



# AGILE

AIRCRAFT 3<sup>RD</sup> GENERATION MDO  
FOR INNOVATIVE COLLABORATION  
OF HETEROGENEOUS TEAMS OF EXPERTS

## AGILE

### THE NEXT GENERATION OF COLLABORATIVE MDO

ICAS CASIMIRO MONTENEGRO FILHO LECTURE FOR INNOVATION IN AERONAUTICS

AWARD FOR INNOVATION IN AERONAUTICS

11<sup>TH</sup> SEPTEMBER 2018



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Deutsches Zentrum  
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Institute of System Architectures in Aeronautics  
Integrated Aircraft Design  
HAMBURG



This project has received funding from the European Union's Horizon 2020 research and innovation framework programme under grant agreement No 636202



# Innovation in Aeronautics

DEMAND



Mobility



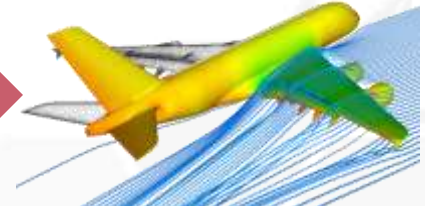
Environment



Economy



Propulsion



Aerodynamics



Manufacturing

TECHNOLOGIES

**AGILE - next generation of collaborative MDO**



# Towards the next Generation MDO

## 3rd Gen. MDO: a system of distributed competences

### 1) first (~80)

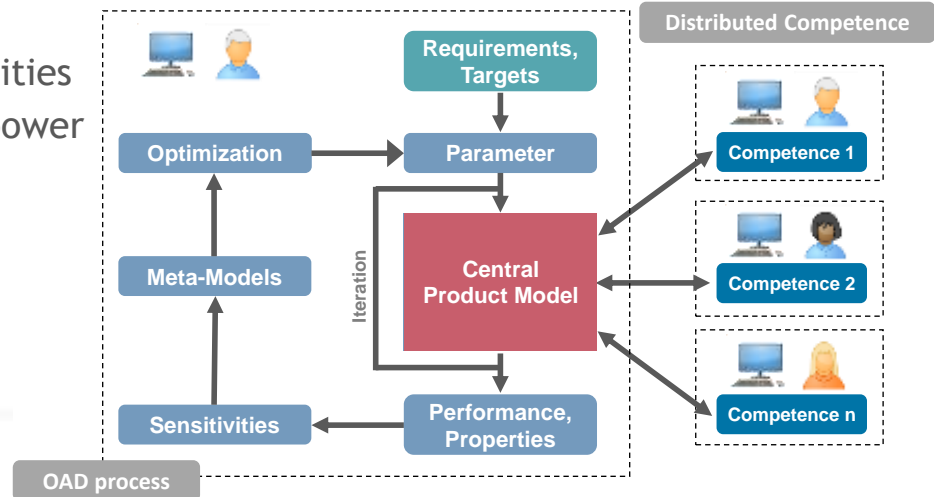
- Disciplinary Simulation and optimization capabilities
- Optimization Strategies for low computational power

### 2) second (~00-today)

- HPC capabilities and simulation distribution
- Automation of analysis capabilities

### 3) third (next gen)

- Integration of expertise in the collaborative optimization
- Knowledge formalization of process and disciplinary domains



**AGILE - next generation of collaborative MDO**

# „Having Tools“ is not „Having Skills“



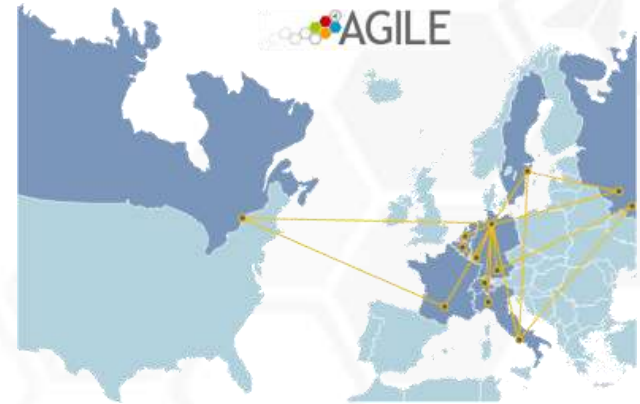
# AGILE AIRCRAFT 3<sup>RD</sup> GENERATION MDO

FOR INNOVATIVE COLLABORATION OF HETEROGENEOUS TEAMS OF EXPERTS



**EU funded H2020 project: 06/2015-11/2018**

- 19 International Partners (EU, Russia, Canada)
- ~ 9M EUR, ~120 MM
- Coordinated by DLR in Hamburg
- EU project **dedicated to next generation MDO processes**



<http://agile-project.eu>

**AGILE - next generation of collaborative MDO**



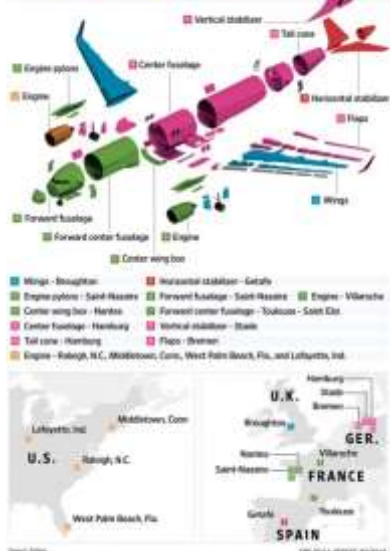
# Speed of Innovation in Aeronautics

- Aircraft Product Development → large number of **parts** and design **sub-processes**
- Cross-organizational → **distributed** and **heterogeneous** knowledge and expertise
- Much more constraints → higher level **integration** of design aspects

## Globally Sourced

Airbus planes are built mostly in Europe but rely on parts, such as some engines, from all over the world.

