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DiMAT

Holistic digital transformation
of the SMEs manufacturing industry

D3.1 DIMAT ARCHITECTURE

31/03/2023

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D3.1 DiMAT Architecture

(First version)

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Abstract	This document presents the general methodology that will be followed in defining the DiMAT architecture, as well as a first version of said architecture. Multiple state-of-the-art standards and referenced implementations have been reviewed and analysed in order to identify relevant features for DiMAT, Furthermore, all the preparation work done for the Description of Action is leveraged to define an initial guideline for the development of DiMAT.
Keywords	DEPLOYMENT ARCHITECTURE, SYSTEM REQUIREMENTS, VIEWPOINTS, SCALABILITY AND CAPACITY PLANNING

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EXECUTIVE SUMMARY

This deliverable will present the Architecture Description (AD) for the DiMAT platform. This means both the entity (the platform itself) as well as its environment will be analysed. The general methodology for defining the architecture is presented, using the standard ruling the AD (ISO/IEC/IEEE 42010), reference architectures based on it and other relevant standards (CHADA, MODA).

Next, the most relevant elements in an AD that the standard defines are explored. The stakeholders, their concerns and the chosen viewpoints are presented, with the preliminary work done for each of them. This includes the analysis of existing development efforts done by consortium partners and how they relate to the different components that will be developed as part of the project.

This document serves as a preliminary architecture document. A second and a more refined version of it will be provided in M9 as part of Deliverable D3.2. While this document gives an overview of the overall architecture, it should be noted that other tasks in WP3 will continue developing the results that are first presented here.

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ABBREVIATIONS

AD	Architecture Description
API	Application Programming Interfaces
CEN	European Committee for Standardisation
CHADA	Characterisation Data
CMDB	Cloud materials database (T4.1)
DTPC	Digital Twin for Process Control (T6.3)
EMMC-CSA	European Materials Modelling Council (project)
EMMO	Elementary Multiperspective Material Ontology
FAIR	Findability, Accessibility, Interoperability and Reusability
GDPR	General Data Protection Regulation
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IIC	Industrial Internet Consortium
IIoT	Industrial Internet of Things
IIRA	Industrial Internet Reference Architecture
IDSA	International Data Space Association
IMSA	Intelligent Manufacturing System Architecture
I4.0	Industry 4.0
ISO	International Standardisation Organisation
KAF	Knowledge Acquisition Framework (T4.2)
KPI	Key Performance Indicator
MEC-LC	Materials Environmental and Cost Life Cycle Assessment (T4.3)
MD	Materials Designer (T5.3)

MDF	Materials Design Framework (T5.1)
MM	Materials Modeler (T5.2)
MMPS	Materials Mechanical Properties Simulator (T6.1)
MODA	Modelling Data
MPS	Materials Processing Simulator (T6.2)
RAM	Random Access Memory
RAMI	Reference Architectural Model Industry
RDF	Resource Description Framework
SME	Small-Medium Enterprise
UAV	Unmanned Aerial Vehicle
UC	Use Case
WP	Work Package

1 BACKGROUND AND VISION

The DiMAT project aims to create a digital platform that offers open modelling, simulation and optimisation tools with a special focus on SMEs, with the purpose of improving the effectiveness of materials design and ensuring of a high level of quality, sustainability and competitiveness of manufacturing processes.

To achieve this, an adequate architecture must be defined, and certain characteristics considered. The different components will be provided as a Software-as-a-Service, will be based on a modular design and will follow best-practices to ensure maintainability and scalability. Security will be taken into account to ensure data confidentiality, integrity and availability.

Usability will be put a focal point to allow users to focus on their needs and finding solutions for their concerns in an intuitive way, suited to their roles as managers, scientists, or other types of stakeholders as we recognize and specify in this document.

The platform aims to promote FAIR principles of data in the domain of materials science. One major effort in this direction is the development of interoperable protocols, known as the CHADA and MODA for standardization of experimental protocols and simulation workflows, respectively. These are based on the Elementary Multiperspective Material Ontology (EMMO), which aims to act as a common language for promoting interoperability in Materials Science and Engineering. DiMAT will contribute to these efforts by accommodating such representations and further developing the ecosystem surrounding these standards.

The architectural work presented here will serve to guide the development of all the DiMAT suites to ensure a unified approach where the different perspectives and requirements of the involved stakeholders can be met.

2 METHODOLOGY

This section will present the approach that will be followed to define an architecture that can achieve the goals mentioned above.

First, the ruling standard (ISO/IEC/IEEE 42010) has been analysed. Second, various reference architectures have been reviewed to identify their most relevant features. The same has been done for related standards like CHADA and MODA, and for the EMMO ontology.

Next, all the gathered information, as well as the initial research done during the proposal writing process and included in the Grant Agreement has been leveraged to start the Architecture Description. Work on identifying stakeholders, concerns and viewpoints has started and will be reported in later sections of this document. All the generated information will be made available to the viewpoint specific tasks as preliminary work and leveraged by them to create the corresponding specifications from each chosen perspective.

2.1 ISO/IEC/IEEE 42010 STANDARD

The architecture description presented on this document has been developed following the standard ISO/IEC/IEEE 42010 (“Systems and software engineering - Architecture description”) [1], specifically its release of November 2022.

This standard defines concepts like stakeholders, concerns and viewpoints, and their connections to each other. These elements are used for defining the AD.

Before going into how those terms are defined in the case of DiMAT, we will quickly present reference architectures that will influence the overall design.

2.2 REFERENCE ARCHITECTURES

2.2.1 IIRA

The Industrial Internet Reference Architecture (IIRA) [2] for Industrial Internet of Things (IIoT) systems is maintained by the Industrial Internet Consortium (IIC) and its latest version, v1.10, was published in November 2022.

From the main concepts of the standard, this reference architectures focusses on stakeholders, concerns, view, viewpoints and models:

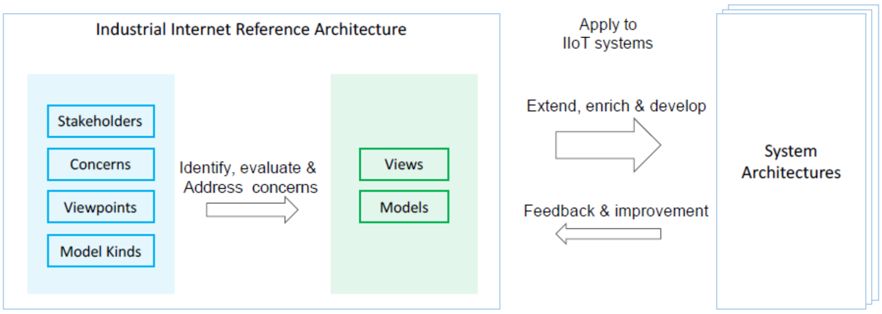

Figure 1: IIRA Constructs and Application

The reference architecture identifies a list of stakeholders related to IIoT, and defines four viewpoints to address their concerns:

- *Business viewpoint*, focusses on the business stakeholders and their vision. It *refines* the objectives of the system and considers things such as the value from a business perspective, the cost of maintaining the system or the return on the investment in a vision and value-driven model.

