DELIVERABLE D 4.10

AGILE4.0 A4F ARCHITECTURE & OCE

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APPROVALS

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DISTRIBUTION LIST

Full Name	Organisation
AGILE 4.0 Consortium	
Externals	

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GLOSSARY

Acronym	Signification
A4F	AGILE 4.0 Framework
MBSE	Model Based Systems Engineering
MDO	Multidisciplinary Design and Optimization
OCE	Operational Collaborative Environment
WP	Work Package

1 EXECUTIVE SUMMARY

1.1 Introduction

The present deliverable is of the type “other”, and it addresses the last version of the AGILE 4.0 Framework (A4F) and its implementation into the Collaborative Operational Environment (OCE). The deliverable D4.10 is publicly available, and the information about the A4F and OCE is made available through the AGILE 4.0 project website at the page https://www.agile4.eu/technologies/. The present report introduces the concepts of A4F and OCE, and explains how their relative information is collected and organized on the project website and can be accessed.

1.2 Brief description of the work performed and results achieved

Since this deliverable is openly accessible to externals, the WP4 partners have organized its activities by deciding what information can be shared publicly (e.g. technologies description, Points of Contacts, videos) and how. It was therefore decided to first identify all the Model-Based Systems Engineering (MBSE) and Multidisciplinary Design and Optimization (MDO) technologies developed and/or integrated in the AGILE 4.0 project. Then, different types of information have been provided by each tool owner or Point of Contact. Finally, a section on the AGILE 4.0 project webpage has been created and all the collected information has been uploaded.

1.3 Deviation from the original objectives

1.3.1 Description of the deviation

The original due date of the deliverable D4.10 was 31st May 2022. After the 6-month project extension, the deadline of the deliverable has been moved to 30th September 2022.

1.3.2 Corrective actions

No corrective actions were required.

2 INTRODUCTION

2.1 Aim of the deliverable and organization of the report

The aim of deliverable D4.10 is to publicly present the last version of the AGILE 4.0 Framework (A4F) and its implementation into the Collaborative Operational Environment (OCE). The deliverable is of the type "other", and it consists of a webpage on the AGILE 4.0 project website containing different types of information about the A4F and OCE. The present report introduces and presents the organization of the webpage.

The definitions of three main concepts developed in the AGILE 4.0 project are provided in Section 3. The concepts are: **AGILE 4.0 MBSE-MDO Architectural Framework**, **AGILE 4.0 Framework (A4F)** and **Operational Collaborative Environment (OCE)**. The relations between the three concepts are also presented. Section 4 instead introduces the project webpage presenting the A4F and OCE. All the types of information collected on the webpage regarding each OCE technologies are presented in the same Section. Finally, Section 5 concludes the report with future directives.

3 AGILE 4.0 TERMINOLOGY

3.1 AGILE 4.0 MBSE-MDO Architectural Framework

One of the goals of the AGILE 4.0 project is the definition of a new MBSE-MDO Architectural Framework. The ISO/IEC/IEEE 42010 standard defines an architectural framework as

> *"a set of conventions, principles and practices for the description of architectures established within a specific domain of application and/or community of stakeholders* [1]*".*

In other words, an architectural framework is a guideline that can be used to represent system architectures, where by architecture it is intended a formal description of a system, its behavior and the relationships among its components.

The scope of the MBSE-MDO Architectural Framework deployed in AGILE 4.0 addresses multiple and interconnected domains, structured as four layers, as shown in Fig. 1.