Made in: France Germany U.S. U.K. Spain



## Can we accelerate aircraft development via MDO?

Today (~10 years from TLAR to flight)



Number of parts: 6 millions  
Design changes per year: 150 000

Tomorrow ?



source: dlr.de

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# Aircraft Development and MDO process

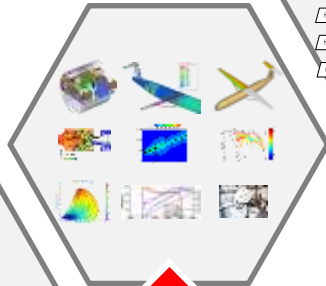
**Setup phase: 60% - 80% project time\***

+ new requirement  
change strategy  
change architecture



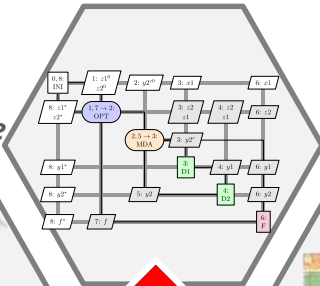
Requirements  
Design for X strategy  
Architectural Decisions

design competence



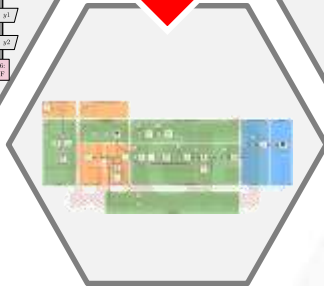
+ new capability

process formulation



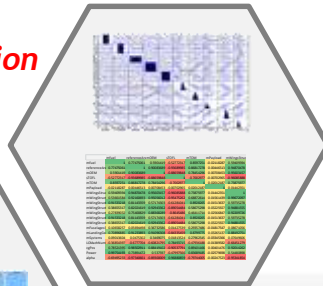
reconfigure

update  
implementation



MDO process execution

decision making



**Lack of agility**

\*survey of last 20 years of MDO RTD oriented projects [3-5 yrs],  
source: p.d. ciampa, b.nagel, "The AGILE Paradigm: the next generation of collaborative MDO"  
AIAA 2017-4137

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# AGILE Ambition

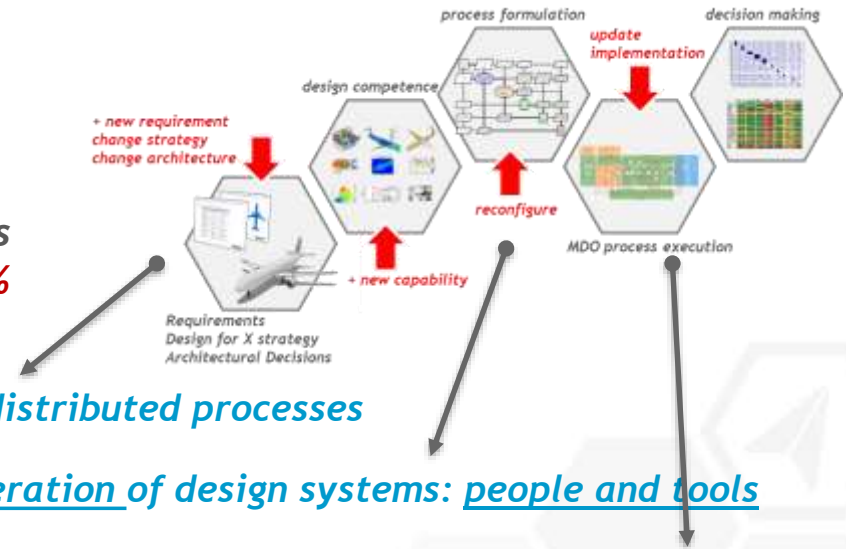
## Objectives:

- Realize the **next generation of MDO processes**
- Reducing aircraft **MDO development time 40%**
- Enabling **Collaborative Aircraft Design**

