EUR3KA

# D4.2

# Plug & Respond Interoperable Trusted Data Connectors

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# D4.2 Plug & Respond Interoperable Trusted Data Connectors

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|---|---|---|---|
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| **Dissemination Level** | |
|---|---|
| PU: Public | ✓ |
| PP: Restricted to other programme participants (including the Commission) | |
| RE: Restricted to a group specified by the consortium (including the Commission) | |
| CO: Confidential, only for members of the consortium (including the Commission) | |

# Revision History

| Revision | Date | Who | Description |
|---|---|---|---|
| 0.1 | 30/07/2021 | IDSA | First release of the ToC, identified partners responsibilities |
| 0.2 | 06/09/2021 | IDSA | Second release of the ToC, with updates on partners responsibilities |
| 0.3 | 30/09/2021 | IDSA | First draft of the document with updates from responsible partners |
| 0.4 | 05/10/2021 | ENG | Updates on chapter 3. |
| 0.5 | 07/10/2021 | VIS | Update to section 4.2.3 |
| 0.6 | 11/10/2021 | IDSA | Added conclusion and updates on formatting |
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| 1.0 | 15/10/2021 | ENG | Final coordinator review before submission |
| 1.1 | 08/06/2022 | ENG, IOSB, INNO, SQS IDSA | Revised the document based on the reviewers' feedback from the first annual review |
| 2.0 | 08/06/2022 | ENG | Final version ready for submission |

# Quality Control

| Role | Date | Who | Approved/Comment |
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| Internal review | 11/10/2021 | ENG | Approved with comments |
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# Disclaimer

# Executive Summary

The primary **mission of the Eur3ka** project is to build and offer a **plug and response framework** to strengthen the manufacturers' ability to respond to **major and disruptive changes** (such as the COVID19 pandemic) by **adapting** their production processes rapidly and successfully. To make this happen, the consortium partners are leveraging their existing manufacturing platforms. This (naturally) brings the need to **ensure trusted data sharing** and **data sovereignty** among all partners/parties. An infrastructure for trusted data sharing is designed and developed to fulfil these needs and this deliverable exhibits the parts of the general infrastructure and their relationship with one another.

This report provides an outline of the data space infrastructure to be used in the project, along with the mapping of the **IDS components** in relation with the **Eur3ka Reference Architecture**. This mapping explains 1) the approach towards intra and inter data spaces interoperability, 2) core components that are required to start experimenting with a Minimum Viable Data Space (MVDS) and 3) available testbed solution. Following this, the **latest updates from the project's foreground components** (connectors and platforms) are provided in detail. In this way, the deliverable provides technical updates (development, validation, and demonstration) on the components developed/used by project partners and describes how platforms work and are connected to data spaces.

This deliverable also constitutes an **extension to deliverable D4.1**, which was previously delivered to provide technical details at a higher level. There is also some complementary work in other work packages of the project: such as Eur3ka **platform architecture in WP2** and the **semantics** (for the information to be exchanged) **in WP3**. These will all together define and describe how Eur3ka service platforms and components work together.

# Table of Contents

# List of figures



# List of Tables

# Definitions and acronyms

| | |
|---|---|
| AAS | Asset Administration Shell |
| AMN | Additive Manufacturing Network |
| CAD | Computer-Aided Design |
| CCE | Clinical Care Equipment |
| CE | Community Edition |
| CLI | Command Line Input |
| CNC | Computer Numerical Control |
| CPPS | Cyber Physical Production Systems |
| CSV | Comma-Separated Values |
| DDA | Distributed Data Analytics |
| DMP | Data Management Plan |
| EAE | Edge Analytics Engine |
| EC | European Commission |
| ECC | Execution Core Container |
| EU | European Union |
| GUI | Graphical User Interface |
| IDS | International Data Spaces |
| MVDS | Minimum Viable Data Space |
| LDAP | Lightweight Directory Access Protocol |
| OPC UA | OPC Unified Architecture |
| P&R | Plug & Respond |
| PAAS | Platform as a Service |
| PPE | Personal Protection Equipment |
| PPE | Personal Protection Equipment |
| RA | Reference Architecture |
| RAM | Reference Architecture Model |
| RBAC | Role-Based Access Control |
| SAML | Security Assertion Markup Language |
| SCSN | Smart Connected Supplier Network |
| SFW | Smart Factory Web |
| SMMA | Smart Matching Mediation App |
| TRUE | TRUsted Engineering |
| UC APP | Usage-Control Application |
| VC 4.0 | Visual Components 4.0 platform |
| VIS | Visual Components |
| VR | Virtual Reality |
| WP | Work Package |
| XML | eXtensible Markup Language |
| YAML | YAML Ain't Markup Language |

# 1 Introduction

## 1.1 Scope and Purpose

This deliverable provides an outline of the data space infrastructure to be used in the project, along with the mapping of the IDS components in relation with the Eur3ka Reference Architecture. This mapping explains 1) the approach towards intra and inter data spaces interoperability, 2) core components that are required to start experimenting with a minimum viable data space (MVDS) and 3) available testbed solution. Following this, the latest updates and news from the project's foreground components (connectors and platforms) are provided in detail.

It is not only planned to provide technical updates (development, validation and demonstration) on the components developed/used by project partners, but also to describe the interaction between the platforms that is provided via connectors.

## 1.2 Relevance to Other Deliverables

The deliverable describes the infrastructure and the connection with the foreground elements such as connectors and platforms offered by the Eur3ka ecosystem. It gives details on the structure of these components as well as their roles and interactions.

This deliverable provides updated information on the work that was accomplished in D4.1, which outlined the main platforms and components (connectors) in the project that will be used as an early deployment of the Eur3ka provided services, also providing details on the development of IDS components within the project.

It also provides additional information that may extend the vision of Eur3ka Reference Architecture that was developed as and fully described in D2.1.

## 1.3 Structure of the Document

The deliverable is structured as follows:

- Section 2 explains the data space infrastructure and approach that was taken into consideration during the project. This involves the approach regarding intra and inter data spaces, core components used and developed during the project and available testbed to be used as a transparent testing ground for the project outcomes.
- Section 3 focuses on the mapping between the services and assets in Eur3ka's Reference Architecture, which have been identified within WP3 and WP4 respectively.
- Section 4 provides information and latest updates on the Eur3ka foreground components, including platforms and connectors that will be used in the project.
- Section 5 is the last and concluding section of the deliverable. It draws main conclusions and provides an outlook for the future developments.

## 1.4 Feedback from the First Annual Review

The points below show the feedback received by the reviewers. All of these feedback were pointing out to a correction of visual quality in figures used within the deliverable, as well as a description about the connectors and their relationship to the pilots. These changes have been addressed in the latest version of the document (v1.1).

- the developed connectors should be shown in a table with the achieved degree of maturity and the relationship to pilot cases.
- Many figures are of low quality (imported from Powerpoint) and blurry.

# 2 Data Space infrastructure

## 2.1 Intra and inter data space interoperability approaches

A distinction is made on their applicability for two development lines for data space instances, which involves a differentiation on the applicability of two development lines for data space instances:

- Intra data space interoperability, between the data space authority, processing and data sharing building blocks within a single data space instance.
- Inter data space interoperability, between multiple data space instances at each of the functional levels as distinguished in the framework.

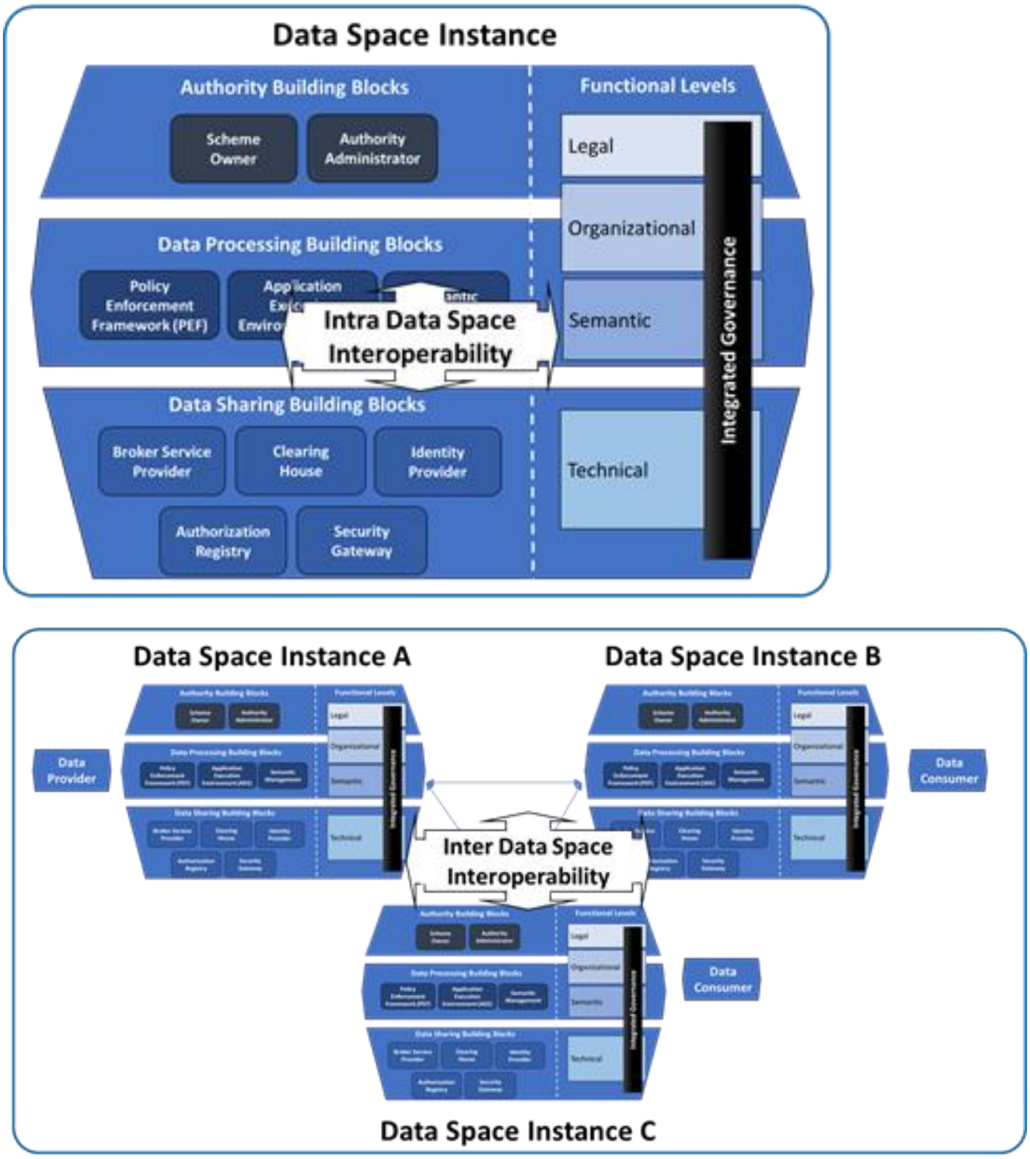


*Figure 1. Intra data space interoperability and inter data space interoperability development lines*

European Interoperability Framework (that has been developed by European Commission), provides an approach to handle interoperability challenges. This framework consists of four functional levels:

- *Technical level,* to provide software and hardware components for controlled, sovereign and secure sharing of data.
- *Semantic level,* to ensure that format and meaning of shared data is preserved and understood.
- *Organizational level,* to let stakeholders align goals, expectations, responsibilities and business processes.
- *Legal level,* to ensure that organizations under different legal jurisdictions and frameworks can share data with common legally binding conditions.