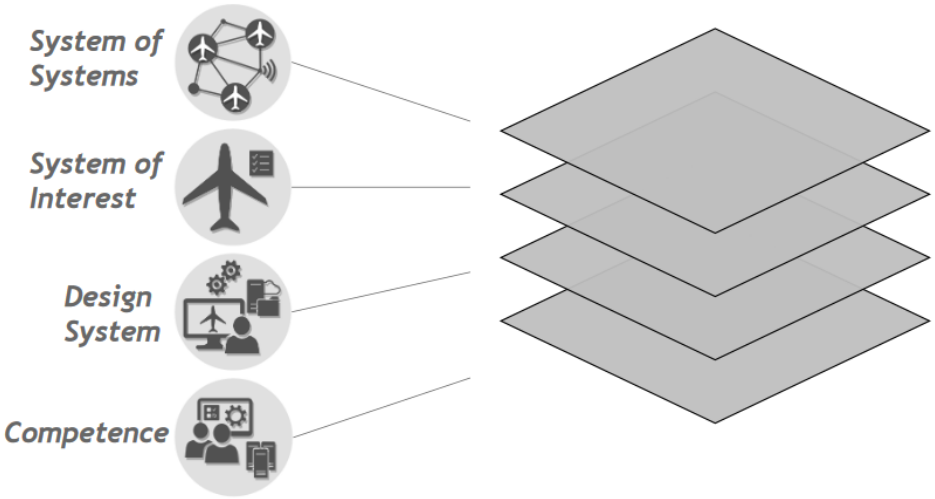

Fig. 1: Four-layer structure of the MBSE-MDO Architectural Framework addressed in AGILE 4.0.

One layer focuses on the *System of Interest*, which is the system being designed and optimized. The System of Interest can be, for example, an aircraft or a component (e.g. a wing), but also an enabling system, like a Supply Chain or a production system. The System of Interest development is supported by a *Design System*, whose deployment and operation should be greatly accelerated. The *Design System* layer refers to the suite of tools and technologies required to develop the System of Interest. **The present deliverable focuses on the *Design System* layer, whose implementation in AGILE4.0 represents the OCE.** Moreover, the development of a System of Interest needs several competences, such as disciplinary components, represented by the *Competences* layer of the Architectural Framework. It can be noted that in AGILE4.0, many competences are already available from the start at different partners, and the AGILE4.0 development system accounts for this scenario as well. Finally, the top layer of the framework in Fig. 1 focuses on the development of multiple systems operating together according to the concept of *System of Systems*.

The Architectural Framework of Fig. 1 is based on a Systems Engineering Product Development approach (refer e.g. to [2] and [3]), in particular a MBSE one, for the development of each of the layers. The high-level representation of such approach, specifically for the development of a *System of Interest*, is schematized in Fig. 1. This approach starts with the identification of system stakeholders and collection of their needs. Then, Concepts of Operations (ConOps) are elaborated to describe through scenarios how the system will operate during its life cycle and therefore to refine and validate stakeholder needs. Validated needs are afterwards transformed into requirements, which drive the system architecting and its development. In other words, several potential solutions are defined by generating different system architectures made of different logical components, i.e. system components (e.g. engine, wing) that are not

constrained to a particular technology. Then, first conceptual designs are performed to derive potential and not optimized physical architectures of the System of Interest. The various system physical architectures are finally designed and optimized through MDO processes. Trade-off analyses are performed and decision-making techniques are adopted to eventually define the *best* solution.

Fig. 2: Schema of the MBSE-MDO process addressed in AGILE 4.0 project.

It has to be noted that, the MBSE-MDO approach illustrated in Fig. 2 can also be employed for the definition, architecting and development of all the layers of the MBSE Architectural Framework, not only the System of Interest. However, the specific components realizing the needed functions might differ for each layer, as well as different modelling techniques and standards used. For instance, the standard and format used to describe the requirements for a System of Systems might not be necessarily the same as used for a System of Interest (aircraft). More information about the AGILE 4.0 MBSE-MDO Architectural Framework can be found in [4] (*System Identification* and *System Specification* steps) and [5] (*System Architecting* step).

3.2 AGILE 4.0 Framework (A4F) and Operational Collaborative Environment (OCE)

The A4F defines, in a MBSE approach, the logics of the *Design System* of Fig. 1, which is developed in the AGILE4.0 project to accelerate the development of complex aeronautical systems (aircraft). The A4F architecture is solution independent (logical architecture). In other words, the A4F architecture is composed only by generic modules, e.g. “Requirements modeling module”, “MDO workflow execution module”.

The Operational Collaborative Environment (OCE) instead represents the implementation of the *Design System* developed by AGILE4.0 project, and therefore used for the resolution of AGILE4.0 application cases. The OCE translates the A4F logical architecture into a specific physical solution (physical architecture), which is composed of heterogeneous specific modules. The list of the specific modules that are part of the AGILE 4.0 OCE is represented in Fig. 3. Information about the modules is presented in the deliverable through the project website, as explained in the following Section.