Accelerate the setup of large scale collaborative distributed processes

Support collaborative operation of design systems: people and tools

Efficient collaborative Optimization techniques



## AGILE Configurations

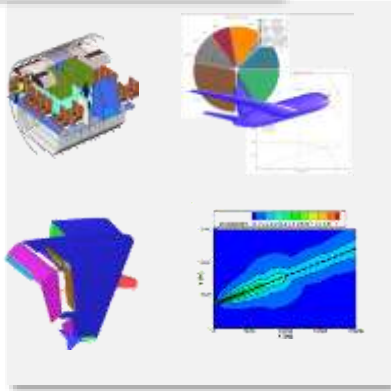


**AGILE - next generation of collaborative MDO**

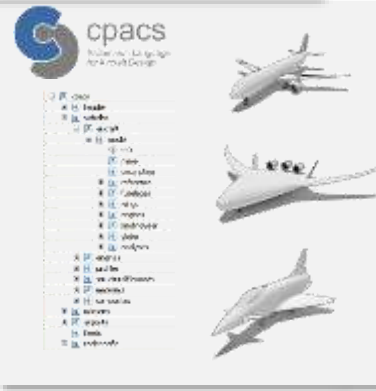


# What do we need for the next generation MDO?

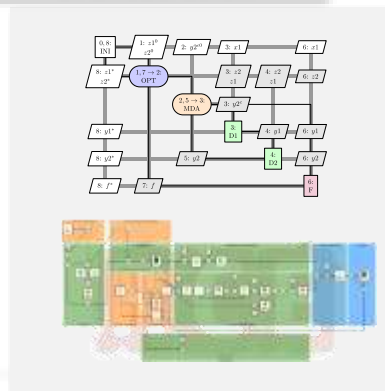
## design competences



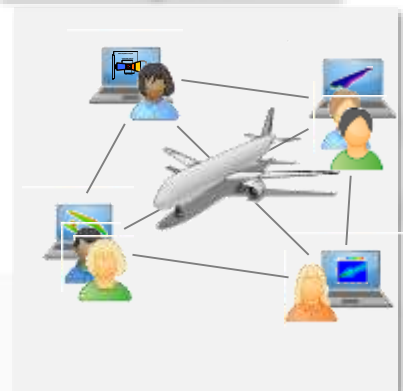
## common languages



## design process orchestration



## knowledge integration



**AGILE Paradigm: “a blueprint for collaborative MDO deployment”**

**AGILE - next generation of collaborative MDO**

# AGILE Paradigm - *Participative Roles*



*Architect*



*Collaborative Eng.*

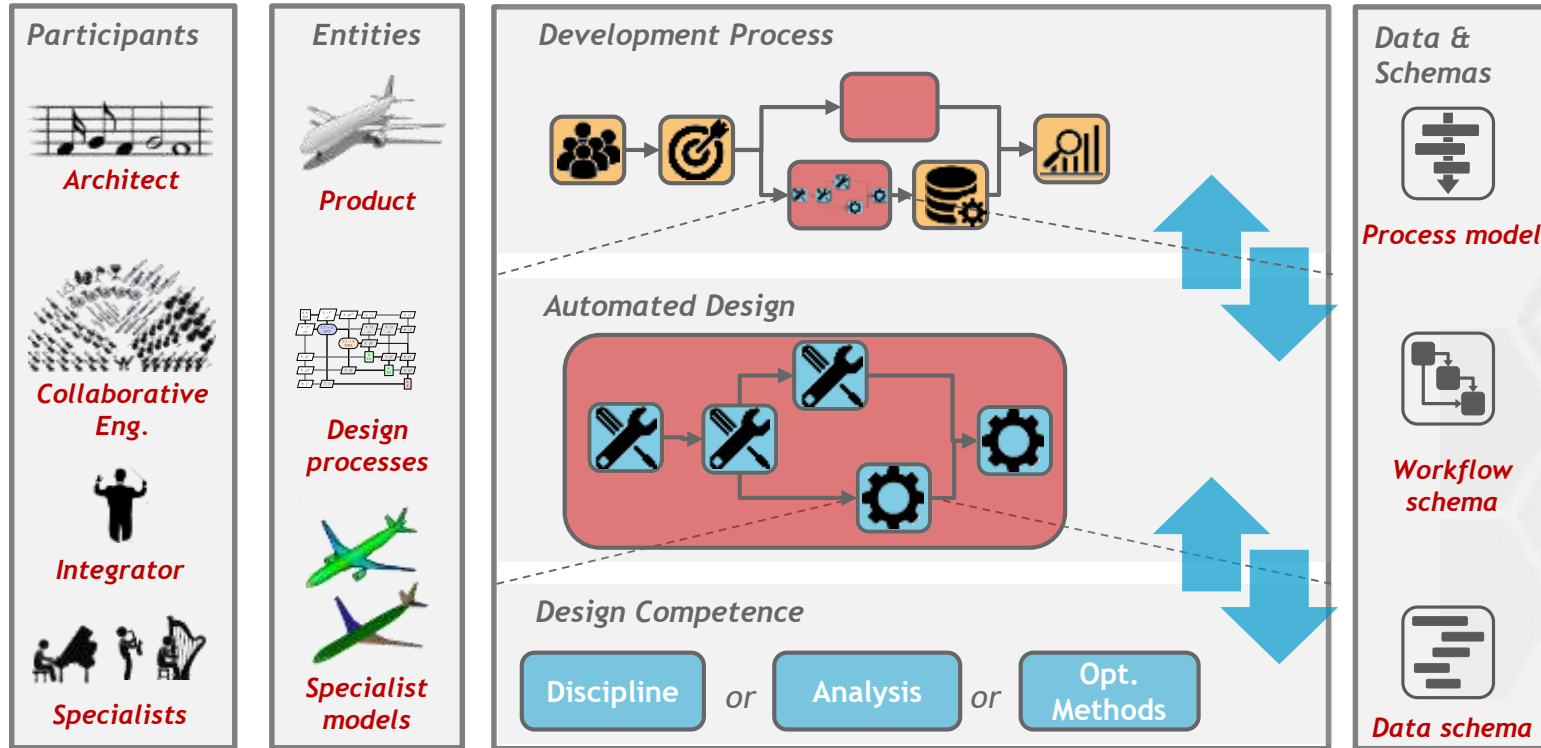


*Integrator*



*Specialist*

# AGILE Paradigm - *Knowledge Layers*

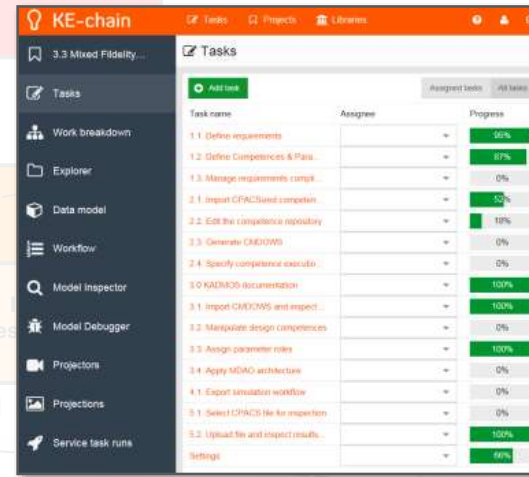
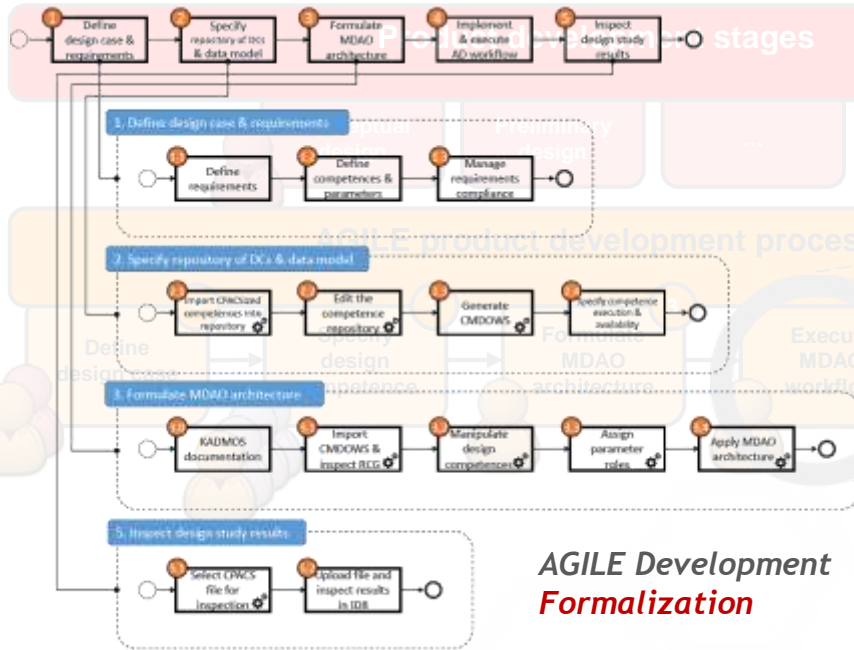