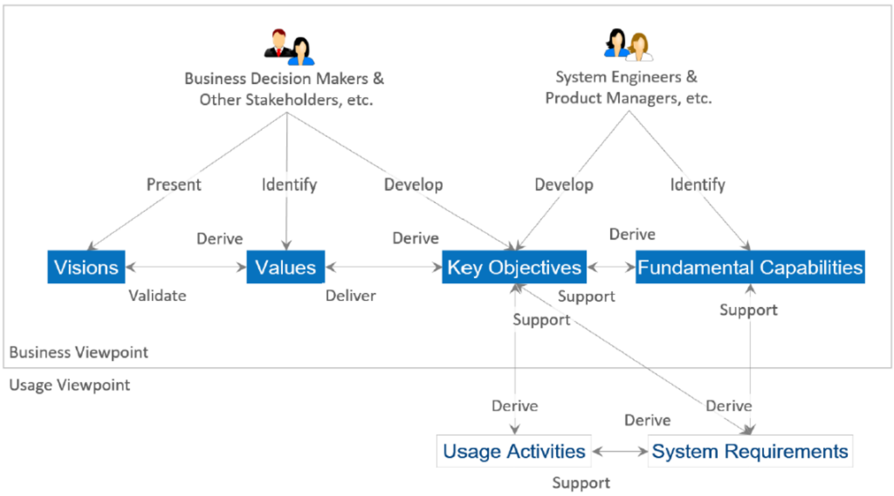

Figure 2: IIRA's Vision and Value-Driven Model

- *Usage viewpoint*, takes care of the expectations regarding the operational aspect of the system and typically defines the sequences of activities a user and the system should carry out. Concerns are typically related to efficacy and efficiency, usability, skill requirements, etc.

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- *Functional viewpoint*, divides the system into functional, distinct domains and provides examples for their components and data/control flows.

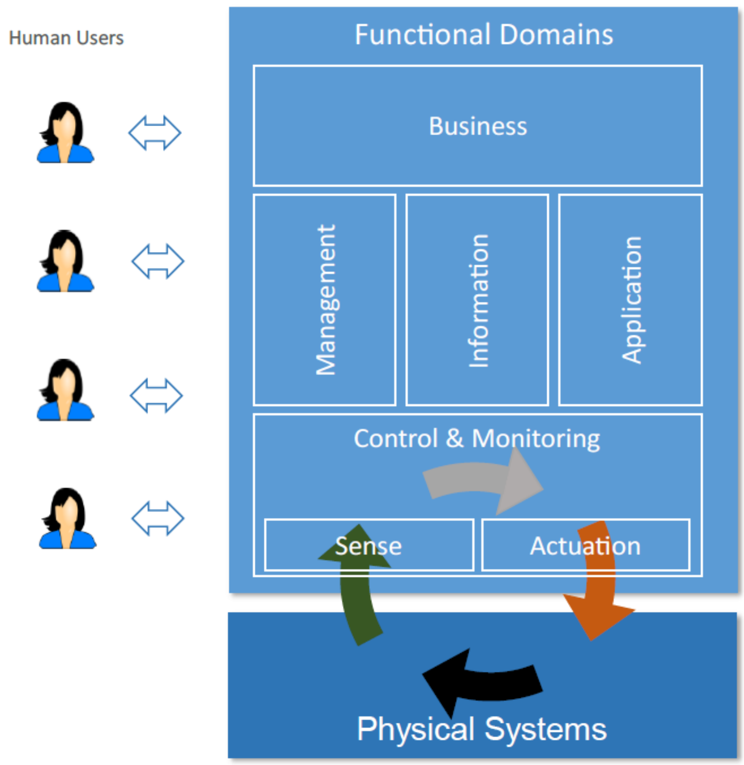

Figure 3: IIRA's Functional Domains. Green arrows: data/information flows; Grey/White arrows: decision flows; Red arrows: command/request flows

- *Implementation viewpoint*, typically follows architectural patterns to define the components that make up the system. The reference architecture provides an explanation on some common patterns of IIoT.

2.2.2 RAMI4.0

The Reference Architecture Model Industrie 4.0 (RAMI4.0) [3] was published as a DIN Specification in April 2016.

It defines three axes by which each asset (or combination thereof) can be characterised, as shown in Figure 4.

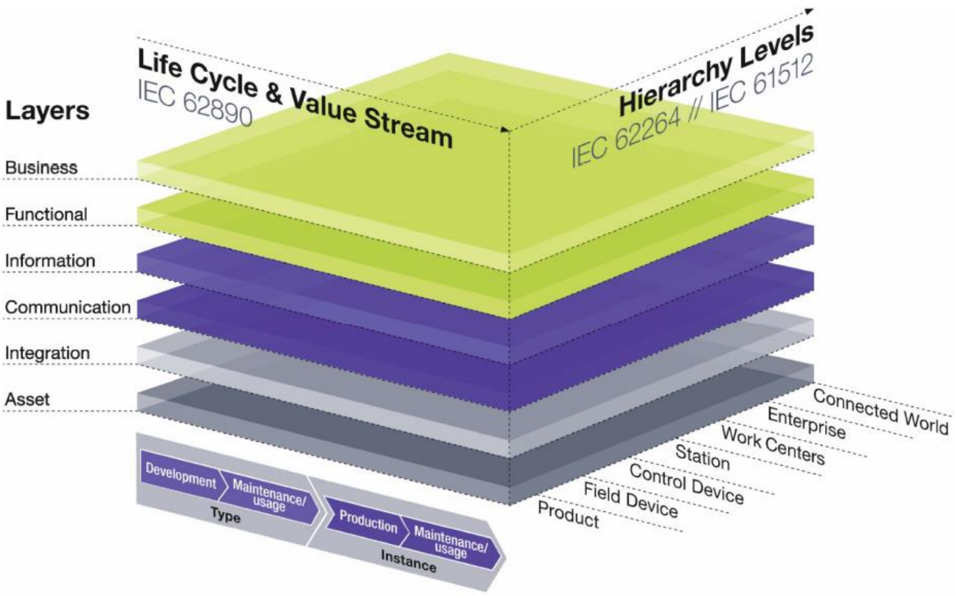

Figure 4: RAMI's three axes

- The Layers define six levels related to the role of an asset, its functions and properties.
- The life cycle & value stream situates the *lifetime* of an asset in time, but also location.
- The hierarchy Levels assign a functional model to different levels based on DIN standards.

The model also defines what an Industrie 4.0 (I4.0) component is. I4.0 components are made up of an asset (either in the physical or the information world) with a specific role and an administration shell (a virtual representation of the asset) and they must have communication capabilities. Details on the characteristics of the administration shell are also given.

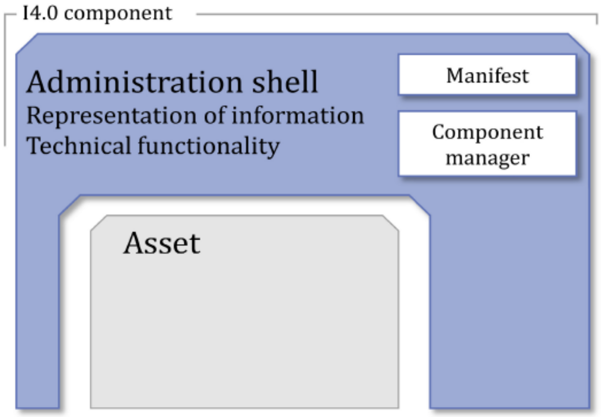

Figure 5: An I4.0 component.