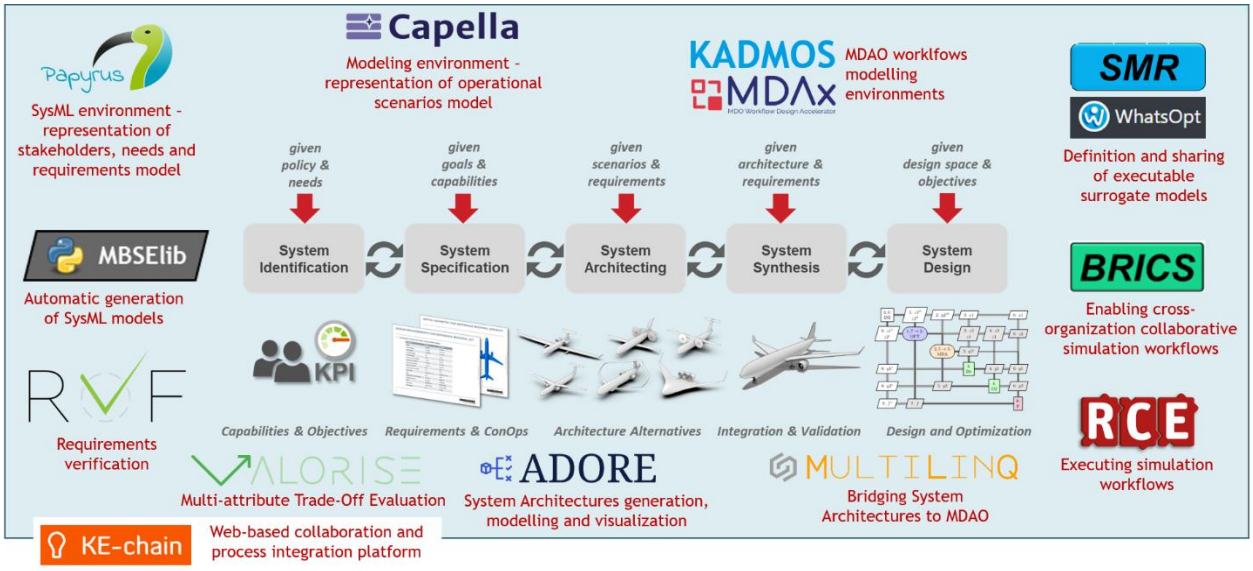

Fig. 3: Representation of the specific modules implemented into the AGILE 4.0 OCE.

4 INFORMATION ABOUT THE SPECIFIC MODULES OF THE OCE

In order to publicly share information about the A4F and OCE technologies of the AGILE 4.0 project, a webpage has been created, with title *AGILE 4.0: A journey from MBSE to MDO*. A screenshot of the webpage is reported in Fig. 4.