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# AGILE Paradigm - *Development phases*

- Requirements Modeling and Management
- Formalization of Product Development Process (PDP)



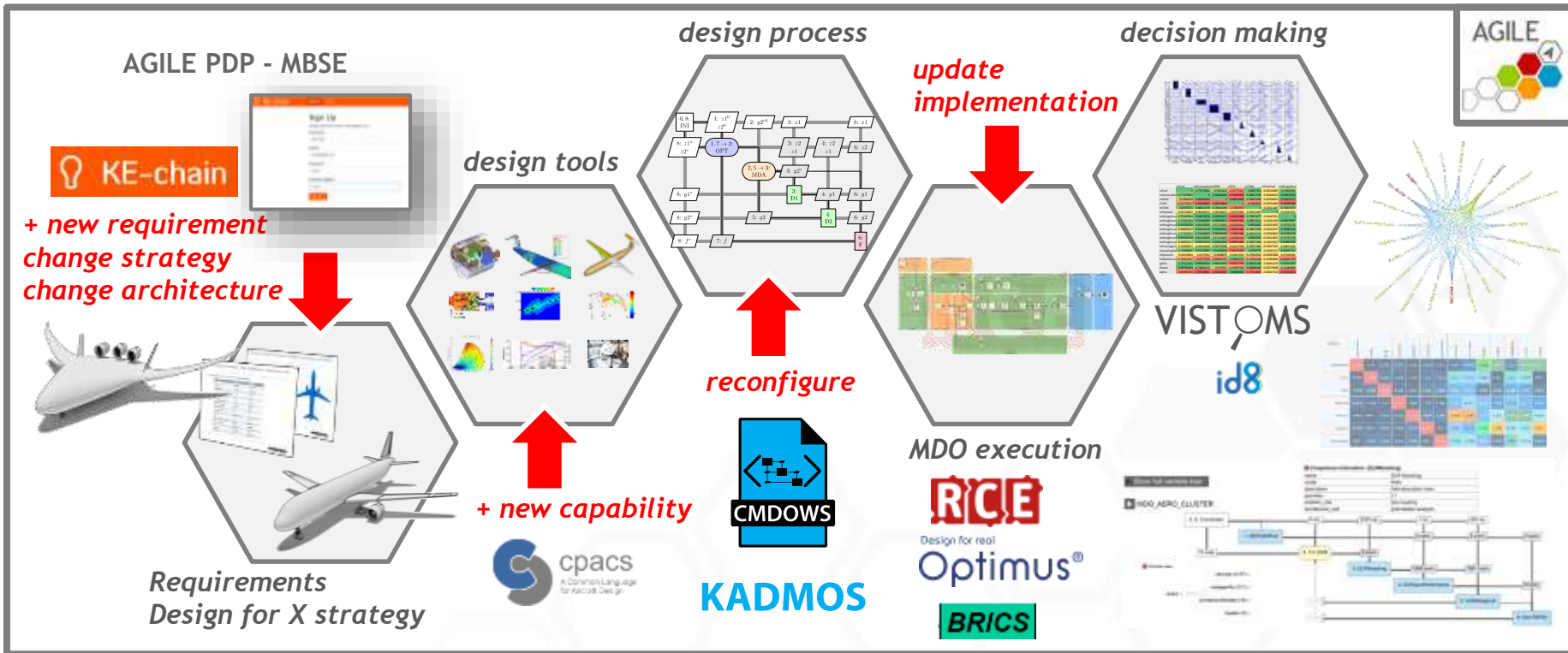
**AGILE Development Implementation**

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# AGILE Paradigm - *Model Based Framework*

