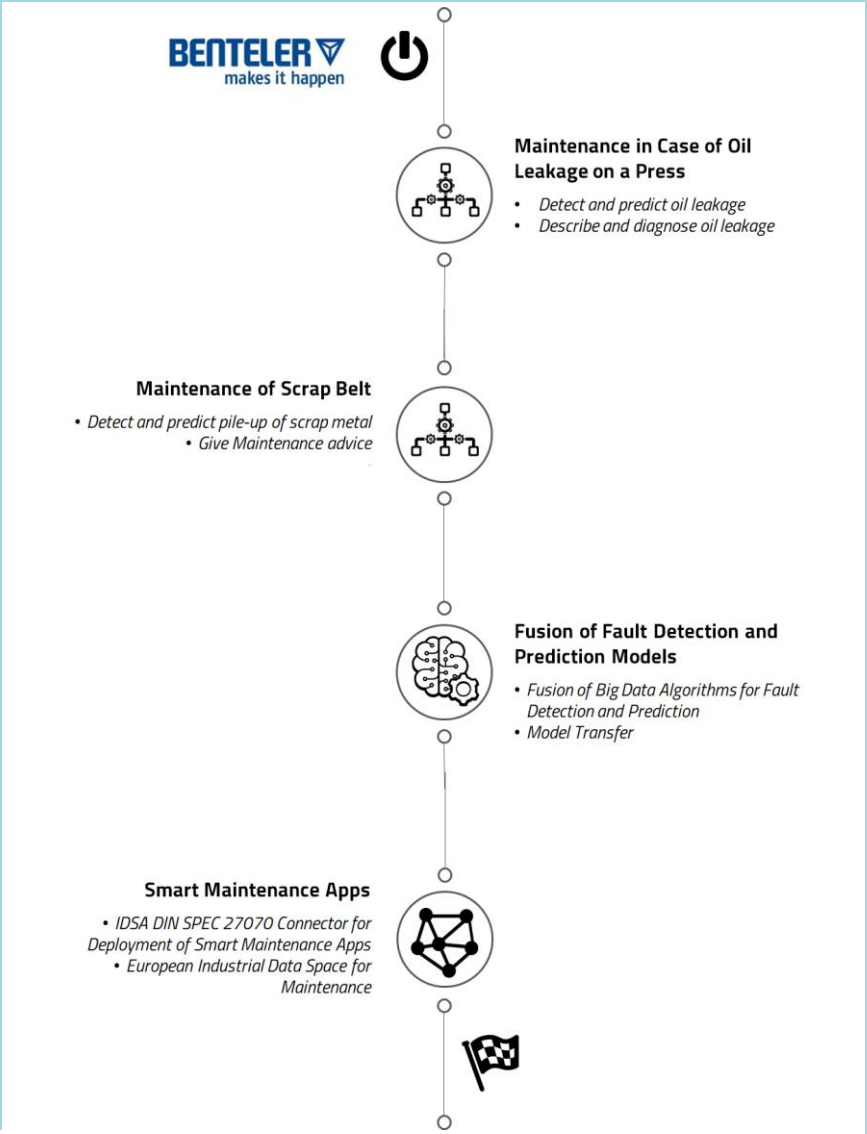
The ambition of the large-scale trial was to establish and roll out a predictive maintenance framework at the BENTELER Automotive factory in Paderborn based on a standardized process covering data acquisition for reference plants, data-driven modelling, model deployment, model transfer to compatible plants (transfer learning), and the integration into the maintenance organization.