Departing from this framework, a recent study on a report[1] by TNO and IDSA has been conducted to define topics requiring governance and applicability of IDS components and governance topics. According to this work, the relationship between IDS elements and interoperability in intra and inter data spaces have been evaluated as on the table below.

| **(A = Applicable, NA = Not Applicable)** | | |
|---|---|---|
| | **Intra Data Space Interoperability** | **Inter Data Space Interoperability** |
| **Technical level** | | |
| **Handshake** | | |
| IDS information model | A | A |
| IDS connector | A | NA |
| Hybrid connector | A | A |
| **Identity and authentication** | | |
| Legal identities (Identity Provider) | A | NA |
| Data space membership (DAPS, ParIS) | A | A |
| **Authorization** | | |
| Definition of access and usage control policies | A | NA |
| Registration of access and usage control policies | A | NA |
| Enforcement of access and usage control policies | A | A |
| **Data, processing and service brokering** | | |
| Findability & Accessibility (Broker & DAPS) | A | A |
| **App enabling** | | |
| Application Execution Environment (AEE) | A | NA |
| Data Apps | A | NA |

[1] "IDSA Governance for Data Space Instances" v0.1 Authors&Contributors: Harrie Bastiaansen, Mike de Roode (TNO), Sebastian Steinbuss, Anil Turkmayali (IDSA)

| | | | | |
|---|---|---|---|---|
| | | Cloud integration (GAIA-X) | A | NA |
| **Semantic level** | | | | |
| | | Common semantic data model | A | NA |
| | | Semantic management data apps | A | NA |
| **Organizational level** | | | | |
| | | Onboarding and certification | A | NA |
| | | Service level agreements and quality control | A | NA |
| | | Operations and customer processes | A | NA |
| **Legal level** | | | | |
| | | Joint legal agreement | A | A |
| | | Verification of legal status for data transaction | NA | A |

***Table 1: Applicability Matrix for IDSA: Intra and Inter Data Space Interoperability***

This table basically explains which existing IDS functionality can be applied to which interoperability process(es) of intra and inter data spaces.

While studying on interoperability of intra and inter data spaces, one of the most important findings was the need for inter data space interoperability. As this is a growing need, it is obvious for IDSA and other initiatives to assess its role and documentation to facilitate the development of (IDS-based) data spaces (both intra and inter). In addition to this, IDSA governance model for development and deployment of the inter data space architectures and standards needs to be defined. Another important need for interoperability in inter data spaces is an overarching 'data space scheme' defining and implementing joint legal and operational agreements between adhering data spaces instances. This is expected to provide an overarching legal framework that individual data space instances agree to adapt and adhere.

## 2.2 Core components for building an IDS-based data space

The specification of the IDSA forms the basis for a data marketplace based on European values, i.e. data privacy and security, equal opportunities through a federated design, and ensuring data sovereignty for the creator of the data and trust among participants.

In order to have IDS standard on data sovereignty distributed and used (wherever data sovereignty is applicable), IDSA initiated the IDS Open Source (OS) project[2], where links to the important technical documentation are available alongside with Open Source projects built around IDS concepts. This OS project has been initiated with the intention to have IDS standard designed in a usable way and ensure transparency among various developers of IDS components. It is completely open for external contributors (both developers and non-

[2] https://github.com/International-Data-Spaces-Association

developers) who might like to contribute to the implementations either by joining technical development processes, or by sharing their ideas, experience and inputs.

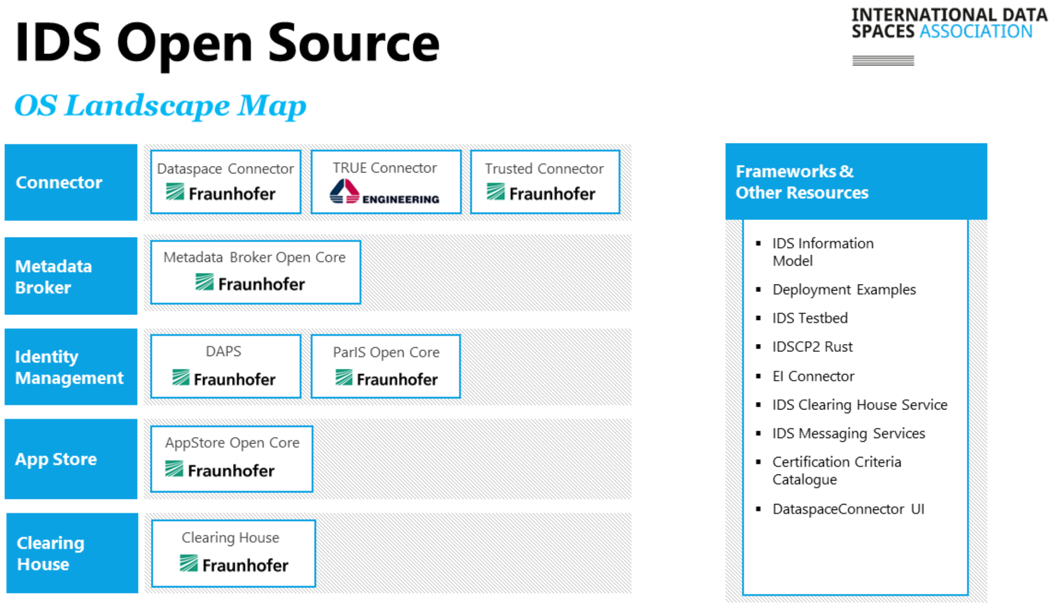


*Figure 2. Existing Components, Frameworks and Resources on IDS Open Source*

The technical documentation is available on the same page that includes step-by-step information on building data spaces. It also includes the concept of Minimum-Viable Data Space (MVDS) which stands as a definition for a data space that consists of just enough number of components, that allows sovereign exchange of data. The purpose is to provide technical guidance (and set of building blocks) for parties who are interested in experimenting with a data space.

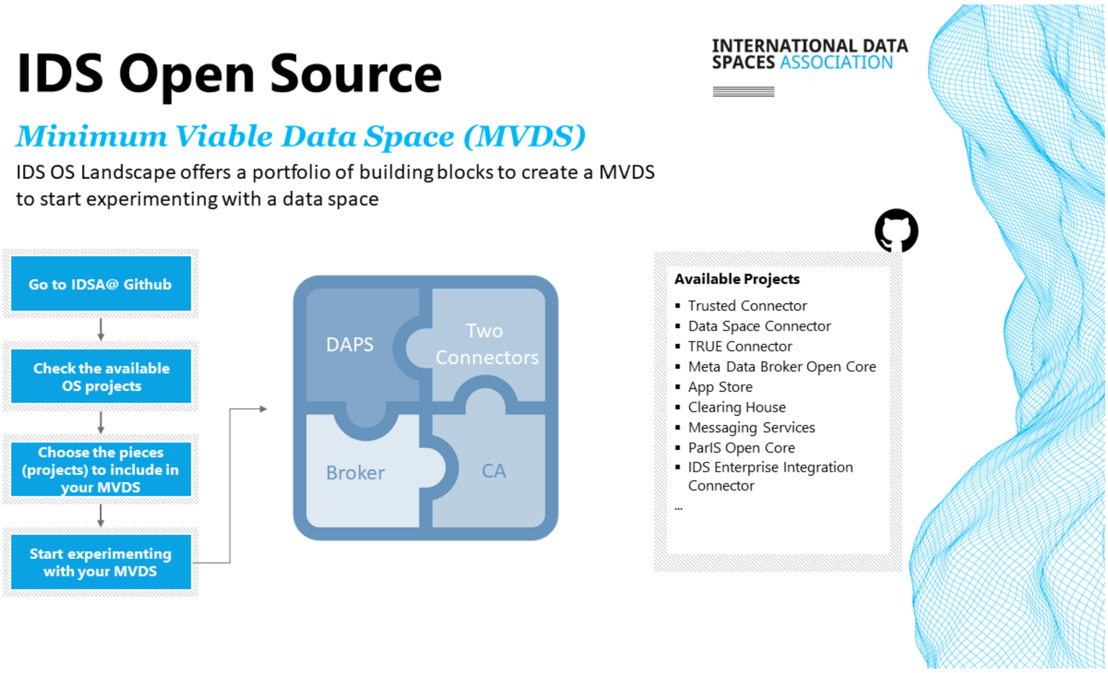


*Figure 3. MVDS and Portfolio of Building Blocks by IDSA*

Majority of the projects on IDSA OS Landscape are openly available under Apache 2.0 license, that allow them to be reused. The group of projects listed there, not only cover most components described in IDS-RAM, but also provide frameworks and other resources to facilitate the development and integration processes.

Available IDS implementations that were used or developed during the project are listed on the table below.

| | **Technology/Implementation** | | | **IDS RA Components** | | |
|---|---|---|---|---|---|---|
| **No** | **Technology or Result** | **Technology Provider** | **License** | **Connector** | **Broker** | **Identity Provider** |
| 1 | Additive Manufacturing Network | SIEMENS | | | | |
| 2 | Eur3ka Certified Assets Catalogue | SIEMENS, INNO, SQS, ENG | | | | |
| 3 | Demand & Supply Marching (SFW) | FHG-IOSB | | | | |
| 4 | Eur3ka Ontology and Data Models | UiO | | | | |
| 5 | Digital Lean Quality Management | INNO, ATOS | | | | |
| 6 | M3 Workspace | INNO | | X | | |
| 7 | M3 Trusted IDS Connector | INNO | | X | | |
| 8 | TRUE connector | ENG | AGPL-3.0 | X | | |
| 9 | Factory Trusted connector | IOSB | Apache-2.0 | X | | |
| 10 | Visual Components 4.0 Platform | VIS | Proprietary | | | |
| 11 | TNO IDS Reference Implementation | TNO | | X | x | X |
| | Other IDSA Technologies/Results (Not developed by consortium members but being used in the project) | | | | | |
| 1 | Dataspace Connector | FHG-ISST | Apache-2.0 | X | | |
| 2 | IDS Metadata Broker Open Core | FHG-IAIS | Apache-2.0 | | X | |
| 3 | IDS Messaging Services | FHG-IAIS/ISST | Apache-2.0 | | | |
| 4 | ParIS Open Core | FHG-IAIS | Apache-2.0 | | | X |

*Table 2: Available IDS Implementations Built and Used in Eur3ka*

## 2.3 Available testbed

**Integration Test Camp**

SQS has built an architecture 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), building an architecture where every IDS component can be tested.

This architecture is opened for everyone, in a monthly event, as a remotely accessible infrastructure where participants can test if their components are ready to work in a real IDS environment. The Evaluation Facility is the ideal place for those who want to prepare their IDS Connectors and other IDS Components for certification.