AGILE Framework

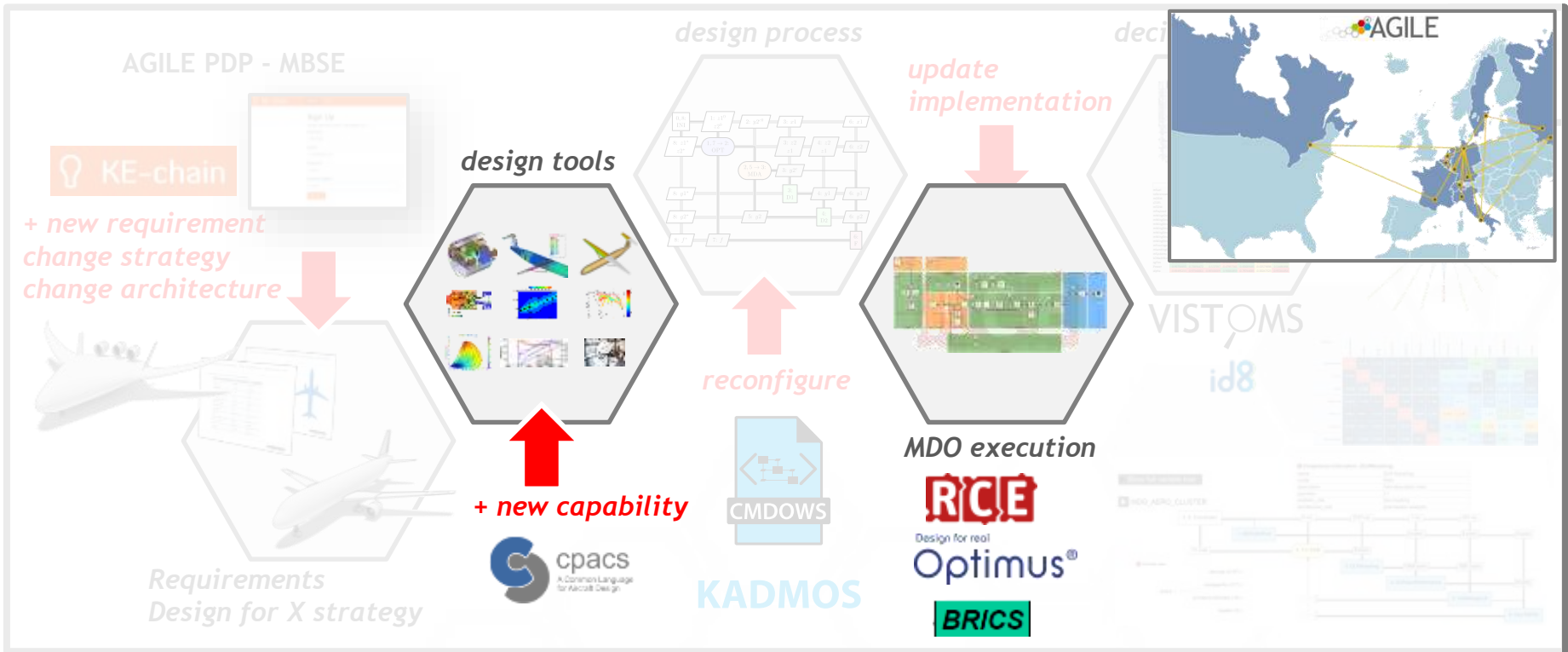


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# AGILE Framework - *Cross-organizational*

AGILE Framework



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# AGILE - Collaboration challenges

- Knowledge Modeling and Collaboration
- Design Competence wrapping process (right syntax) → Speaking the same “language”
- Disciplinary interpretation process (right semantic) → Meaning the same “Concepts”
- Design Competences Integration → Accessing and providing “tools and knowledge”

AGILE reference aircraft CPACS



<https://cpacs.de>

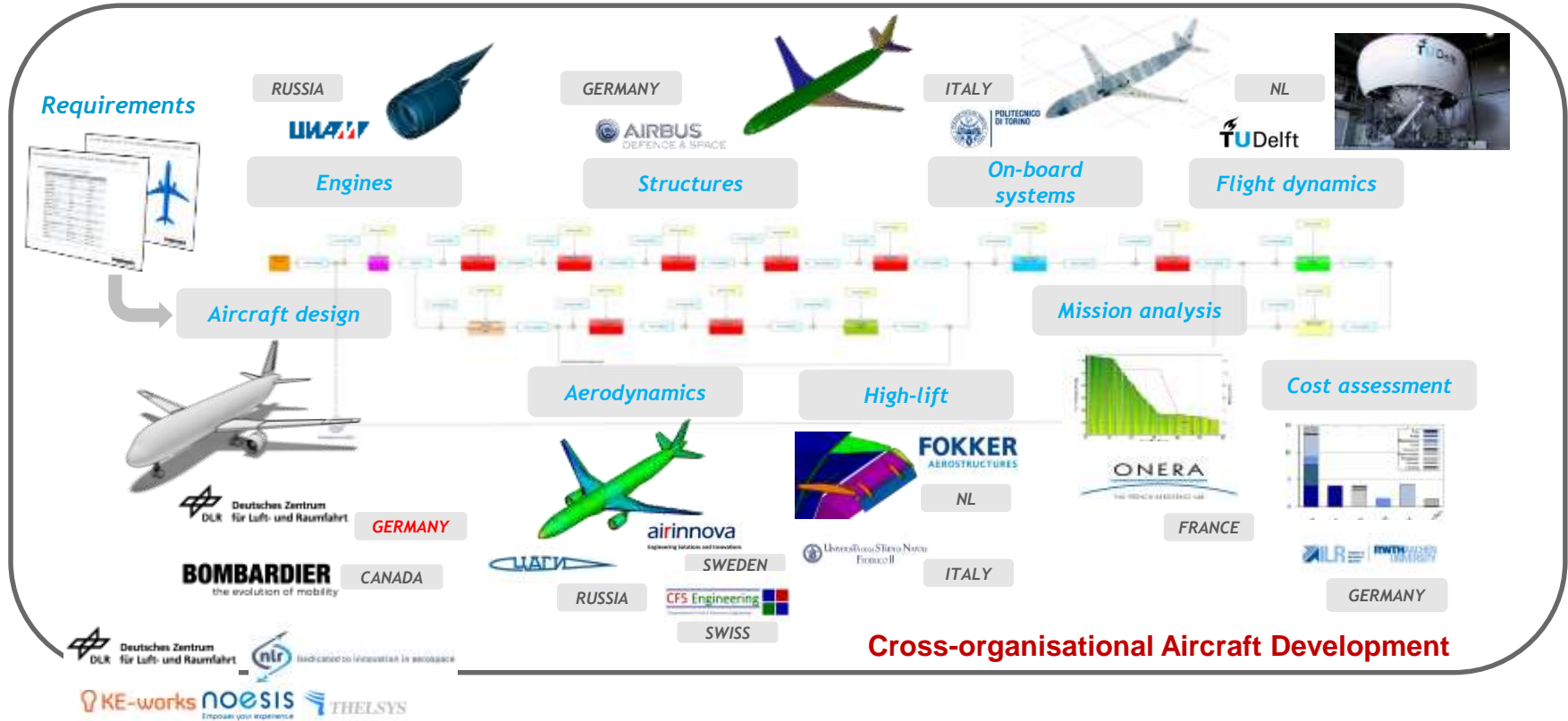


AGILE reference aircraft disciplinary models by Partners from a single source

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# AGILE Phase 1 - *from TLAR to "flying" in 15 months*