2.2.3 IDSA-RAM

The International Data Spaces Association [4] published the third version of their reference architecture model (IDSA-RAM) on 2019.

As seen on Figure 6, the reference architecture model defines five layers (viewpoints) with different granularity levels

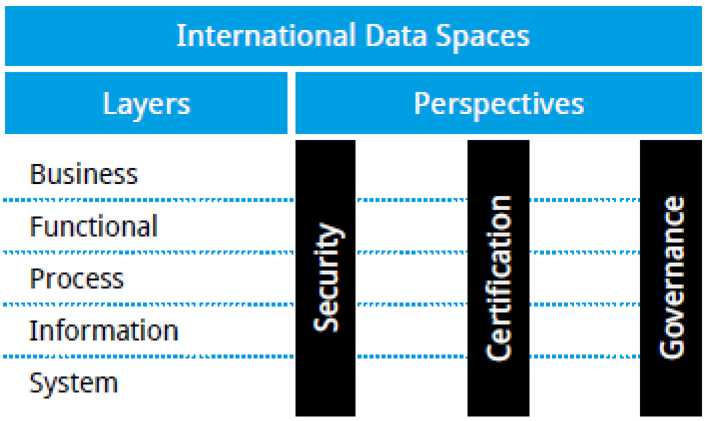

Figure 6: General structure of IDSA-RAM.

- The business layer defines the roles participants can take and their categories.
- The functional layer defines requirements of data spaces in terms of their objectives and the functions these imply.
- The process layer defines the interactions among the components in three major steps (onboarding, exchanging data and publishing and using data apps).

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- The information layer defines the common language for all data spaces to achieve interoperability and (semi-)automated exchange of resources.
- The system layer defines the software components, and how they are integrated, configured and deployed.

Furthermore, it specifies three perspectives (security, certification and governance) that affect all five layers.

2.2.4 IMSA

The Intelligent Manufacturing System Architecture (IMSA) published in December 2015 by the Ministry of Industry and Information Technology and the Standardization Administration of China is made up of three different dimensions, as shown on Figure 7.

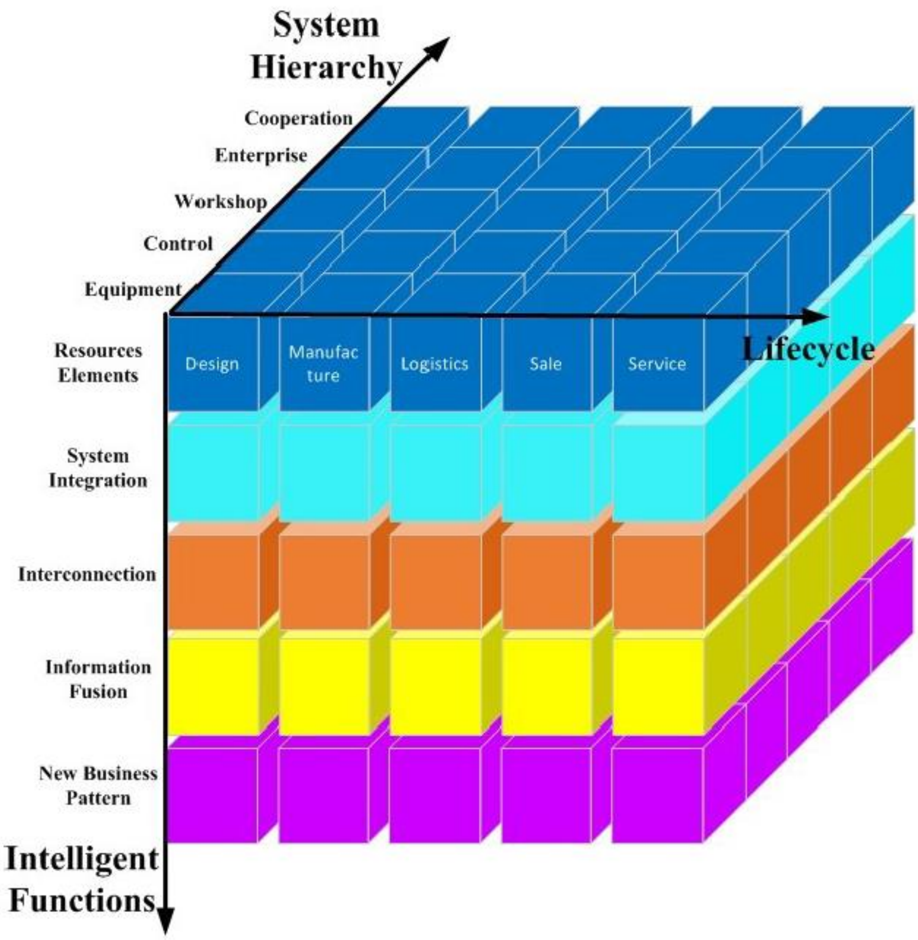

Figure 7: IMSA dimensions.

2.2.5 MarketPlace

The MarketPlace project [5] is an ongoing European project that sets out to develop an online platform [6] that acts a virtual market for the field of materials modelling in which users can browse, purchase and execute various products that were made available by 3rd-party providers. The MarketPlace platform shares the vision of the DiMAT platform when it comes to FAIRness of data and its revolving technologies and standards (e.g., EMMO), and therefore is a valuable architecture reference here.

In the MarketPlace, software providers can register their applications with fine-grained control over which functionalities are exposed, within which scope, to what extent, and for what price. The providers have control over the usage of their software as the MarketPlace offers built-in authentication and license management services. All registered applications are published in the MarketPlace app store to allow MarketPlace users to browse them and then – after purchase – run them directly in a private or public secured environment. Additionally, applications can be integrated into complex workflows that can also be made available as saleable items in the app store and can be executed by the MarketPlace. Inter-app communication is facilitated by the MarketPlace platform via standardized APIs and communication channels. Figure 8 shows the basic layout of the system architecture, where the system components are bundled together into four groups.

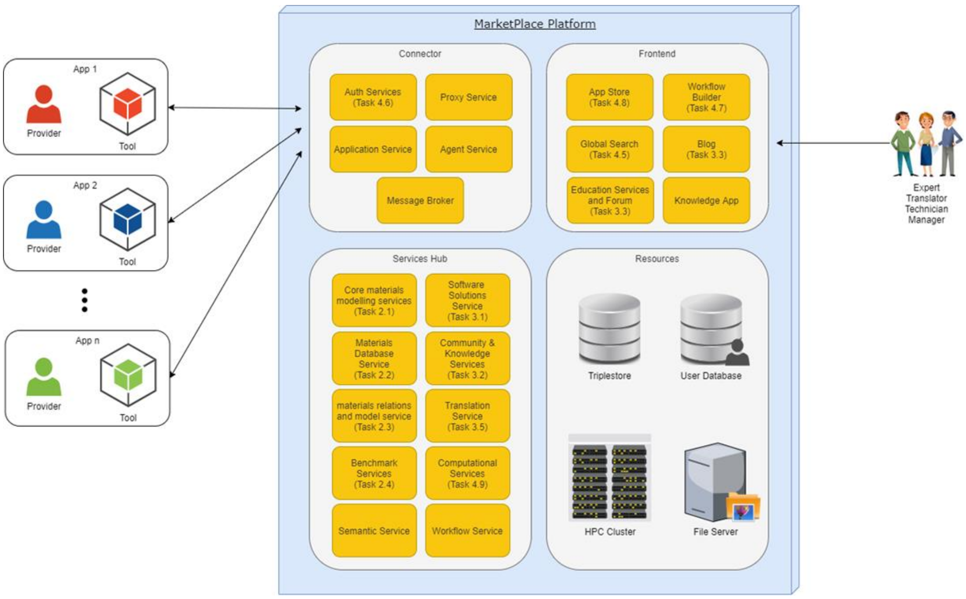

Figure 8: The MarketPlace components (logical view).