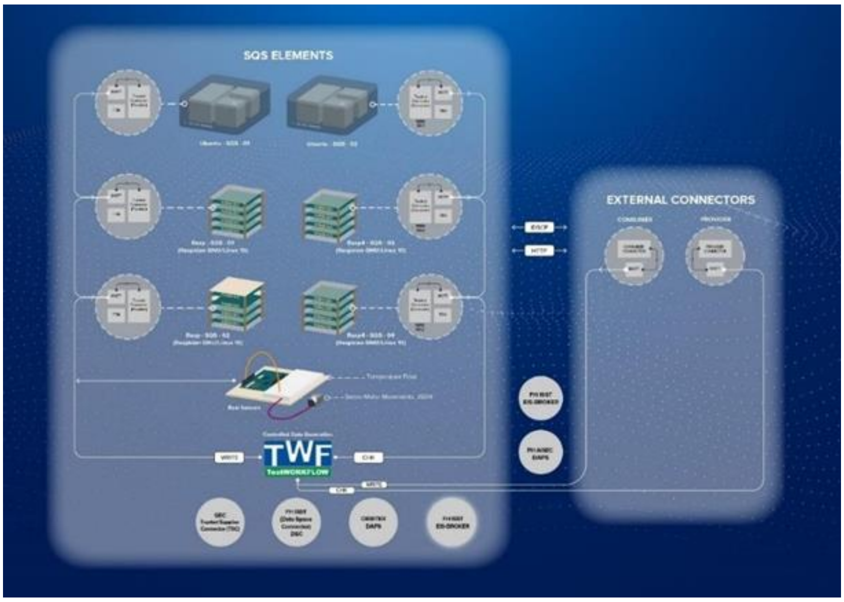


*Figure 4. Architecture of the Integration Test Camp*

# 3 Mapping toward the Eur3ka Reference Architecture

The following section is focused on the mapping between the services and assets, which have been identified within WP3 and WP4 respectively, with Eur3ka´s RA (see Figure 5).

### A) Industrial Agreement and coordination framework

Eur3ka certification services will be supported by the **Certification Support Tools (7),** which are aimed to certificate the products and the processes, either new or repurposed. More specifically, this service will provide guidance and specifications for the **Validation& Verification (V&V) Service Platform** and **Product-Production Conformity Assessment,** to demonstrate to all participants of the network, that the operational environment offers a certain level of security regarding availability, confidentiality, and integrity.

### B) Technical building blocks

**IDS for Manufacturing Repurposing (2)** will enable the **Eur3ka Response and Resilience Data Space**, by means of which all the user of Eur3ka network will have access to it and all their tools will operate trusted services for enabling the data sharing.

Regarding the **Data Models and Format**, they will be sustained by **Eur3ka Ontology and Data Models (6)**.

By means of the data connectors, it will be possible to manage the identity of data consumers and data providers **(Identity Management)**, assure a trusted data exchange between participants **(Trusted Exchange)**, enforce different data access and usage policies that ensure trustworthiness of data sharing and exchange between participants (**Data Usage Policies**), trace and track the data provisioned and consumed (**Data Provenance and Traceability),** facilitate the sharing and exchange of data between data space participants (**Data Exchange APIs)** or publish and discover mechanisms for data resources and services **(Metadata and discovery protocol**). Therefore, within Eur3ka framework, there will be available a number of connectors to cover all the specific needs: **M3 Trusted IDS Connector (14), TRUE Connector (15), Factory Trusted Connector (16).**

### C) Eur3ka Catalogues and Registries

**Eur3ka Certified Assets Catalogue (4)** will be a catalogue for 3D object/product design, providing interface and services for managing and consuming. This catalogue will provide access to products that are ready to be produced under the Eur3ka production agreements and with specific Eur3ka manufacturing assets.

### D) Repurposing Transformation Enabler

The definition of these blocks is driven by four manufacturing repurposing scenarios:

#### 1. Resilient Smart Supply Network Services

The **Supply Chain Transparency Services** to tackle unpredictable events can be supported by Eur3ka Manufacturing Ecosystems. In this way, it will be possible to exchange information to know in real-time the status of the supply chain and to adapt it on demand to reduce the impact on operations.

In the middle of **Resilient Smart Supply Network Services and Robust On-demand manufacturing Network** is placed the **Smart Mediation & Matching Services**, which will be driven by **Demand & Supply Matching (SFW) (5)** platform. Given the inputs for the factory and supply chain search (products or product groups, capabilities and constraints like delivery time, price or number of pieces), the desired output will be a sorted and filtered list of factories which are matched to accomplish the request.

Additionally, suppliers will also have access to the **Addicting Manufacturing Network (3)** manufacturing ecosystem, a cloud ready solution able to digitalize the order to delivery process over a collaboration platform.

2. **Robust On-demand manufacturing Network**

The **Production Quality Control Digital workspace** will be supported by **M3 Workspace (15),** helping quality experts to implement their quality improvement plans and contributing to Quality management.

3. **Smart Matching: Rapid Reconfiguration & Production Line Continuity**

**3.1. COVID19 Aware Shifts Scheduling (9)** will guarantee the **Business Continuity Framework,** which provides a set of services for plant and production continuity. It comprises a range of multiple services including sub-system and components (Plant Risk Assessment, Shift Allocation, Context Awareness, Remote Supporting, Financial Assessment, Training, Reskilling).

**3.2.** The **Plant Risk Assessment Tool (8)** will enable the **Risk Assessment Services** to drive organizational and technological processes, as well as the boost of manufacturing flexibility.

**3.3.** The **Virtual Training and Remote Support (11)** will be the base for the **Repurposed Production Line Virtual Commissioning**, in order to allow companies to evaluate the impact of the repurposing strategies to be implemented and accelerate ramp-up processes of new repurposed production systems, as well as to simulate and evaluate virtual scenarios.

4. **Reliable Repurposing of Production Line Services**

**4.1 Resilient Supply Chain Design Tools** will allow to (re)design supply chains in order to tackle unpredictable events. This enabler in the architecture, which can be supported by Eur3ka Manufacturing Ecosystems is intended to provide the necessary tools and methods to assess and stress supply chain scenarios.

**4.2 Visual 4.0 Platform (17)** will make possible to create **Flexible Production Line Designs,** to adapt production lines quickly to unstable scenarios.

**4.3 Digital Lean Quality Management (12)** will enable **Quality Control Design Tools** for implementing the design o like ZDMap and M3 software can afford the quality control.

**4.4 Manufacturing Repurposing Best Practices (1)** and **Financial Impact Analysis & S-ROI (10)** will facilitate the **Production Repurposing & Resiliency Maturity Assessment**

**Services,** for analysing repurposing and resilience maturity. These will provide a benchmark in terms of digital transformation readiness and pathway for shopfloor modernisation and digitisation. This will also support services for the assessment of business opportunities and gap to realise production repurposing strategies.

The following figure shows the mapping between the technologies/results and the Reference Architecture.

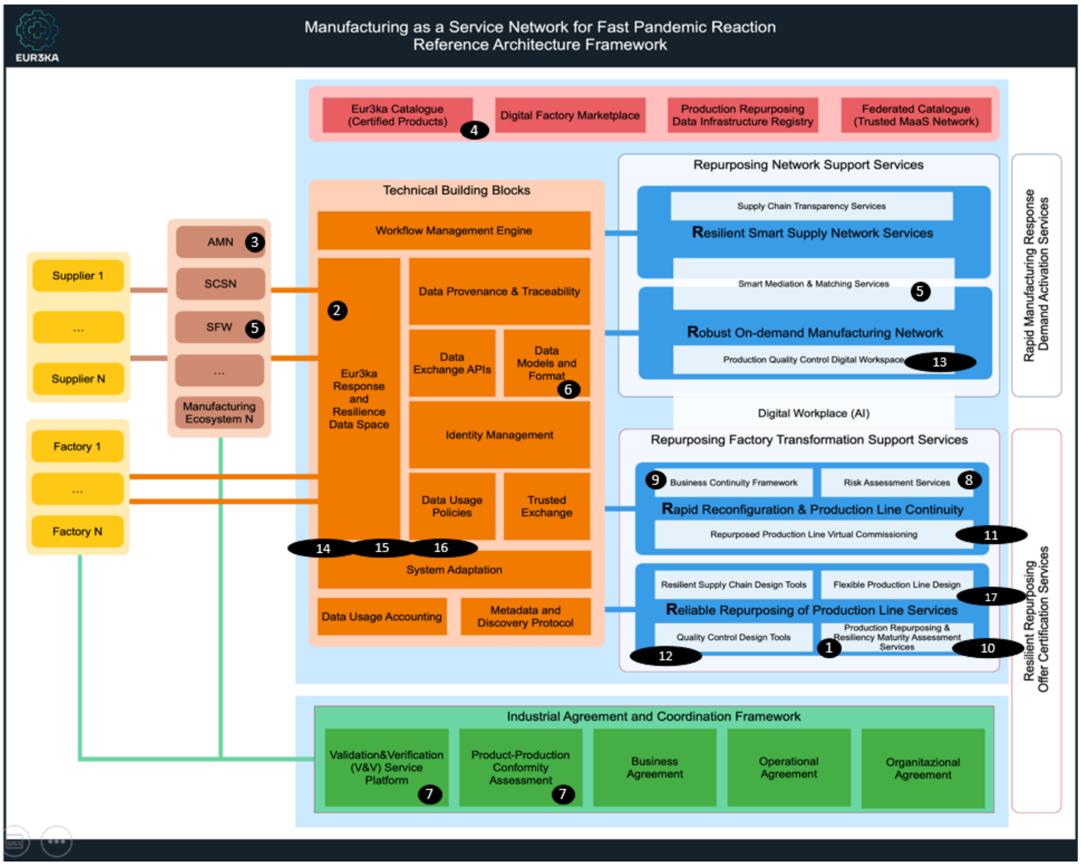


*Figure 5. Mapping of Eur3ka Reference Architecture*

# 4 Eur3ka Foreground Components

## 4.1 Data Connectors

| Connector | Level of Maturity | Relationship to the Eur3ka Pilot Cases |
|---|---|---|
| M3 Trusted IDS Connector | TRL6 | The connector is developed and functional and is integrated in a 3D Printing Network to exchange information on the objects to be printed. It has been implemented in a local network. It is linked to the SIEIL pilot and further applications are under investigation. |
| TRUE Connector | TRL6 | The connector will be integrated in the SEAC pilot, for the secure data exchange between the plant and the remote environments. The integration with the AMN and further pilots is under investigation. |

*Table 3: List of Connectors Used in Eur3ka*

### 4.1.1 M3 Trusted IDS Connector

We propose to offer two ways to exchange metrological data: with IDS connector (with sovereignty) and without the connector.

As stated in the previous deliverable *"D4.1 Early Deployment of Eur3ka R3 Service Platforms and Infrastructure*s", M3 Workspace will rely on **IDS Trusted connector** -following IDS RA-, an open-source FIWARE-based component to link all the Innovalia customers with M3Workspace, creating a competent environment to offer metrological services. Therefore, M3 and its clients will use a certified IDS Connector to offer or import safely metrological and manufacturing data exchange with well-defined usage controls. Specialized IDS broker (**Orion Context Broker**) will handle the management of all communication between Innovalia and their customers.

Therefore, the challenge is to ensure that all data that is exchanged within Eur3ka environment is in a format compatible with the **FIWARE** context and **NGSI**. For this, the IDS Connectors must contain the necessary modules (functions) for the conversion/transformation of the data received into the required compatible format and forward it to other entities (consumers) that must also be able to receive and handle information under same context and compliances.