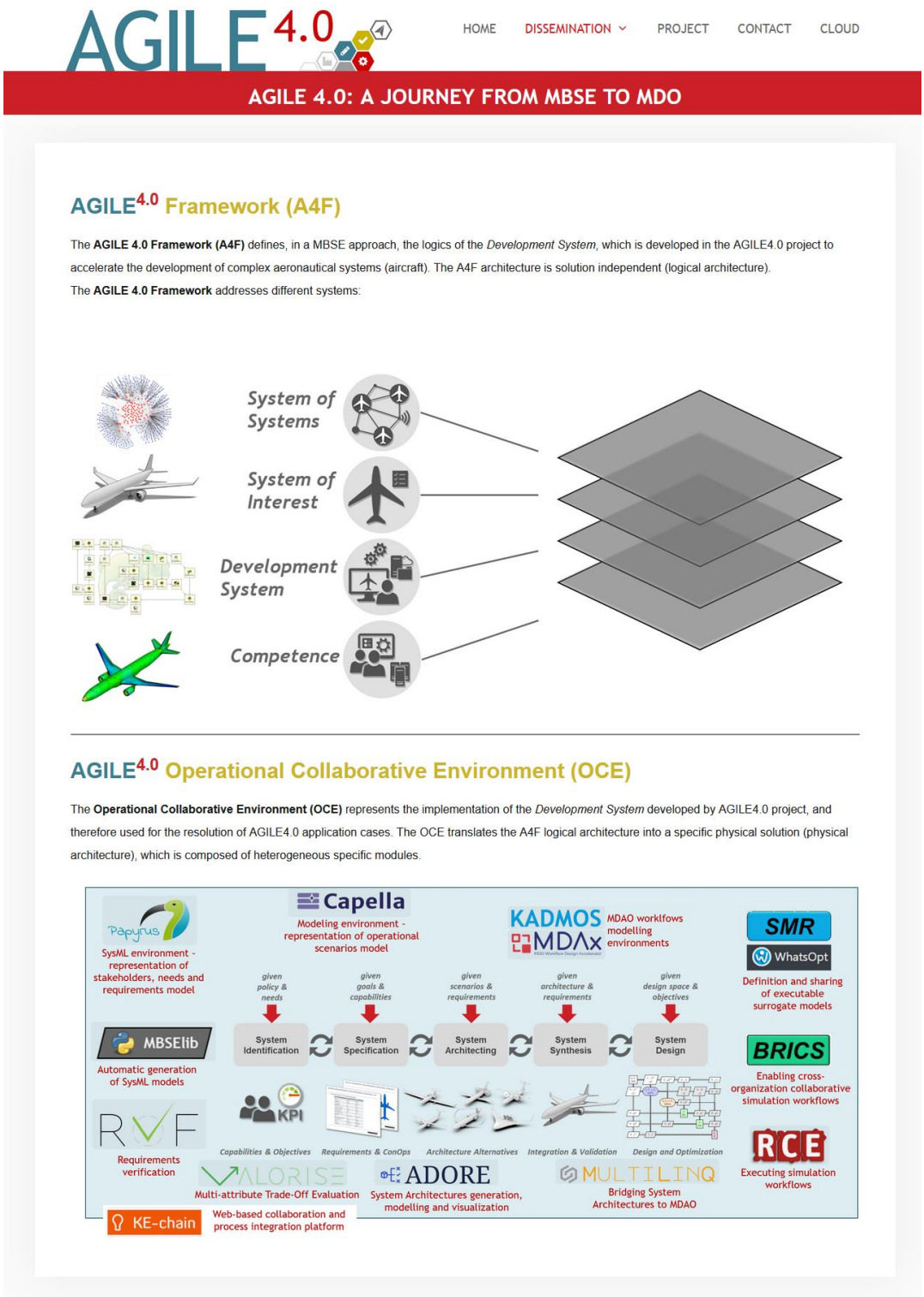

Fig. 4: Screenshot of the AGILE 4.0 project webpage collecting information about the A4F and OCE (adapted).

An image of the 5-step MBSE-MDO process developed in AGILE 4.0 (similar to Fig. 2) is reported in the webpage, and explanations about each step are given when clicking on them. In addition, all the OCE specific modules are presented, and the following information is provided for each one of them:

- **Description**: what is the usage (in the AGILE 4.0 project) of the module within the MBSE-MDO development process.
- **Links**: several OCE modules are openly available, and can be downloaded from the web. For other modules instead, additional information can be found in internet. This type of information therefore is about the link from where modules can be downloaded or additional details are provided.
- **Point of Contact**: when applicable, the email address of a module owner/developer/responsible is provided, so that additional information can be asked.
- **Video**: examples of usage of the OCE modules are provided through videos.
- **Project example**: simple examples of project created with the OCE modules are uploaded onto the website and can be freely downloaded by anyone who is interested.

5 CONCLUSIONS AND FUTURE DIRECTIVES

This deliverable is the last one of WP4: "Development Framework & Platforms". Therefore, D4.10 presents the final version of the A4F and OCE developed in the AGILE 4.0 project. The deliverable is publicly available, and information belonging to it is collected on the project website and introduced in the present report.

The AGILE 4.0 project website – therefore including the webpage collecting information about the A4F and OCE – will be maintained active beyond the conclusion of the AGILE 4.0 project, i.e. 28th February 2022.

REFERENCES

[1] International Organization for Standardization, "ISO/IEC/IEEE 42010 - Systems and software engineering - Architecture description," 2011.

[2] INCOSE, Systems Engineering Handbook v.3, 2006.

[3] NASA, Systems Engineering Handbook Rev 2, 2016.

[4] L. Boggero, P. D. Ciampa and B. Nagel, "An MBSE Architectural Framework for the Agile Definition of System Stakeholders, Needs and Requirements," in *AIAA Aviation Forum*, Washington (US-DC), 2021.

[5] L. Boggero, P. D. Ciampa and B. Nagel, "An MBSE Architectural Framework for the Agile Defintion of Complex System Architectures," in *AIAA Aviation Forum*, Chicago (US-IL), 2022.