The MarketPlace architecture features a micro-service design, where multiple small and focused services comprise the overall functionalities of the platform. Figure 9 illustrates the communication between the different layers of the architecture.

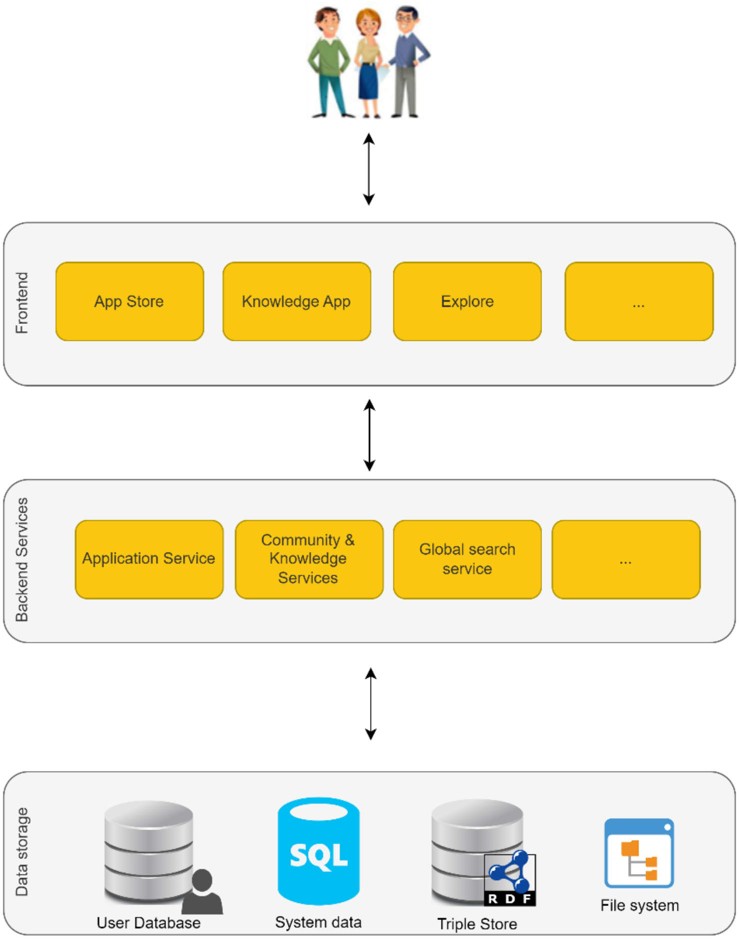

Figure 9: Components are organized as a stack of layers. Communication takes place between neighbouring layers.

The development view, given in Figure 10, shows the platform from the perspective of a programmer in terms of software management.

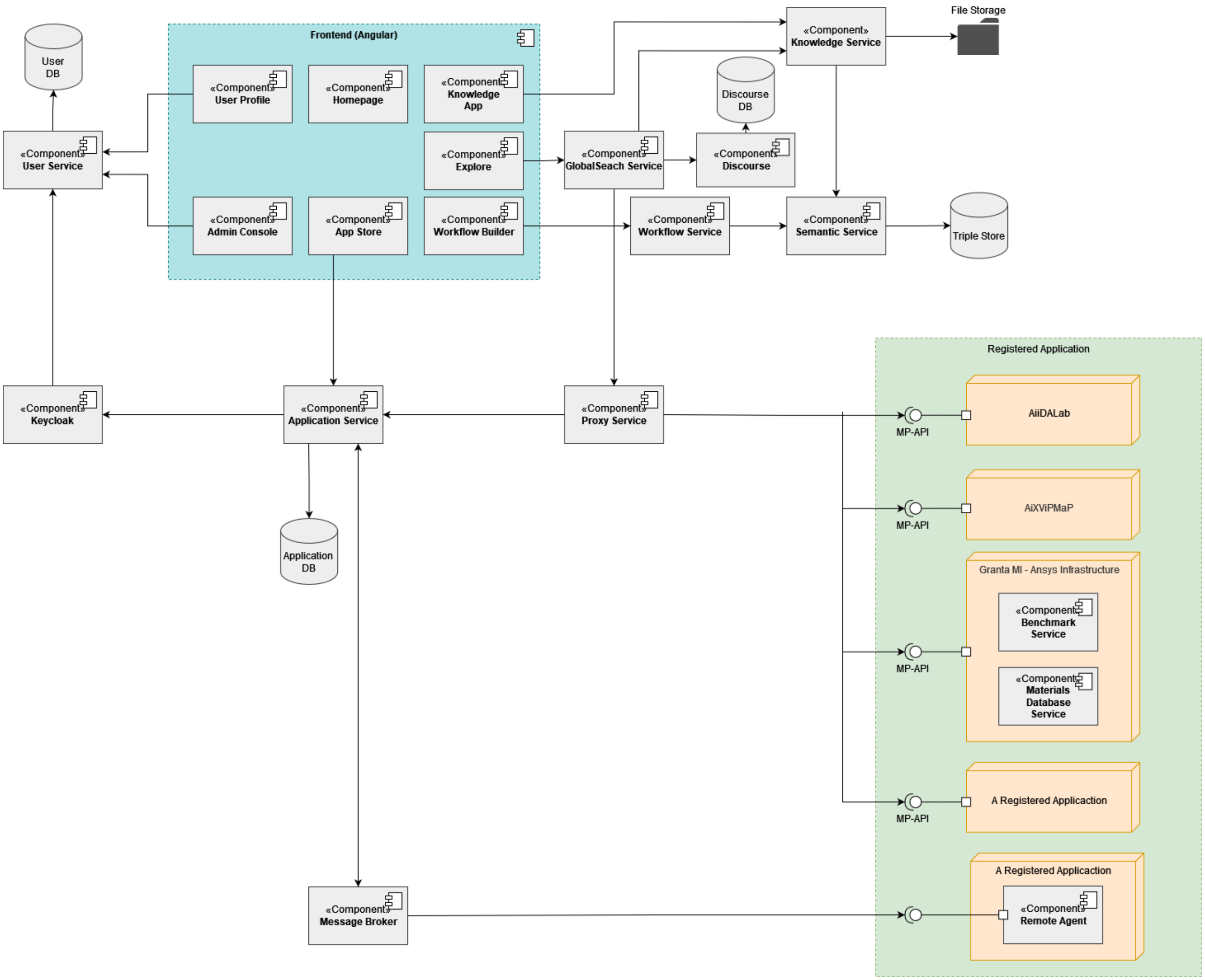

Figure 10: The MarketPlace platform's development view.

Figure 10 illustrates all the involved services as components, including the relevant storage systems and interconnections. The frontend is divided into different sections that interact with different services, such as user authentication and authorization via Keycloak.

The physical view, shown in Figure 11, comprises a system engineer's perspective, focussing on the topology of the components and their connection at the physical level. Figure 11 also indicates how the different platforms and components are deployed on different infrastructures.