In the most generic possible architecture, each IDS Connector embeds three levels of functionalities within it:

1. A level of functionalities related to the modules where it is able to either pre- or post-process data. These are the so-called **System Adapters** or **Data Apps**, respectively.
2. Another level of functionalities deals with all ID recognition/certification, history logging, redirection and handling of data. These integrate a **Data Router**.

3. Finally, a third level of functionalities are the **Broker** itself, which communicates only with its counterparts placed in the IDS Connectors of the other end point(s) of the communication segment(s).

Hence, the first conversion of the data will occur at the first IDS Connector they pass by. All files and data streams should be converted into **NGSI compliant** files in the IDS Connectors. This conversion will be processed at the **System Adapters**, which are specific functional modules within the IDS Connectors.

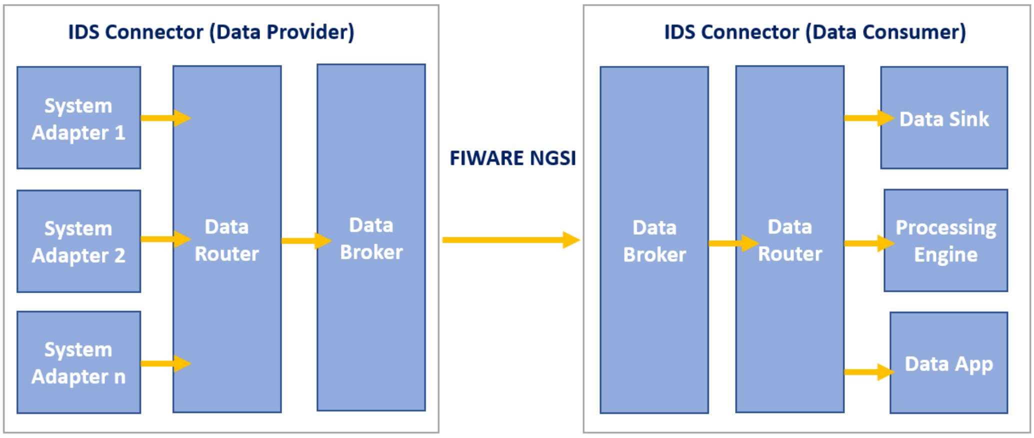


*Figure 6. End-to-end data communication flow between the two generic IDS connectors*

The **System Adapters** and **Data Apps** are the features that may be unique for each IDS Connectors within Eur3ka. They deal with data conversion, pre- or post-processing and push/pull from/into the corresponding Context Broker. They are unique interfaces with the specific components of the overall architecture.

The System Adapters and Data Apps for the Cloud Level Eur3ka Components depend on the detailed specifications of each of those components, regarding what information is exchanged, what results are expected from their processing, when are such results outputted and where to are they being sent.

The connector can be deployed with multiple System Adapters for different types of information, data type or different systems, as long as they can handle the information received and transform it into an Orion Context Broker compatible format so that it can be sent to other entities. Also note that systems that already provide the information in NGSI, format compatible with FIWARE, may not need to use any System Adapter and the information goes directly to the Orion Context Broker to be sent to another entity.

The IDS connector from the provider will be implemented with the System Adapter module that is responsible for receiving and handling the raw data received from the Data Provider (e.g., the shopfloor sensors and/or devices or the data collectors implemented at the edge level) and translating or converting them into the NGSI format that is compatible with the Orion Context Broker and thus the Eur3ka context itself.

M3 Trusted connector is FIWARE enabled, and this means that it composed by a system adapter, from Quality Information Framework (QIF) standard, which enables the capture, use and reuse of metrology-related information throughout the Product Lifecycle Management (PLM) and Product Data Management (PDM) domains, to the NGSI standard. Thus, the system adapters will be capable of collecting data from different types of sources and in different formats and complexity and then converting (or just re-adjusting) it into NGSI file format. This system adapter is deployed and configured on the M3 Trusted IDS connector.

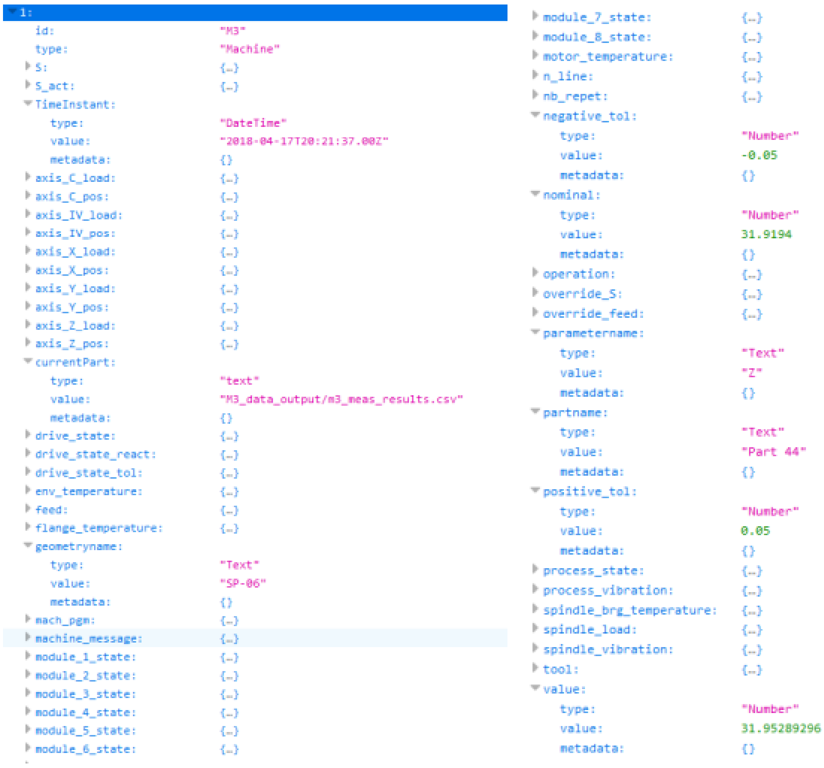


*Figure 7. NGSI formatted publications made available through the M3 Trusted IDS Connector*

This system adapter allows that the GD&T (Geometrical Dimensioning and Tolerancing) results can be accessed and offered to data apps, using QIF standards. Innovalia is integrating and developing QIF scheme as the data model of the GD&T results (an XML data file).

During each measurement, Innovalia not only obtains measurement results, but also contains modules for units' transformation, measurements and machine traceability, geometries definitions or part register.

## 4.1.2 TRUE Connector

As already described in *D4.1 Early Deployment of Eur3ka R3 Service Platforms and Infrastructures*, the TRUE (TRUsted Engineering) Connector is an open-source component defined, implemented and maintained by Engineering. It is aligned to the IDS base security profile and it represents a multi-protocol connector aiming to exchange data with several representations (IDS-like) through different communication protocols. In the following a briefly summary of the main features.

The architectural structured is still as already described, namely, it is composed by three components:

- **Execution Core Container (ECC)**, in charge of the data exchange through the IDS ecosystem representing data using the IDS Information Model and interacting with an external Identity Provider. It is also able to communicate with an IDS Broker for registering and querying information.
- **Data Application (Data APP)**, an open-source project designed by ENG. It represents a basic data application for generating and consuming data on top of the ECC component.
- **Usage-Control Application (UC APP)**, a customized version of the Fraunhofer IESE base application for integrating the MyData Framework (a Usage Control Framework designed and implemented by Fraunhofer IESE) in a connector.

Currently it ensures a Base security profile, supports Multipart/mixed, Multipart/form, HTTP-header data formats for data exchange, use HTTP/HTTPS, websocket over HTTPS and IDSCPv2 communication protocols, implements the Access Control integrating the IDS Identity Provider services like Fraunhofer AISEC v1, v2, and Orbiter and is able to register transactions to the ENG Clearing House. The last but not the least feature is that it is totally configurable to be flexible for each business requirement.

The TRUE Connector is under continuous improvement, to make it step by step richer of features and as much integrate-able as possible with other component and ecosystems.

The IDS Information Model update is one of the new improvements done, now the connector and all its components support the version v4.1.1. The same discourse for IDSCP protocol, the old IDSCPv1 is now deprecated, and the TRUE Connector use IDSCPv2.The new version of the transport protocol, that is used only for the communication between ECCs, is based on:

- The DAPS driver, to provide and verify dynamic attribute authorization tokens (DATs)
- The Remote Attestation (RA) prover and verifier drivers in charge of obtain the remote attestation between peers
- The SecureChannel driver to ensure the protected communication channel (e.g. TLSv1.3)

The TRUE Connector was also incubated to the FIWARE 8.0 release becoming a FIWARE Generic Enabler. A dedicated FIWARE Data App will be designed and developed for that scope, with the purpose to ensure a trusted context sharing in a FIWARE Ecosystem.

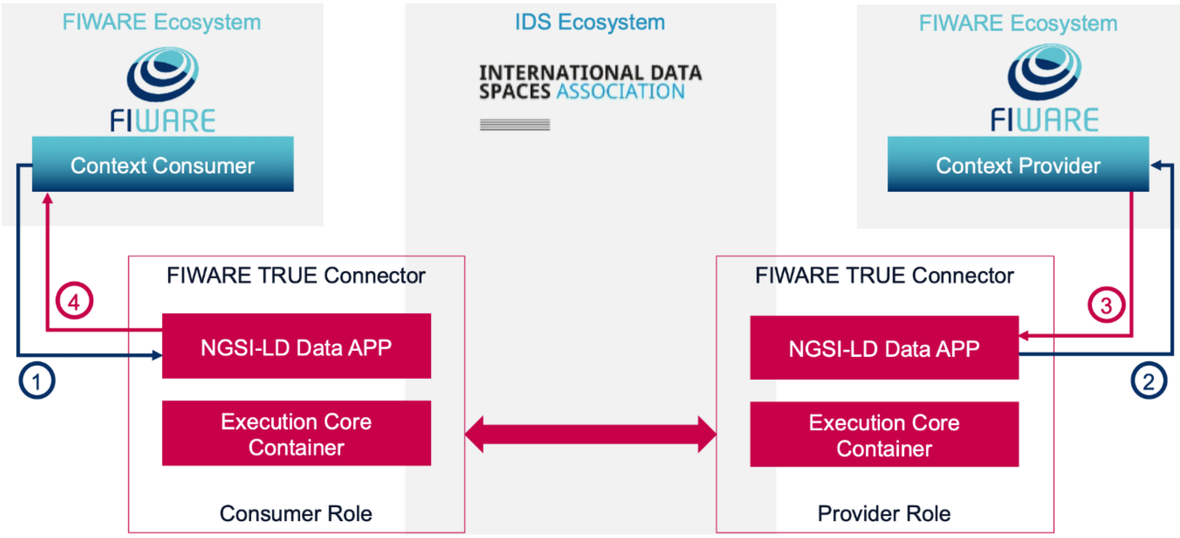


*Figure 8. FIWARE TRUE Connector*

The Usage-Control Application component, previously stateless, is now stateful. It means that before after each restart of the application all the policies were lost, instead with the last update they are stored, in this way it is no more needed to provide each time the policies to be used to the UC.