Photo source: Benteler

Predictive Maintenance 4.0 for Stamping Lines

Deployment and evaluation of a predictive maintenance framework at BENTELER

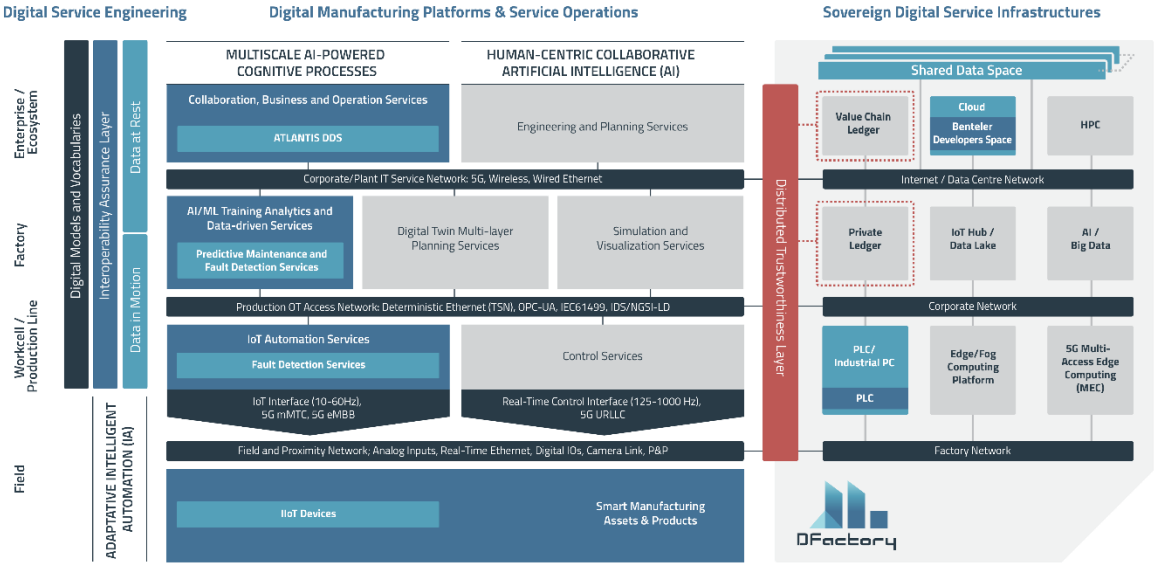
- Standardized process from data acquisition to integration within the maintenance process
- Systematic collection and analysis of machine data of a hydraulic press system and a scrap belt
- Detection and prediction of fault patterns in the production process at BENTELER



Key Facts & KPIs

Unplanned downtime (h/m)	↓50%
Maintenance costs	↓ 5%
Number of unplanned maintenance incidents	↓83%
MTBF (days)	↓9x
MTTR (h)	↓33%
Overall equipment Efficiency (OEE)	↑5%

Digital Factory Alliance (DFA)
Digital Service Integration Reference Model



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ATLANTIS ENGINEERING

Fraunhofer IEM

Dr Emerson Luis Galina
COO
BENTELER Automotive GmbH

Thanks to Boost 4.0 trials, we improved significantly our big data infrastructure. And we reach the next level of data analytics within BENTELER. The project is a driver to increase our expertise in the field of Industry 4.0. As a direct benefit, it raised the overall equipment effectiveness of considered machines by five percent. The next step is to multiply the project results to all of our plants worldwide. This way, we use this important benefit of the project systematically. As a result, we can meet the need of our customers faster, more reliably and with even higher quality.

Cosmas Bambalis
CEO
Atlantis Engineering

ATLANTIS Engineering, through the BOOST4.0 project had the chance to implement, validate and improve its Predictive Maintenance Platform in one of the European Industrial leaders: BENTELER. The know-how gained by applying predictive maintenance strategies and by getting experience on Big Data processing was precious for its products development. Concluding, this high level and quality collaboration was an important asset for our company to be able to further penetrate in a global and very competitive market.

Prof. Dr Roman Dumitrescu
Director Product Engineering
Fraunhofer IEM
Managing Director
It's Owl

Boost 4.0 is a perfect example of successful know-how transfer from research to industry. The project learnings have already been picked up in transfer projects within the Leading-Edge Cluster it's OWL, with promising results especially for small and medium enterprises.

Further reading

Digital Factory Alliance – www.digitalfactoryalliance.eu

Network of Lighthouse Factories – https://digitalfactoryalliance.eu/lighthouse-digital-factory-network/

EC Boost 4.0 Big Data Experimental Project – www.boost40.eu

Join the Digital Factory Alliance:

https://digitalfactoryalliance.eu/join-us/

Document prepared by
Digital Factory
Alliance