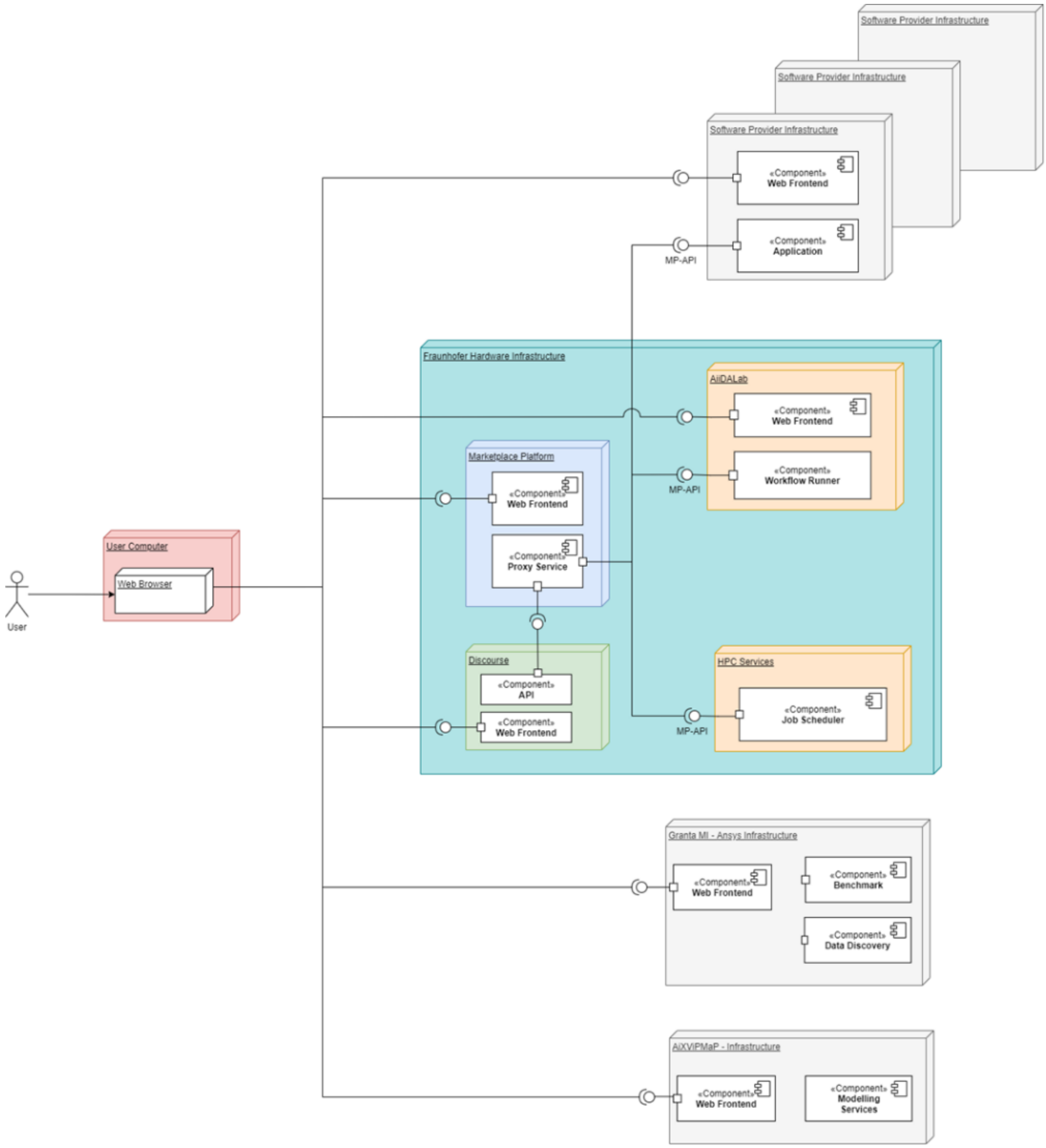

Figure 11: The MarketPlace platform's physical view. The main deployment is hosted in Fraunhofer's Hardware infrastructure, to which the different registered applications, as well as the users connect.

2.3 APPROACH TO EMMO, MODA, AND CHADA STANDARDS

In order to ensure an effective development and a consequent acceptance in the community, current standards and ontologies developed in the domain should be inspected, reused and further developed when possible.

Fraunhofer has been closely involved in the development of the Elementary Multiperspective Ontology (EMMO) [7], as well as the MODA and CHADA standards for modelling and characterisation data, respectively.

2.3.1 EMMO

EMMO is a comprehensive ontology that provides a standardized and structured vocabulary for describing materials and their properties in a machine-readable format. Developed by the European Materials Modelling Council, EMMO is designed to promote interoperability and seamless data exchange between different materials modelling software and data sources. EMMO defines a rich set of concepts, relationships, and properties that enable researchers, developers, and engineers to model materials accurately and efficiently. EMMO adoption by the platform will facilitate interoperability and integration between materials modelling workflows by providing a common language that enables communication between different tools and data sources.

A brief introduction to EMMO is provided in [8], an ontology applied for CHADA (Section 2.3.2.2 below), by one of its developers. It points out the relevant elements in EMMO created with the intention of serving as a standard representation system for applied sciences:

1. EMMO's top level is minimal and stems from a few fundamental principles from science, such as the notion that everything is 4D, and that there is a Universe object and a fundamental quantum 4D object. Otherwise things can only be classified as physical or void. Abstract objects are not present in EMMO; all must be described in terms of physical objects.
2. EMMO's middle level focuses on the different ways objects can be represented, which are called "Perspectives" and very useful for considering multiple disciplines with different views. There are five main Perspectives:
    a. *Holistic*: whole and the parts that make it up.
    b. *Persistence*: processes (i.e. time persistence) and objects (i.e. space persistence): this perspective facilitates mapping to other widespread ontologies like BFO or DOLCE.
    c. *Physicalistic*: gives a meaning to objects from a scientific perspective.
    d. *Reductionistic*: hierarchical view of objects based on granularity.

   e. *Perceptual*: arrangements in time and/or space such as sounds or alphabet characters.

3. There are three types of relationships between instances: topological, mereological and semiotic.
4. The semiotic triangle [10] is used to show what we want to say and our knowledge about objects. It represents the relationship between the speaker (subject), an object (referent) and how the object is designated (symbol).

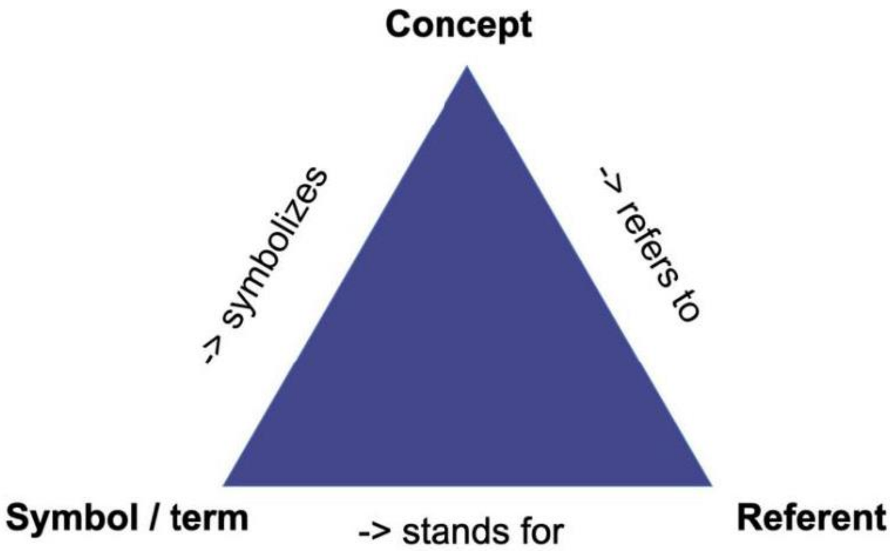

Figure 12: The semiotic triangle.