Another relevant topic is the willingness to be able to communicate, or to be compliant, with existing IDS Connectors. In this term it's under continuous investigation the integration with DataSpace Connector (DSC), the attendance to the last IDS PlugFest where the TRUE Connector was presented as on the three available solutions to "hands-on".

The ones described above are not the only planned goals to achieve, in the roadmap there is a wide list of expected outcomes. As mentioned above the design and the development of a custom FIWARE Data App is ongoing, such as the certification process started act to obtain the IDS Ready Label. New synergies with other projects are on the roadmap, like the one with PLATOON project to integrate new features in the usage control framework, or the already supported Market4.0 where the connector, as a core part of the Market4.0 platform, is the object of several experimentations in real environments.

## 4.2 Platforms

### 4.2.1 SmartFactoryWeb

The Smart Factory Web (SFW) provides an open software architecture that enables the design and set-up of sustainable and resilient industrial ecosystems[3]. In the Eur3ka project,

[3] Heymann, S.; Stojanovic, L.; Watson, K.; Nam, S.; Song, B.; Gschossmann, H.; Schriegel, S.; Jasperneite, J. Cloud-based Plug and Work architecture of the IIC Testbed Smart Factory Web. In Proceedings of the IEEE 23rd International Conference on Emerging Technologies and Factory Automation (ETFA 2018), Torino, Italy, 4–7 September 2018; IEEE: Piscataway, NJ, USA, 2018; pp. 187–194, ISBN 9781538671085.

the SFW will be used as an open marketplace for industrial production, including its supply chain. The focus will be on the medical sector and on the dynamic marketplace scenarios.

To achieve this, the SFW has been extended in several ways in recent months. Here we name the most important extensions. They are related to the main functionalities of a marketplace[4], namely registration and search.

1) Automated onboarding

Registration of factories is based on the capability model to describe the production capabilities of the factories. Capabilities can be expressed in terms of what the asset produces (e.g., a face mask as a product) or in terms of how the asset produces, processes or transforms a product (e.g., 3D printing). As manual registration is a time-consuming and error-prone activity, there is a need for methods and tools to facilitate automated registration.

To speed up registration and facilitate maintenance of registered information, the SFW will be extended with the support for the Industrie 4.0 Asset Administration Shell (AAS) for registration. As shown in Figure 9, we have already developed a concept for this.

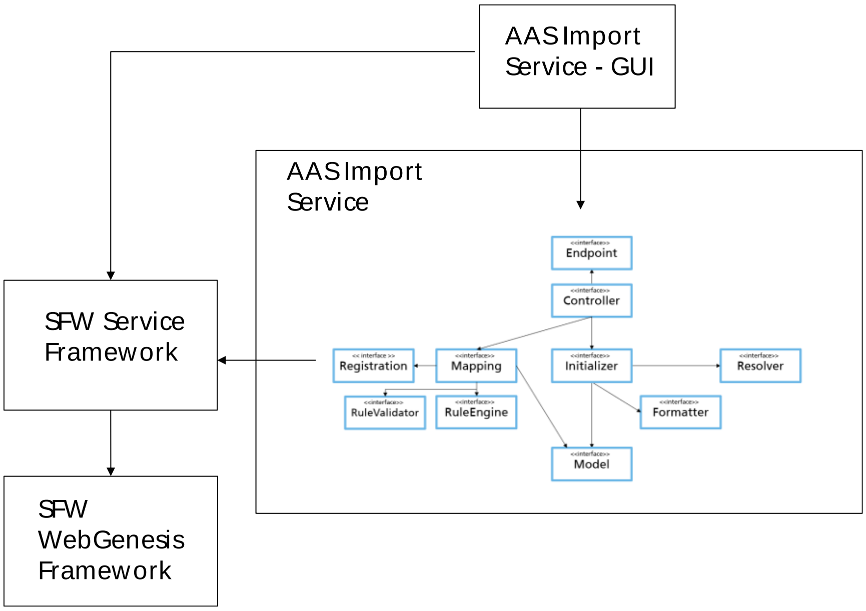


***Figure 9. AAS onboarding***

The proposed approach allows for easy integration with the other platforms used in the Eur3ka project, such as SQS. Moreover, the approach is general enough to be applied not only to AASs, but also to for example a list of products available as an excel file.

[4] Usländer, T.; Schöppenthau, F.; Schnebel, B.; Heymann, S.; Stojanovic, L.; Watson, K.; Nam, S.; Morinaga, S. Smart Factory Web—A Blueprint Architecture for Open Marketplaces for Industrial Production. Appl. Sci. 2021, 11, 6585. https://doi.org/10.3390/app11146585

2) Extended search

A key function of a marketplace is to search for factories, factory assets and supply chains for a desired production process. The search is extended to include not only static information such as capabilities, but also dynamic data such as price, availability, risks, etc. This requires the extension of the user interface to specify these requirements, as shown in Figure 10.

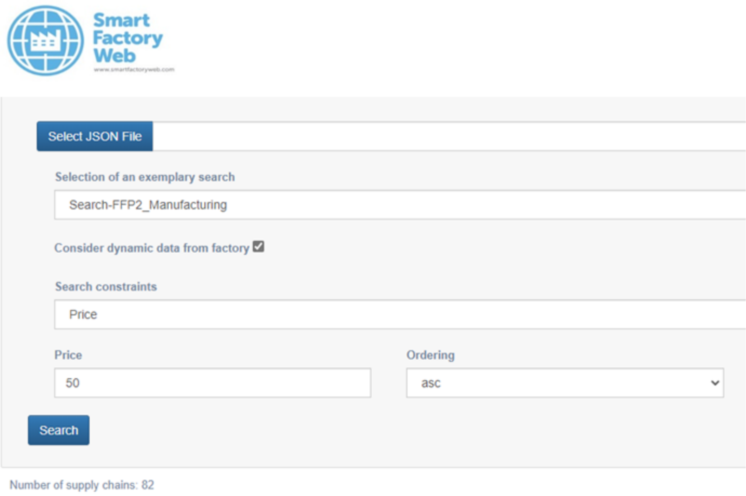


***Figure 10. SFW portal extension to deal with confidential information***

3) Ranking of the search results

Previously, the result of the search was an unsorted list of results, as it was a purely ontology-based search. The search has been extended to allow matching between user queries and not only the capabilities but also the capacities of the registered factories, including their supply chains. Another improvement is the sorting of search results according to the user's preferences. This is illustrated in Figure 11.

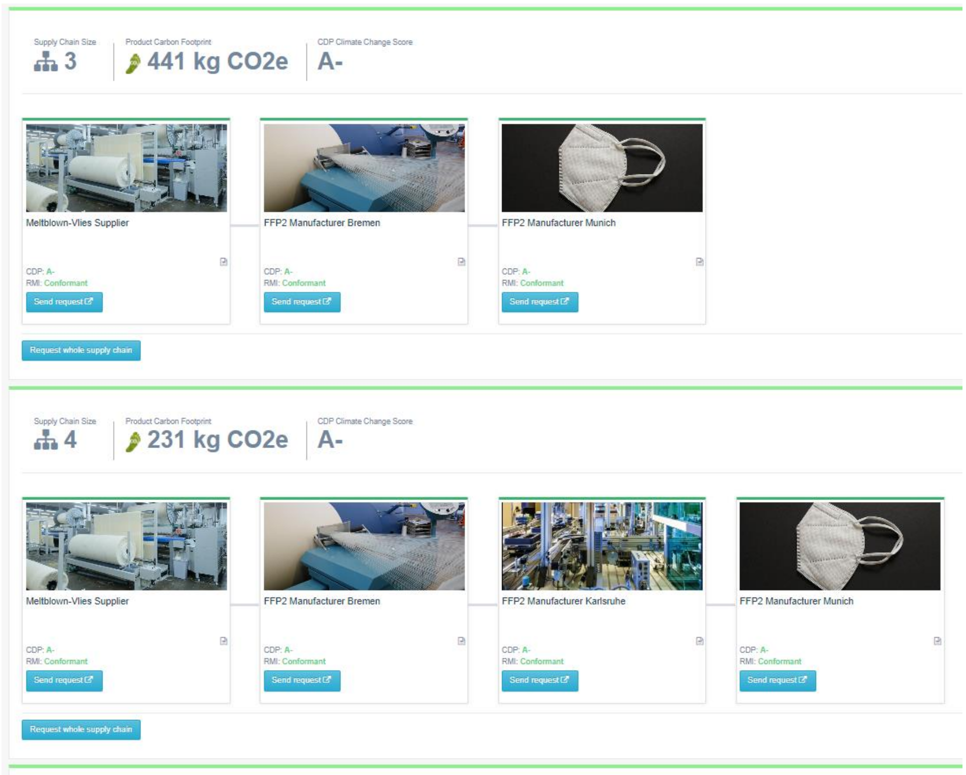


*Figure 11. Ranking of the search results*

4) Handling of sensitive data

While factory capabilities are public information and are used for registration in the SFW, capacity and workload are sensitive data and are therefore not stored in the SFW. To take this sensitive information into account and thus to ensure trustworthiness in dynamic marketplace scenarios, there is a need to attach the SFW to a trusted data space that ensures data sovereignty, e.g., data usage control. Therefore, we have extended the SFW with the SFW IDS connector, since IDS is a viable option to technically enforce these usage restrictions.

Originally, the SFW IDS connector was based on the Trusted connector. As the configuration of this connector is a manual and time-consuming activity, we decided to use a newly developed DataSpace connector. This is shown in Figure 12.

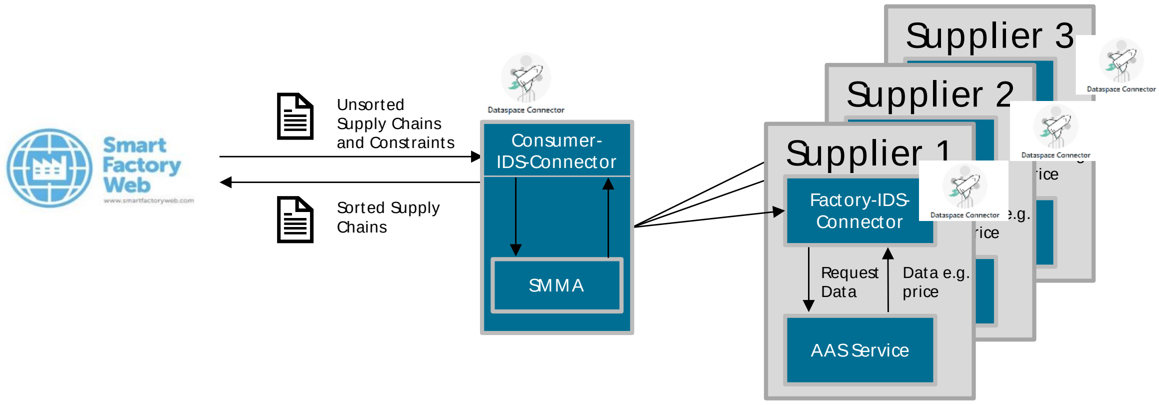


*Figure 12. SFW and DataSpace connectors*

The SFW DataSpace connector has already been integrated with the SFW and the Smart Matching and Mediation App (SMMA) has been deployed in it. The SMMA fetches sensitive data (e.g. prices) via IDS connectors from AAS services of different suppliers. The supplier connectors must provide a contract that matches the expected contract of the consumer connector. Otherwise, the supplier cannot be considered.