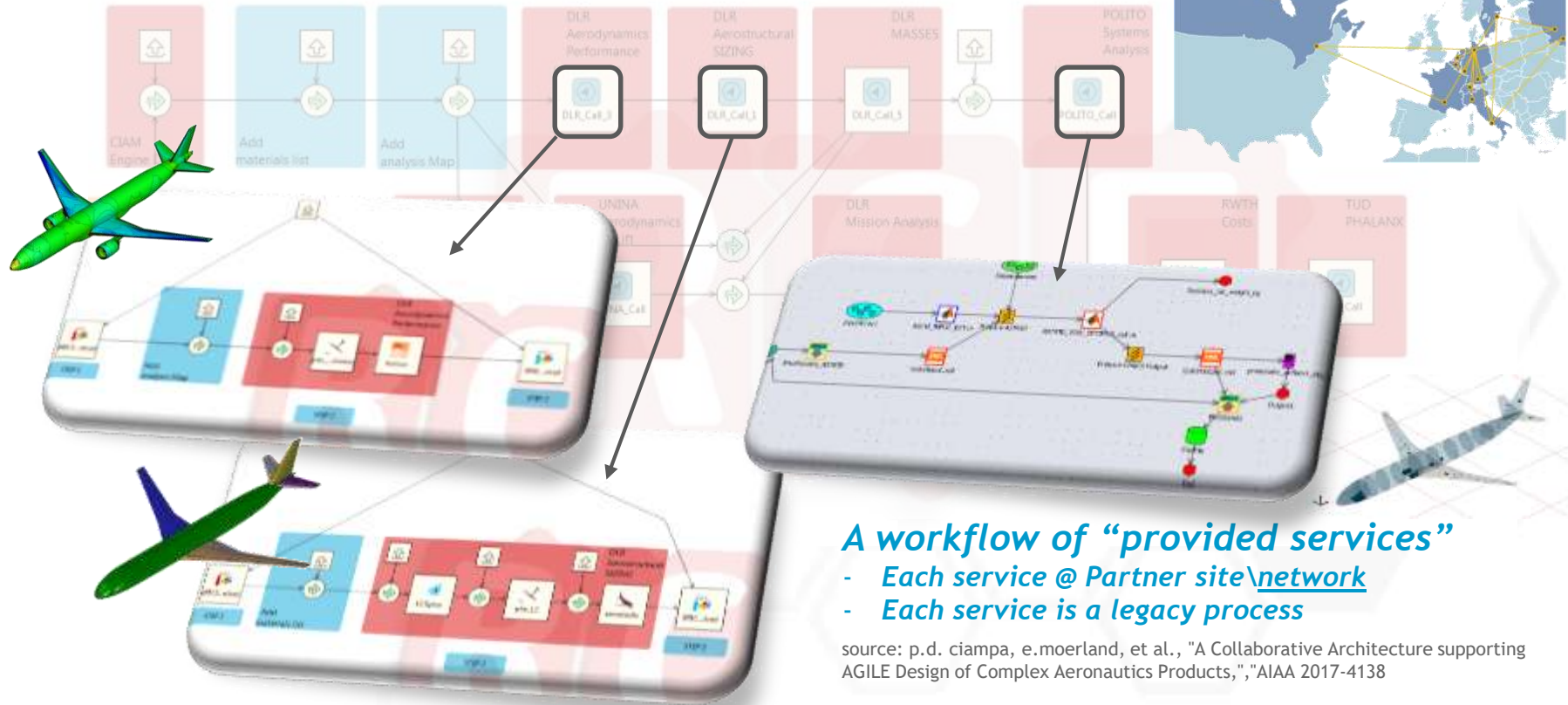
**Cross-organisational Aircraft Development**

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# AGILE - Service Oriented Architecture



## A workflow of “provided services”

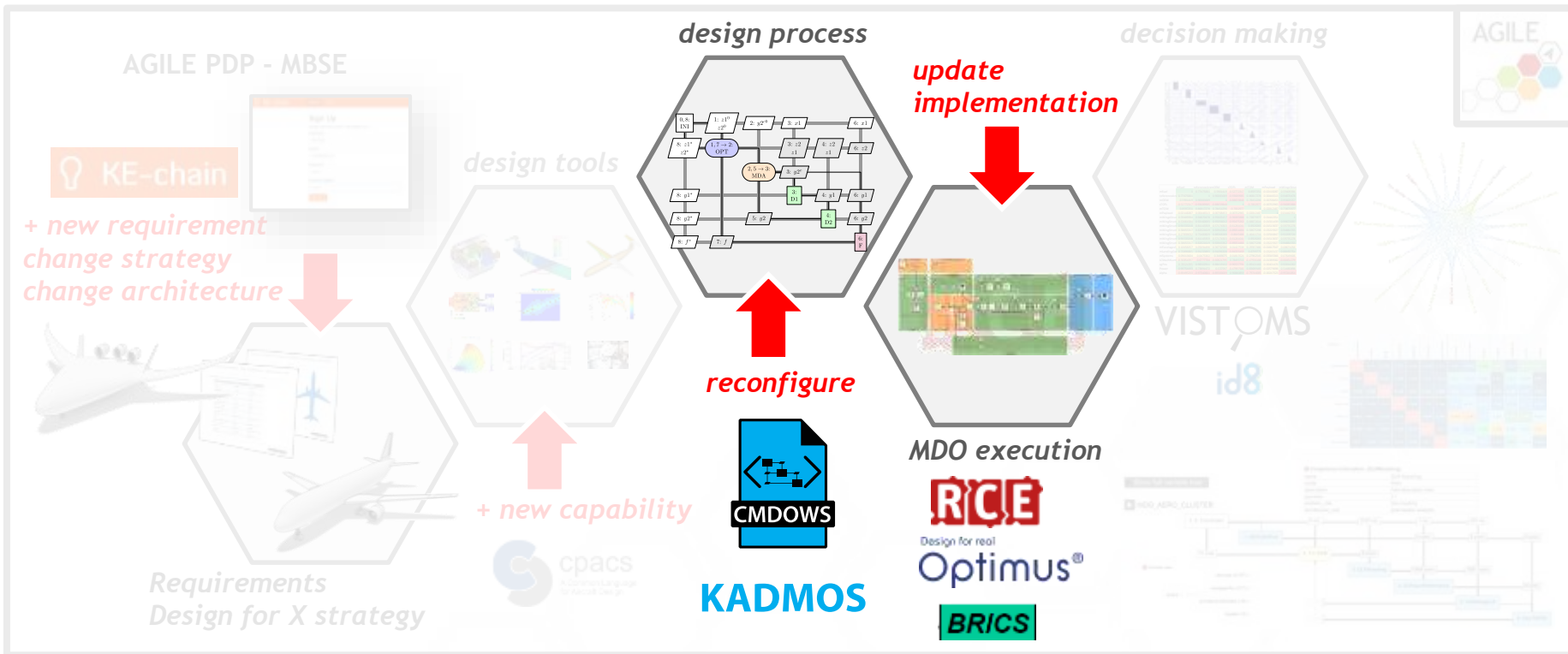
- Each service @ Partner site network
- Each service is a legacy process