5. Alternative labels and annotations are leveraged by EMMO to encompass the different meaning that diverse disciplines and standards give to words.

EMMO is publicly available on GitHub [9].

2.3.2 MODA and CHADA

The development and standardisation of MODA (MOdelling DAta) and CHADA (CHAracterization DAta) are important steps for systematic and traceable representations of modelling and characterization workflows.

In DiMAT, CHADA and MODA will be represented digitally, which will allow creating and editing them via GUI in an interactive manner and will enable their interoperability. Furthermore, while CHADA and MODA were originally conceived to capture protocols, the DiMAT platform will also enable them to be associated with data.

The following subsections provide a general explanation on these two standards.

2.3.2.1 MODA

MODA is a web tool that was developed by Fraunhofer within the EMMC-CSA project [11]. It offers a template for users to build static documentation of the involved physics and data. Figure 13 shows this basic template that can be extended to capture complex cases. Figure 14 illustrates a particular instance of a MODA, pertaining the Use Case (UC) 3 of the aforementioned MarketPlace project. The UC aims to study the different characteristics in the performance of nanomaterials (e.g. particle morphology, particle size) to improve the design and operation of nanopowder production technologies.

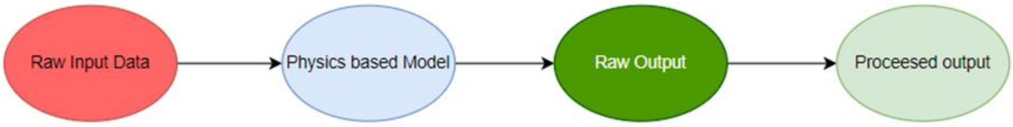

Figure 13: MODA template for the (standardized) description of materials model.

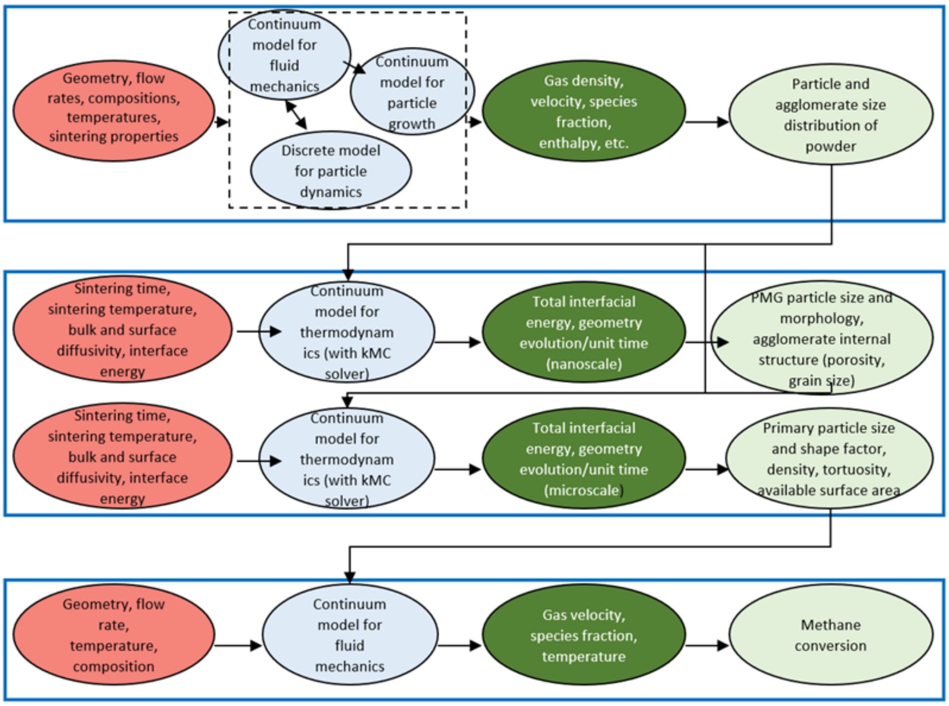

Figure 14: Example of MODA documentation (UC 3 of MarketPlace).

Note that MODA is not a workflow representation, but rather a high-level description of it. Recently, MODA has been the subject of a CEN Workshop Agreement [13].

2.3.2.2 CHADA

The purpose of CHADA is to provide a standard structure for documenting materials characterisation methods. CHADA has been developed in the OYSTER project [12], following the 'template' of a similar structured documentation for materials modelling, the MODA. CHADA has also been the subject of a CEN Workshop Agreement [14].

More information regarding CHADA can be found on [15], but we will summarise the most relevant concepts here.

There are four kinds of concepts involved in the classification of a characterisation workflow (also known as simply “characterisation”):

1. **User Case**: encapsulates the sample and the information on the testing environment. It contains information on the material being probed and the environment which surrounds it.
2. **Experiment**: covers the process of the measurement chain for a single experiment. Core elements such us detector, signal, noise and probe are defined.
3. **Raw data**: the data directly resulting from the measurement, which is usually a function of time, position or photon energy.
4. **Data processing**: any analysis carried out on the raw data that results in its final form.

Refer to Figure 15 for a general CHADA scheme with all concepts involved.

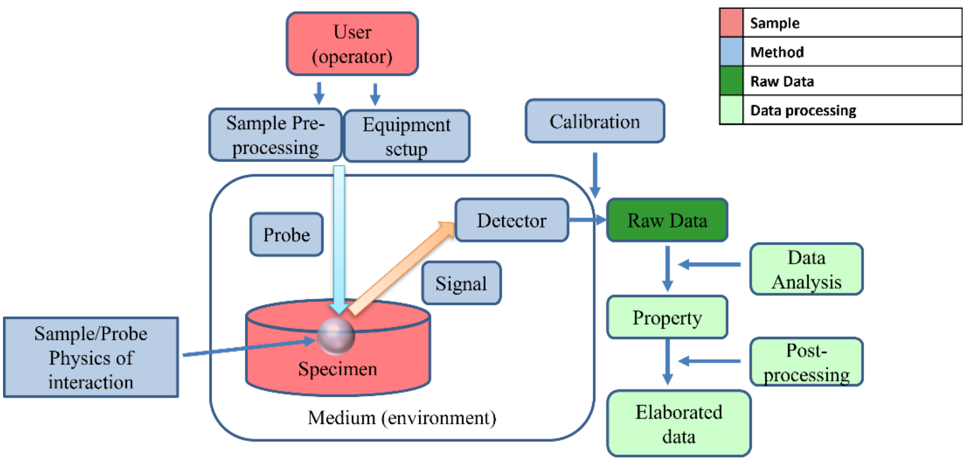

Figure 15: General CHADA scheme with all elements needed for a characterisation method.

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2.4 EXISTING DEVELOPMENTS FROM PARTNERS

The main source of information and knowledge to the project are the consortium members. Apart from standards and common practices from the domain, they also contribute with tools and frameworks that have been developed in previous projects.