Given a SFW request in the form of supply chains and constraints, the SMMA filters and sorts the supply chains based on the data retrieved from the supplier connectors (e.g. price). However, the SMMA does not send the sensitive data back to the SFW, only the filtered and sorted supply chains. The IDS connectors ensure that no sensitive data leaves the secure IDS environment.

As for the supplier connectors, it is currently expected that they will also be based on the DataSpace connectors. In the future, we hope to be able to support other connectors used in Eur3ka, such as the True connector or even the Trusted connector.

### 4.2.2 AMN

Siemens AM Network (AMN) provides an advanced cloud-based solution to foster collaboration and process orchestration between engineers, procurement and suppliers of 3D printed parts. Providing an end-to-end digital process that connects the demand for parts with a supplier network it enables globally distributed manufacturing.

In the context of Eur3ka project, the objective of AMN is to be extended with the ability to import medical parts from the Eur3ka certified parts catalogue application.

Eur3ka certified parts catalogue application is supposed to be provided and implemented by SIERO. The features that are proposed to be implemented in this context are:

- Add a new computer-aided design for a medical part
- Add certification for that particular medical part
- List the parts inventory

In this regard we have identified three personas depicted by below picture:

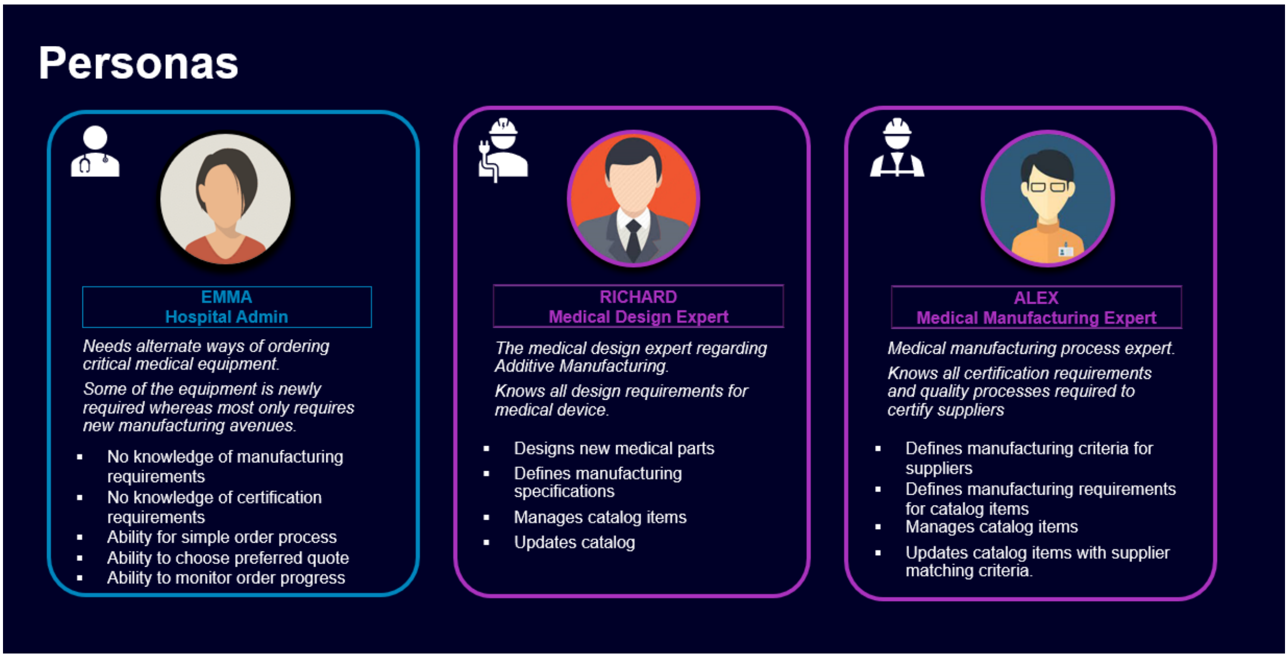


*Figure 13. Identified Personas*

The proposed user journeys within the system are depicted by the below figure:

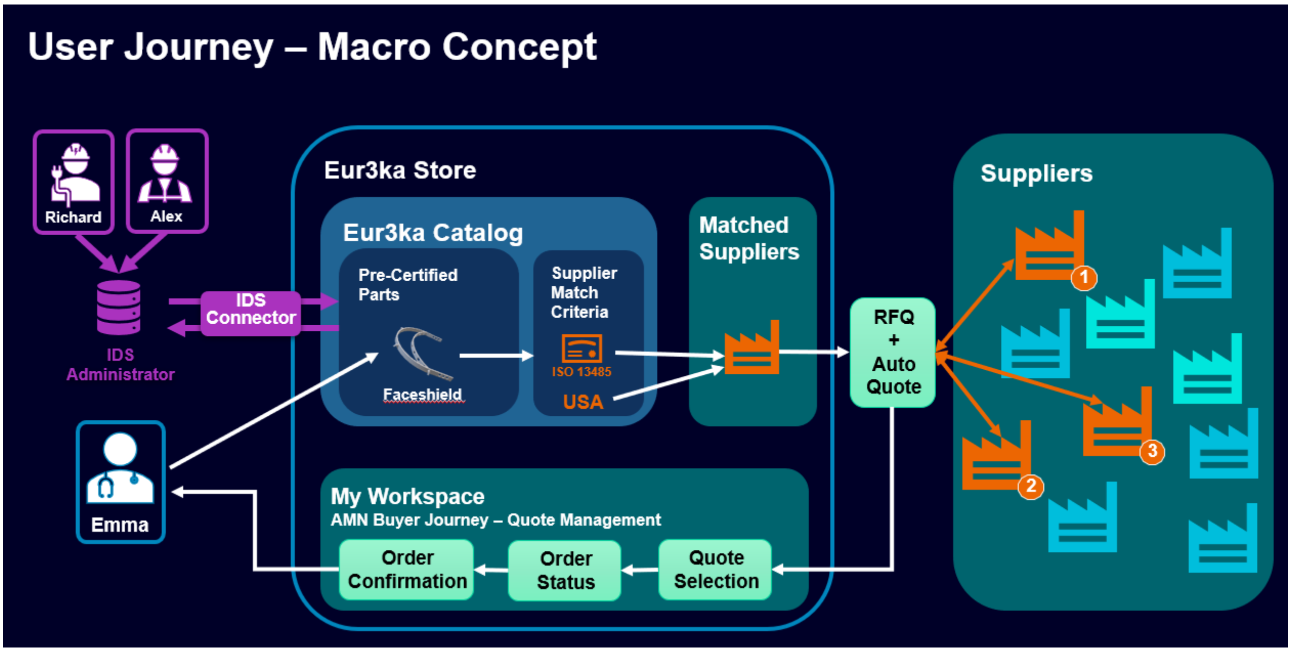


*Figure 14. Proposed user journeys within the system*

In order to achieve the objective of integrating AMN with Eur3ka parts catalogue, we would like to experiment with the IDS TRUE Connector provided by ENGINEERING.

The following diagram sketches how the involved systems might be integrated:

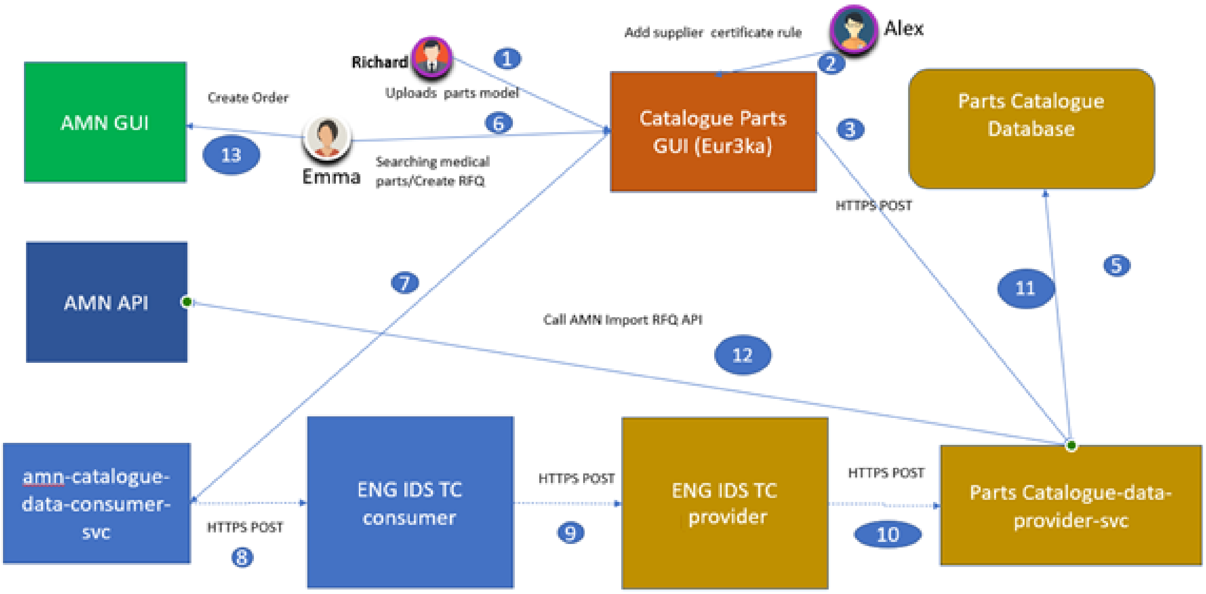


*Figure 15. Integration of the Involved Systems*

The integration between systems is comprising on API services that we intend to implement in the context of the Eur3ka catalogue. In order to achieve this, we would like to explore and to experiment the ability to use IDS TRUE Connector for the following data exchange:

- A connector as consumer for getting the medical parts from the catalogue
- A connector as provider for sending to AMN the Request for Quote for a selected medical part

Investigations and experiments have been conducted in order to validate the feasibility of using IDS technology in our context.