source: p.d. ciampa, e.moerland, et al., "A Collaborative Architecture supporting AGILE Design of Complex Aeronautics Products," AIAA 2017-4138

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# AGILE Framework - *Automation & Optimization*

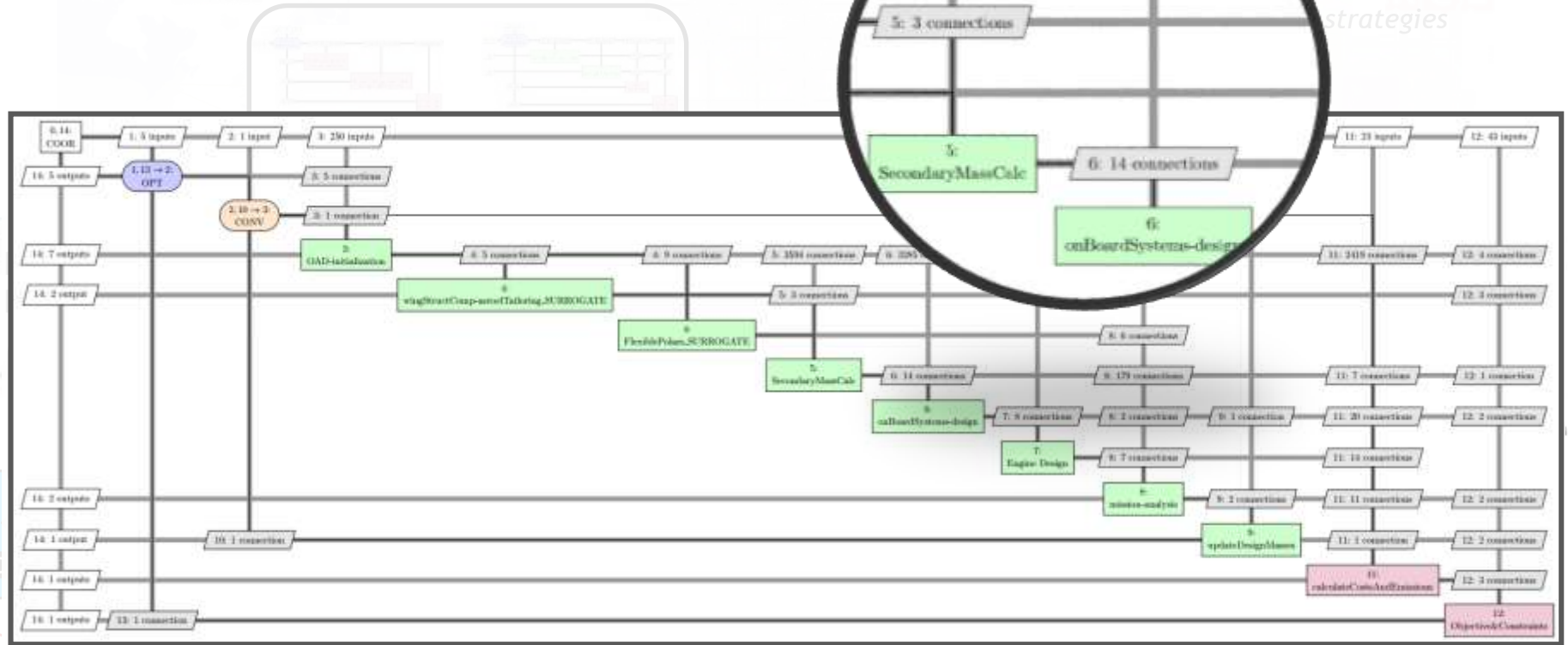
AGILE Framework



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# Design Process Automation

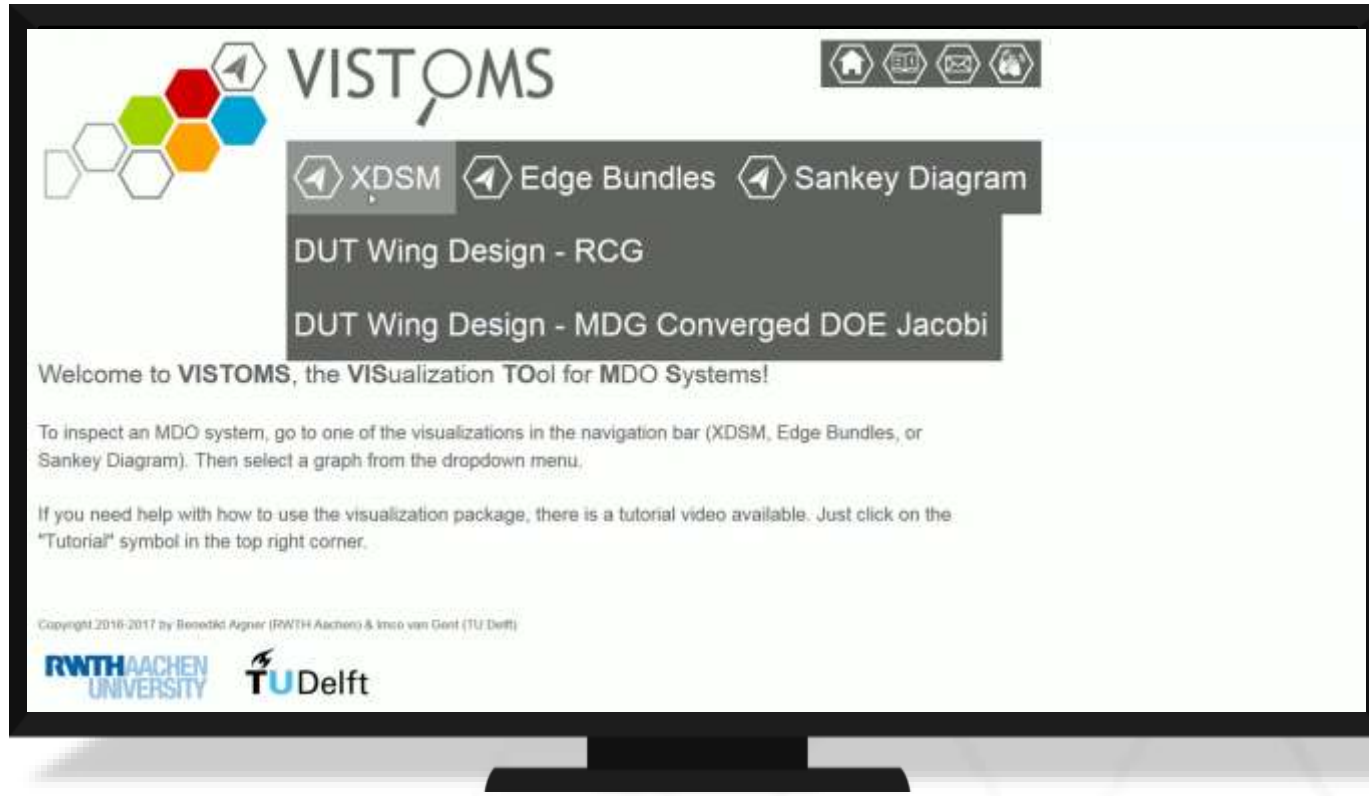


AGILE Strut Braced Wing