An initial list of such elements is provided as part of the implementation viewpoint in Section 5.4.

2.5 CONNECTION TO OTHER TASKS

The development of an architecture is an iterative process. Each time the requirements change, the architecture should be reviewed and updated (if necessary). For the DiMAT project, this means a close interaction between Task 2.3 (Use Cases Scenarios Requirements and KPIs) and Task 3.1.

Furthermore, an Architecture Description (more specifically, one of its viewpoints) will provide details as to which technologies should be used in which components. The available technologies are analysed as part of T2.2 (Benchmarking of Digital Technologies for Materials Modelling, Design, Processing and Manufacturing), so collaboration with that task will also be continuous.

The governing standard for the Architecture Description (section 2.1) dictates the need to specify different viewpoints that will tackle different aspects of the architecture. These are reflected in the remaining tasks of WP3, and T3.1 will provide a starting point for them. See Section 5 for further details on the viewpoints.

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3 STAKEHOLDERS

A *stakeholder* is an entity that has an interest in the system. Their interests are represented by concerns (see Section 4).

Based on the research done for the Grant Agreement (specifically, the part B), a preliminary list of stakeholders is:

- Material Designers (compounding industry, machine tool manufacturers, polymer designers…)
- Material Producers (Compounding, fibers, glass, graphite, resin, spinning)
- Manufacturing Industry (Automotive, ceramics, composite, footwear, furniture, class, metal, plastic)
- Digital Technologies Providers
- European Commission
- Consortium members
  - Platform developers
  - Platform owners

This list will be further extended based on the project vision (D2.1) and input from the consortium.

4 CONCERNS

A *concern* is a topic of interest in a system that one or more stakeholders have.

Task 2.3 will help identify the concerns of the pilot cases, which represent different types of stakeholders. An initial list of concerns could be:

- Can I store/query time series data?
- Can I store/query material data?
- Can I predict ___ from ___ data?
- Can I connect my software to the DiMAT platform?
- Is my data easy to find?
- Is my data easy to access?
- Is my data interoperable?
- Is my data reproducible?
- Is my data private?
- Is my data backed-up?
- Is there a secure user management system?
- Are there different user roles with different rights?
- Are existing tools and processes reused and adapted?
- Are available standards (MODA, CHADA, EMMO) used?
- Is a cost Life Cycle Assessment included?
- Is an environmental Life Cycle Assessment included?
- Is the platform sustainable?
- Is the platform competitive?

5 VIEWPOINTS

ISO/IEC/IEEE 42010 requires the establishment of architecture viewpoints to analyse and cover different aspects of the architecture and ensure that all the concerns coming from the stakeholders are satisfied.

DiMAT has defined four different viewpoints that will be presented in the next sections.

5.1 BUSINESS VIEWPOINT

This viewpoint will frame the development from the business perspective, providing the requirements that are not technology related, but rather "real-world". It will define the stakeholders and their requirements and match them to the experience and capabilities of the experienced consortium members that will be gathered via questionnaires or interviews.

The work will be carried out in T3.2.

Out of all the stakeholders (see initial list in Section 3), the task will focus on business related stakeholders and extend the list where necessary. Their requirements will be defined and used for the matching to the partners' capabilities.

The structure of this business viewpoint will be based on the IIRA business viewpoint. Specifically, it will be based on a pure business perspective of the business stakeholders, jointly with a first technical perspective focused solely on capabilities provided by technological actors.

The business stakeholders frame the vision, values and objectives of the business regarding the new proposals. Furthermore, other technical actors will participate in the alignment of these objectives with the capabilities of the new systems.

5.2 USAGE VIEWPOINT

Similarly to how T3.2 will focus on the business perspective, T3.3 will bring into play the users, their roles and activities, as well as the different parties.

A preliminary general list of users (with different roles) would be:

- Unregistered users, have no access to the platform, only to a landing page. Potentially, some demoing features could be made available as an advertising strategy.

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- Registered users, with limited access to most features. T3.3 will identify which features of the platform require special permission, and the requirements needed to attain them.
- Platform developers, have extended access and are familiar with the inner workings and deployment strategy. Have access to additional documentation only relevant to maintainers.
- Platform owners/administrators, have full access and control of the platform.

5.3 FUNCTIONAL VIEWPOINT

T3.4 will identify which data and process flows will take place in the platform, and which components are involved in them.

For this, the pilot cases provide real life scenarios that will be vital to identify what a future use of the platform will look like. T3.4 will synchronise with T2.3 (Use Cases Scenarios Requirements and KPIs) to translate those requirements into actual decisions and information flows.

For reference, the pilot cases are:

- Pilot 1: Synthetic Textiles Production (Polymer)
- Pilot 2: UAVs Manufacturing with Advanced Composite Materials (Composite)
- Pilot 3: Innovative Glass Forming Process in Digital Environment (Glass)
- Pilot 4: Speeding-up the New Product Development Process (Graphite)

A preliminary analysis identified the following connections between the pilot cases and the toolkits (see Section 5.4):

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PILOT	DATA AND ASSESSMENT SUITE			MODELLING AND DESIGN SUITE			SIMULATION AND OPTIMISATION SUITE		
	CMDB	KAF	MEC-LCA	MDF	MM	MD	MMS	MPS	DTPC
PILOT 1	☒	☒	☐	☒	☒	☒	☒	☒	☐
PILOT 2	☒	☐	☒	☐	☒	☒	☒	☒	☒
PILOT 3	☒	☒	☒	☐	☐	☐	☒	☒	☒
PILOT 4	☒	☒	☒	☒	☒	☒	☐	☒	☒

Table 1: Preliminary estimation of which toolkits which be used by each pilot

Appendix A includes the complete information gathered from the pilots for Table 1, where not only the toolkits, but also an expected workflow is specified.

5.4 IMPLEMENTATION VIEWPOINT

The implementation viewpoint (T3.5) will list the different components, its connections, a selection of technologies required to carry out the implementation. Application Programming Interfaces (API) for standardised communication will be defined here.

This viewpoint and its influence from the other viewpoints in the architecture will lay the ground work for the development activities carried out in WP4, WP5 and WP6.

In the Description of Action, three suites were defined, with a total of nine toolkits (three per suite). The grouping of toolkits per Suite can be seen in Table 2.

DATA AND ASSESSMENT SUITE	MODELLING AND DESIGN SUITE	SIMULATION AND OPTIMISATION SUITE
CLOUD MATERIALS DATABASE (CMDB)	MATERIALS DESIGN FRAMEWORK (MDF)	MATERIALS MECHANICAL PROPERTIES SIMULATOR
KNOWLEDGE ACQUISITION FRAMEWORK (KAF)	MATERIALS MODELER (MM)	MATERIALS PROCESSING SIMULATOR
MATERIALS ENVIRONMENTAL AND COST LIFE CYCLE ASSESSMENT (MEC-LC)	MATERIALS DESIGNER (MD)	DIGITAL TWIN FOR PROCESS CONTROL (DTPC)

Table 2: DiMAT suites

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The implementation viewpoint will define which components are required per toolkit, and the technologies to implement them. The common orchestration deployment that connects all toolkits and enables user interaction will also be decided.