Our experiments were successful and a draft of True Connector integration has been sketched for getting a list of medical part from the catalogue:

Scenarios/demo implemented with IDS TRUEConnector – Get all catalogue data )

- Request

```
curl --location --
request POST 'http://3.120.120.131:8084/
proxy' \
--header 'Content-Type: text/plain' \
--data-raw '{
    "multipart": "form",
    "Forward-To": "https://ecc-
provider:8889/data",
    "message": {

  "@type" : "ids:ArtifactRequestMessage"
,
  },
  "payload" : {
  }
}'
```

- Response

[{"iconPath":"https://3.120.120.131:19999/mendix/file/05fa24b4-8d5f-4d15-a224-81c86deb4580","mendixEntityId":14073748835532801,"partName":"MyPart2","manufacturerName":"manuf1","cadModelPath":"https://3.120.120.131:19999/mendix/file/05fa24b4-8d5f-4d15-a224-81c86deb4580","certificationType":"iso1","materialName":"abs","description":"d1"},{"iconPath":"https://3.120.120.131:19999/mendix/file/6efa96cb-c9ad-4d68-8975-01e45ac53f19","mendixEntityId":14073748835532802,"partName":"p3","manufacturerName":"m2","cadModelPath":"https://3.120.120.131:19999/mendix/file/6efa96cb-c9ad-4d68-8975-01e45ac53f19","certificationType":"c2","materialName":"mat2","description":"d3"},{"iconPath":"https://3.120.120.131:19999/mendix/file/703439aa-4dc1-4617-9465-d0e44e8bb020","mendixEntityId":14073748835532901,"partName":"d3","manufacturerName":"c2","cadModelPath":"https://3.120.120.131:19999/mendix/file/703439aa-4dc1-4617-9465-d0e44e8bb020","certificationType":"c3","materialName":"a2","description":"d3"},{"iconPath":"https://3.120.120.131:19999/mendix/file/d20c0677-cd69-47f7-9383-43c12adeb2ca","mendixEntityId":14073748835533002,"partName":"day2test","manufacturerName":"day2test","cadModelPath":"https://3.120.120.131:19999/mendix/file/d20c0677-cd69-47f7-9383-43c12adeb2ca","certificationType":"day2test","materialName":"day2test","description":"day2test"},{"iconPath":"https://3.120.120.131:19999/mendix/file/3a37739d-47ec-40fa-9341-f91d4e092589","mendixEntityId":14073748835533101,"partName":"robot gripper","manufacturerName":"DTI","cadModelPath":"https://3.120.120.131:19999/mendix/file/3a37739d-47ec-40fa-9341-f91d4e092589","certificationType":"iso-certicatio2021","materialName":"ABS","description":"my desc"}]

*Figure 16. TRUE Connector Integration Experiment*

As conclusion remarks, we would like to emphasize that the proposed solutions and architectures might be changed drastically on next deliverables, depending on the results of the discussions between technical and business partners.

### 4.2.3 Visual 4.0 Platform

Visual Components 4.0 (VC 4.0) provides the 3D simulation and visualization platform to develop from concept to operation a new medical manufacturing system or extend the functionalities of existing ones accelerating repurposing and reusing available resources. The platform provides an intuitive environment to support in the virtual world the development of the systems to virtually commissioning before the real system is deployed for operation.

Within the virtual environment, the design of the system can be started from the concept which collects requirements and functionalities that the system should provide once in operation. Available pick and place capabilities facilitates the management of the digital models within VC 4.0, which extended with plug and play functionalities facilitates the creation of the first simulations to start working in the initial virtual prototypes.

The virtual models developed within VC 4.0, mirror the real system at different levels of detail accelerating engineering development and commissioning, as it is possible to detect during the simulation possible design errors, even before the equipment has been started to be assembled. Workflow performance is adjusted within the simulation, avoiding bottlenecks, and using efficiently the facilities and resources available. Automation and control systems are tested and validated using the virtual commissioning capabilities. As introduced in deliverable D4.1 the platform provides open interfaces, which allows to extend the data models as required as well as implemented standard communication interfaces such as IEC 62541 (OPC UA), etc. These open capabilities will allow to extend within Eur3ka the applications in new production verticals, such as different medical domains, investigating during the project further capabilities.

The results obtained during Factory2Fit[5] targeting the development of the virtual factory brought to the front line the importance of the VR/AR technologies combined with the simulation and the digital twin as training and skills development enablers. By using interactive VR, was enhanced the collaborative design at the same time that the operators were developing faster the skills required for their new working tasks.

During Eur3ka will be extended the development and use of the technologies implemented in Factory2Fit to the medical domain. Furthermore, the initial work developed in WP 5 foresee that the utilization can be extended in the concept and engineering phases, as it will be possible to extend the use of VR as communication tool. In a pandemic scenario, where social distance must be kept guaranteeing the security of the workers, interactive VR allows the seamless cooperation between the stakeholders involved in the virtual space. By using VR solutions it is increasing the security of the workers as they can be in different locations during development and training phases, in addition can be also collaborating along the project and provide valuable feedback between the different stakeholders of the project while they are getting the required skills for the new working tasks.

VC 4.0 supports the entire system life cycle, from concept to operation (Figure 17). While operation new production alternatives can be evaluated, allowing the reusing of production data sets for production optimization or even repurposing if new production requirements are demanded.


*Figure 17. Product Lifecycle Phases of a Manufacturing System*

**Concept phase**

The base of VC 4.0 is the virtual component. The virtual component is the digital representation of the of the real asset in the virtual environment provided by VC 4.0. The platform supports different levels of detail, from a simple sensor to the entire machine that is composed of different systems (Figure 18Figure 18).

Creating the virtual component is facilitated by the open interfaces available as it allows to use the most extended CAD industrial standards, such as STEP (ISO 10303), IGES (ANSI Y14.26M), Collada (ISO/PAS 17506), etc., as well as the possibility to extend the data model to import serialized data models such as AutomationML (IEC 62714) and ontologies.

Behaviour can be added to the virtual components, VC 4.0 provides the most common behaviours for automatic systems in its catalogue, but customized behaviours for defining the system operation can be created from scrap or modify the existing ones using the Python interface.

[5] Factory2Fit Grant agreement ID:723277, https://cordis.europa.eu/project/id/723277

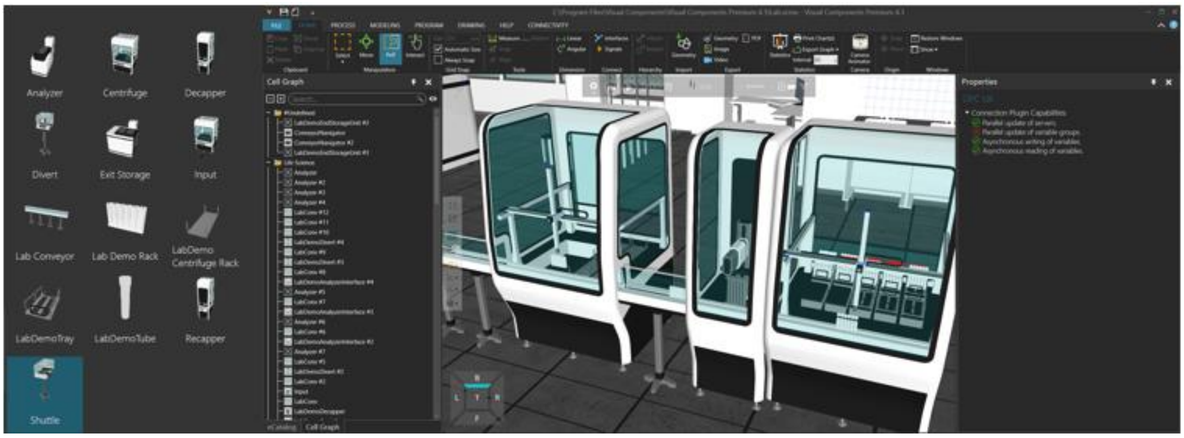


*Figure 18. VC4.0 Virtual Environment*

The virtual layout can be created from available topology datasets or manually selecting the required virtual components (Figure 18) and plug and play into the simulation layout at VC 4.0 and define all the parameters required. On the left, example of different machines for pharma and lab in the virtual environment of VC 4.0 ready to be used. On the right screenshot of layout of the automatic analysis test machine.

**Engineering phase**

During the engineering phase, the simulation models created in VC 4.0 are extended with additional parameters, and with communication capabilities using OPC UA, FIWARE, or proprietary interfaces depending on the required automation interfaces to be deployed. During this phase is deployed the virtual commissioning, connecting the virtual models with the automation controllers (virtual controllers or real hardware) to validate the configurations before commissioning in the real system.

Engineering phase is crucial to validate development and identify all the errors to accelerate ramp up and improve productivity.

**Operation phase**

Operation phase targets the utilization of the digital twin and the virtual shadow available in VC 4.0. Communication interfaces using OPC UA and FIWARE supports the operation of both as production data is exchange between the real and the virtual systems to validate and optimize operations while visualizing the runtime operation in next to real time (Figure 19). Utilization of IDS connector is possible as the open interfaces allows its deployment when required.

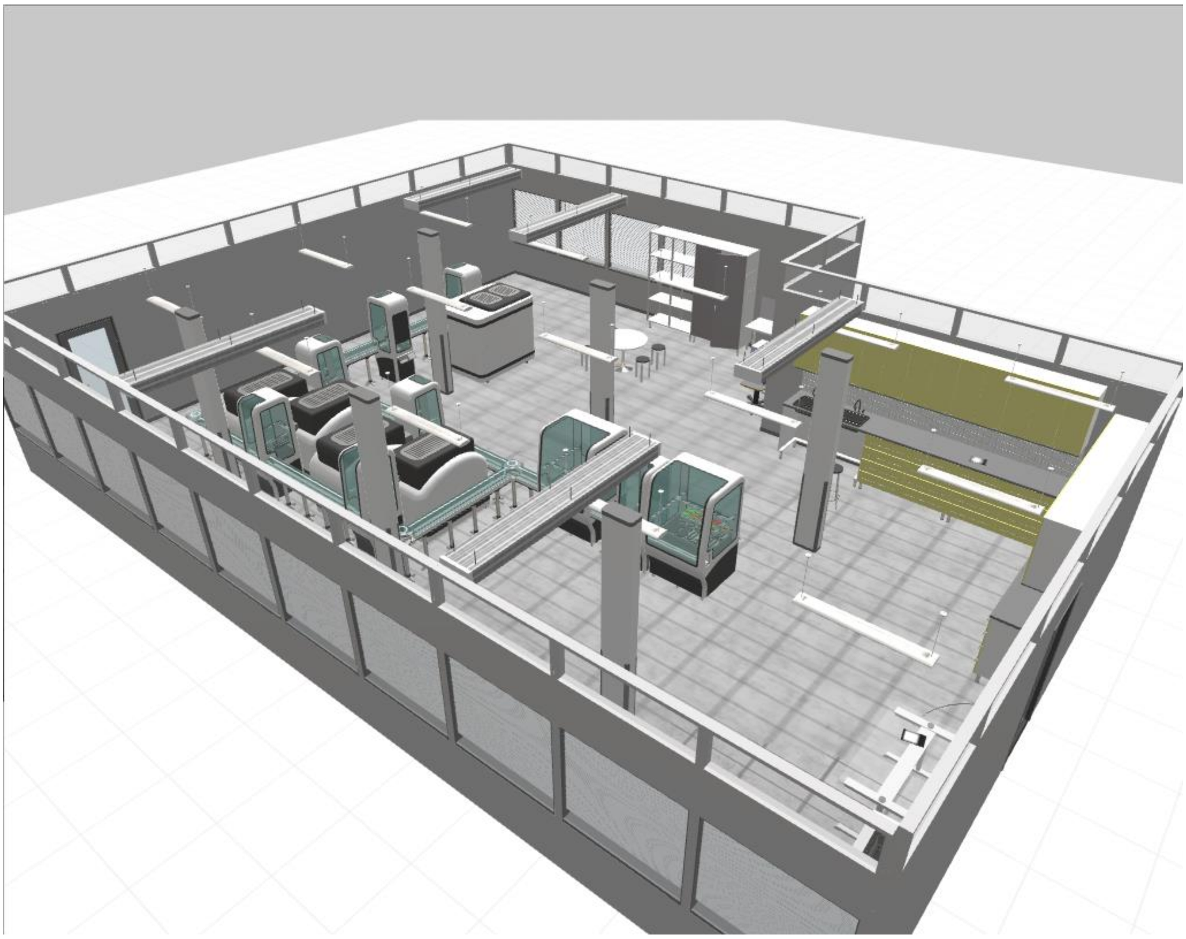

*Figure 19. Visualization of the Entire Production Layout and Systems*

### 4.2.4 M3 Workspace

M3 Workspace is an innovative platform for the **quality management** of pieces made by additive manufacturing, which allows to manage all the information of these pieces and to keep the quality of the 3D printing process under control. The platform facilitates the exchange of information (3D models, results reports, etc.) with manufacturers, by means of a simple and intuitive interface.