Each component of every Suite will be able to be accessed and executed in a stand-alone manner, adopting a modular approach for its development and lifecycle management, while interoperability with the other toolkits of the same suite will be supported through open APIs. To support the modularity of the tools, a microservices-based approach will be followed ensuring also the scalability of the overall architecture. The toolkits belonging to the same Suite can access common data repositories (e.g., databases, RDF triple-stores) and the existence of lightweight APIs enables data exchange among them but also between components of different Suites, in case that such dependencies exist. Aiming to provide easily understood and maintained APIs, a Swagger implementation will be considered. Access to the toolkits will be provided by a unified front-end with an appropriate user authentication and authorisation mechanism. Aiming to provide open and extensible components, the focus will be on adopting a homogeneous technology stack to the greatest extent.

All components will be thoroughly documented to simplify platform maintenance, deployment and further development, and additional user documentation will be provided with usage examples and tutorials.

5.4.1 Re-use of existing developments by partners

A key feature to ensure a rapid and sustainable development that is accepted by the community is to integrate existing technologies. Task 2.2 (Benchmarking of Digital Technologies for Materials Modelling, Design, Processing and Manufacturing) will carry out an analysis on the digital technologies' knowledge possessed by the project partners and compare their features. This information will be very relevant for the specification of the implementation viewpoint.

A preliminary inquiry of the project partners provided the list presented on Table 3.

This task will carry out a first iteration of the process and share the results with the relevant tasks (viewpoints and development in WP4, WP5 and WP6), so more iterations can be carried out when needed.

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TECHNOLOGY	PARTNER	FEATURES	USAGE
DSMS	FRAUNHOFER	SEMANTIC DATA SPACE	CMDB
SIMPHONY	FRAUNHOFER	SEMANTIC INTEROPERABILITY	SEMANTIC DATA SHARING
MARKETPLACE	FRAUNHOFER	PLATFORM	GENERAL
OIE	FRAUNHOFER	PLATFORM	GENERAL
ROBOFUSE	ROPARDO	PLATFORM	GENERAL

Table 3: Preliminary summary of technologies brought by partners

6 CORRESPONDENCE

By identifying which viewpoint is expected to tackle which concerns and which stakeholder has which concern, we can populate a correspondence table like Table 4. Please note that it is a sample that will be filled once the stakeholders and concerns have been thoroughly defined.

	Business viewpoint	Usage viewpoint	Functional viewpoint	Implementation viewpoint
Material Designers			Can I store/query material data?	
Material Producers			Can I store/query time series data?	
Digital Technologies Providers			Can I connect my software to the platform?	Are existing tools and processes reused and adapted?
European Commission	Is the platform sustainable?			Are available standards (MODA, CHADA, EMMO) used?
Consortium (platform owners)		Are there different user roles with different rights?		
Consortium (platform developers)	Is the platform competitive?			

Table 4: Correspondence between stakeholders, viewpoints and concerns

7 PLATFORM SECURITY

Platform security is an important aspect to take into account from the very first stages of the design of a digital platform because it helps to protect the platform, its users, and the sensitive information that may be stored or processed on the platform. Compliance to regulations like GDPR [16] should be considered from the beginning to avoid complicated modifications at a later stage.

Security is not part of a unique viewpoint, but affects all elements and should consider the input from all the different stakeholders and their perspectives. Different approaches can be followed to find the critical components and the measures needed to protect them. For instance, the assets of the platform could be identified, and the risks in terms of Confidentiality, Integrity and Availability for the stakeholder types could be graded to create an initial prioritisation.

8 CONCLUSIONS

A pre-conceived architecture design is key for enabling efficient and focused work on the software product it describes, as it connects all the different aspects the project aims to consider before spending resources on its implementation.

In the following months, additional iterations on the architecture design will take place, which will be finally reported as part of Deliverable D3.2, where the focus is expected to be the software solution the project would then work towards. Further refinement will continue beyond Task 3.1 and D3.2 in the other tasks of WP3.

The list of the stakeholders, concerns and their correspondence to the viewpoints will be further populated, and all the information generated so far will be made available to all other relevant tasks to ensure a unified approach and understanding.

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APPENDIX A

This appendix includes the initial information gathered from the pilots in terms of which toolkits they expect to interact with and how.

Pilot 1: Synthetic Textiles Production (Polymer)

- Partner
  - NTP
  - AITEX
- Toolkits
  - CMDB
  - KAF
  - MDF
  - MM
  - MD
  - MMS
  - MPS
- Workflow
  - Store a big amount of information in order to make better further decisions with Toolkit **KAF** and **MDF**.
  - Selection of the most suitable materials before trials with **MM** and **MD** to predict their behaviour in an accurate way.
  - **MMS** Toolkit for improving the materials' design and optimising the simulation process.
  - **CMDB** and **MPS** Toolkit for storing information and optimize compounding parameters and processing conditions

Pilot 2: UAVs Manufacturing with Advanced Composite Materials (Composite)

- Partners
  - ACCELI
  - CERTH
- Toolkits
  - CMDB
  - MD
  - MM
  - MMS
  - MPS
  - MEC-LC

- DTPC

- Workflow
  - Load all the data materials into the **CMDB**
  - Simulate a few configurations of the layup to evaluate the mechanical properties
  - (**MD**/**MMS**/**MM**) and select the final layup configuration, results will be stored in the **CMDB**
  - Simulate the manufacturing processes (compression/bladder moulding) using the **MPS**
  - Assess the economic and environmental impact of the two candidate processes via **MEC-LC**
  - Monitor and control the manufacturing process with **DTPC**

Pilot 3: Innovative Glass Forming Process in Digital Environment (Glass)

- Partners
  - Hegla
  - Fraunhofer
- Toolkits
  - CMDB
  - KAF
  - MEC-LC
  - MMS
  - MPS
  - DTPC
  - MM (unclear yet)
- Workflow
  - Load the comprehensive glass materials data (characterization, batch information) and glass bending process data (time-series) onto **CMDB**.
  - Explore and present the relationships in the stored data using **KAF**.
  - Assess the environmental and economic impact of glass bending process via **MEC-LC**, for comparing the innovate glass bending technology with the conventional one.
  - Retrieve materials data from **CMDB** using **MDF**.
  - Simulate material thermo-mechanical responses of different glasses (float glass, borosilicate glass etc.) by **MMS,** the data will be stored in **CMDB**.
  - Develop numerical simulations for the glass bending processes with different global and local thermal gradient, boundary condition (where is fixed and where is movable) and simulate glass materials in the process using **MPS**. The data will be stored in **CMDB**.
  - Train machine learning model based on the generated data in **CMDB** with the help of **KAF**, the trained models facilitate a rapid prediction and will be implemented in **DTPC** for a more instant or automatic process control. (i.e. automatically adjust furnace temperature or laser power for bending a thicker glass pane).

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Pilot 4: Speeding-up the New Product Development Process (Graphite)

- Partners
  - IMERYS
  - SUPSI
- Toolkits
  - MEC-LC
  - MPS
  - KAF
  - MM
  - MD
  - MDF
  - DTPC
- Workflow
  - Load material and process parameters (anonymised) onto **KAF**
  - Select most suitable tool between **MM** and **MD** in order to correlate product characteristics with customer performance data
  - Use **MPS** in order to correlate process parameters with product characteristics and finally with customer performance data
  - Use **DTPC** for a more instant or automatic process control
  - Assess the environmental and economic impact of process via **MEC-LC**