It is a cloud-based metrology software that synchronizes with the main M3 Metrology software and allows uploading automatically any metrology results straight to the cloud. M3 workspace is web based and allows users with access to visualize the results (Point clouds, CAD models, Colour mapping, Reports, etc.) using any smart device. In addition, M3 Workspace acts as a sort of repository where all the results that come from the measurements are located and can then be easily downloaded for further analysis. It permits the massive management of digital parts and point clouds, storing and sharing the metrological information.

This platform is a solution part of the M3 (a high-performance software for online automatic scanning point cloud capture and analysis for the reliable and efficient acquisition of 3D information for different materials) complete Platform. Specifically, it is the metrological high-performance software developed by Innovalia, a Platform As A Service (PAAS) cloud-based solution providing metrological after-sales assistance services. It consists mainly on a customer-manufacturer **collaborative space for sharing metrology data in a secure way** during the manufacturing process, allowing the correct management and monitoring of the quality control process but also to manage all customer needs across their quality control process.

M3 Workspace has a large variety of functionalities, such as Software user guides, operative measurement guidelines, trainings and, above all, the **My Workspace service, a collaborative space for the trusted sharing** of metrological, product design and manufacturing data. It is one of the set of services offered within M3 Software as a cloud-based service for quality control service assistance.

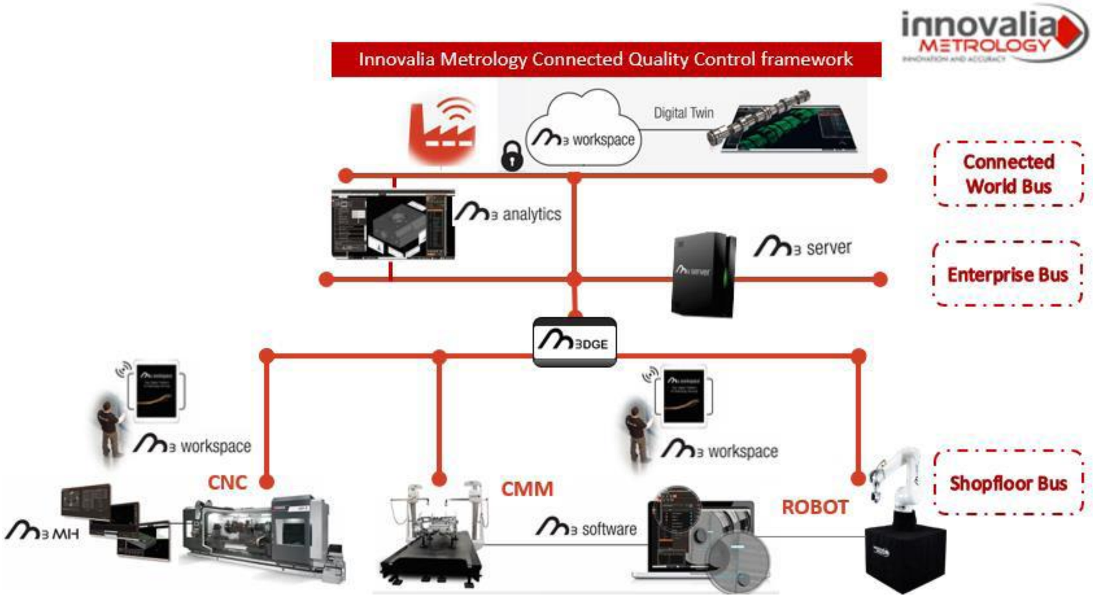


*Figure 20. M3 Platform Components Portfolio and Connected Quality Control Framework*

The IDS feature developed within the M3 Workspace Platform is the **IDS connector**, thanks to which it will be possible to achieve secure data exchange between customer - manufacturer, in which the information provider can establish the limitations on the use of his data, securely and in a trusted manner thanks to this IDS connector.

In this manner, available data from different heterogeneous products, metrological sources and different locations will be integrated, managed and stored in the M3 Workspace. The **secure data exchange** will be carried out between the **M3 Trusted IDS connector and the customer IDS connector**.

Thanks to the **IDS connector** it will be possible to:

- Meet the IDSA requirements and guarantee the reliability and secureness on data sharing.
- Ensure both, transmission and quality of data.
- Ensure the ownership of the data that is being shared.

For each connection, **data exchange format** will be JSON, and i**nteroperability-standards:**

- OPC-UA (IEC 19941 & ISO 27070 - NGSI)
- QIF (ISO 23952 & ISO 27070 - NGSI)

All in all, the most important functionalities of M3 Workspace can be summed up as it follows:

• **Licenses:** for user/customer M3 license management.

• **Support:** as a help desk service chat to solve incidences and customers problems.

• **Documentation:** Space kept for documentation referring to M3 user guides.

• **My Contacts:** Customer contacts within their quality control supply chain.

• **Messages**: Mail service as a communication channel with M3 users regarding software updates, license expiring awareness, etc.

• **Training:** Space kept for M3 user guidance webinars, specific measurement steps webinars, etc., generated in different languages (English, Spanish, Chinese, Russian, Japanese)

• **My Workspace:** this is the tool where the work in Eur3ka will be focused, for the secure data exchange, in which the information provider can establish the limitations on the use of this data, securely through IDS connectors.

Through M3 Workspace, will be possible to carry out the following activities:

- **Upload/download of documents**, mainly concerning to products design, measurement projects, measured parts or even metrological and statistical reports, supporting any format with which you work and depending on the type of file (CAD, STEP, XML, CSV, txt…), This process can be both done by the customer and by Innovalia.
- Direct **upload of measurements results** from M3 software interface.
- **Visualization of files on the proper M3 Workspace interface**, either CAD files, point clouds or metrological reports.

### 4.2.5 Smart Connected Supplier Network

Smart Connected Supplier Network or SCSN is an open communication standard for exchanging order-related data between various types of (industrial) organizations (i.e. within the supply chain). The standard focusses mainly on low-volume, high-mix, high-complexity sectors where many organizations work together to manufacture products. In order to offer as much interoperability as possible between multiple organizations, the SCSN initiative intends to support many of the existing industry-standards.

In order to provide a communication network wherein (high-tech) manufacturers are able to easily exchange order information, SCSN is constructed out of two main components:

1. **SCSN message standard**
   Based on other industrial standards such as the Universal Business Language 2.1 (UBL) by OASIS and the CEF Digital Building Block eInvoicing, the SCSN message standard helps manufacturers to determine and agree on which format is standardized for certain types of information. The complexity and extensive usability of UBL itself makes this language unfit for the entire industry-domain. SCSN defines the required rules for practically making use of UBL by manufacturers. Next to this, SCSN fits seamlessly with the European Commission's eInvoicing infrastructure.

   **Types of information captured**
   The SCSN has a wide variety of message types, ranging from *Bill Of Materials* and *Production specification* to *Invoice* and *Price catalogues*. Overall, SCSN provides message specifications for every purchase-to-pay scenario. For instance, when looking at ordering processes, an order message is required to convey information regarding the order itself, a response from the party that needs to accept or reject (a part of) the order and finally, updates about the order status.

   A full overview of all message types with additional information is accessible through the SCSN Semantic Treehouse.

2. **SCSN technical infrastructure**
   By making use of the four-corner model, the SCSN network consists out of multiple networks. Each service-provider and each broker are directly connected which allows any manufacturer within the SCSN to connect and exchange information with other manufacturers in the network, independent of the service provider any manufacturer is connected to.
   This network-model is easily comparable with our consumer telecommunications. Anyone is free to choose a service provider that provides the best offer, but by allowing service providers to connect with other service providers, the end-user is able to connect to anyone connected to a service provider in the network. The network model is based on a TNO implementation of the IDS Connector, Broker, Identity Manager, and Dynamic Attribute Provisioning Service (DAPS).

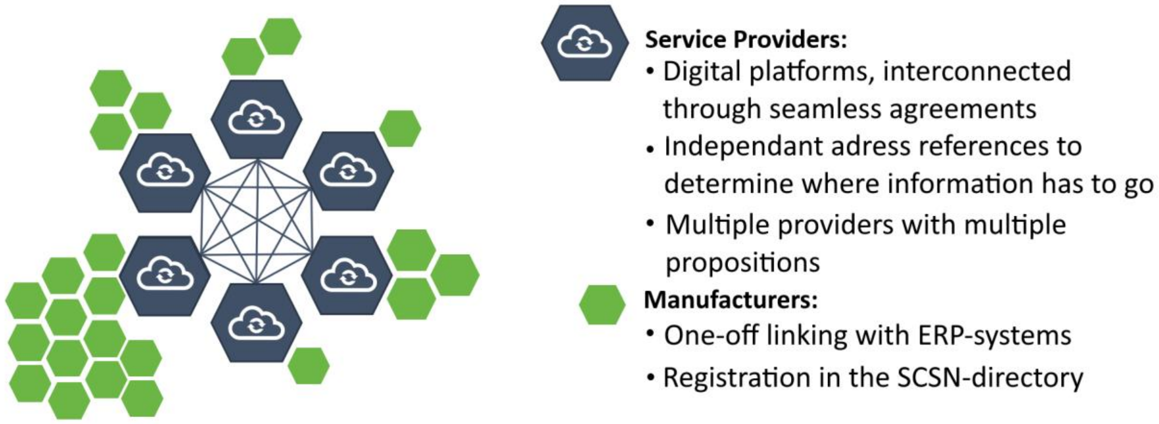


*Figure 21. SCSN Technical Infrastructure Model*

# 5 Conclusions and Future Outlook

This deliverable aimed to: 1) provide an extended outline of the foreground components that form Eur3ka's data space infrastructure, 2) show how these components help to form synergies between platforms and connectors, and 3) list which IDS connectors are being developed or used.

This deliverable also continues the illustration of the ongoing development (according to the Eur3ka deployment architecture defined in WP2) in the use of various connectors that are being used to integrate individual platforms and components to the data space (as the continuation of deliverable D4.1).

Future work as a continuation of the current deliverable includes:

- Continuation of the software development activities, including development of foreground components and integration of platforms.
- Pursuing the discussion on the interoperability requirements for intra and inter data spaces. Such as trying to find answers to the question on how IDS components can be used in the future of data spaces, while interoperability between various data spaces becomes a requirement.
- Creating more synergies between partners on platform/connectors usage and have more cases for initial validation of data exchange services.
- Keeping up with updating the list of IDS components available in the market (and via open source), to be used for project-related future experiments.

In conclusion, this deliverable forms a study of how project partners work with IDS components and concepts, as well as providing an overview on their experience while integrating the platforms. In addition to the reliability, security and sovereignty aspects of data sharing, it also provides the interoperability functionalities of various IDS connectors.

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for Research & Innovation

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