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# Collaborative Inspection



← *Inspect & validate* 

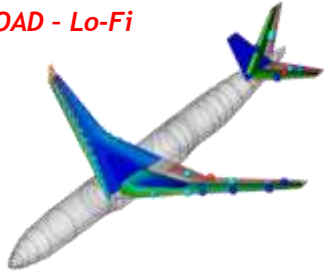
← *Inspect & validate* 

← *Inspect & validate* 

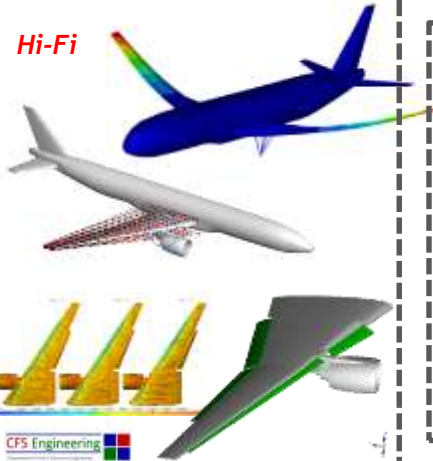
# AGILE Phase 2 - 1 aircraft, 5 MDO scenarios in 12 months

Multi-Fi Models @ Partners

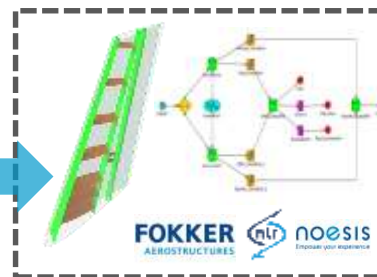
OAD - Lo-Fi



Hi-Fi



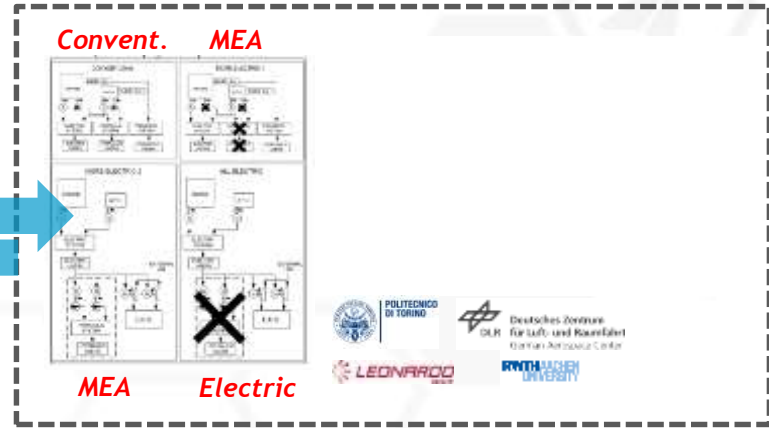
Airframe OEM



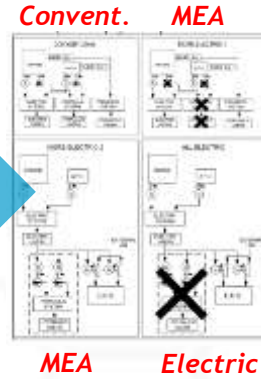
Rudder Supplier



Propulsion OEM



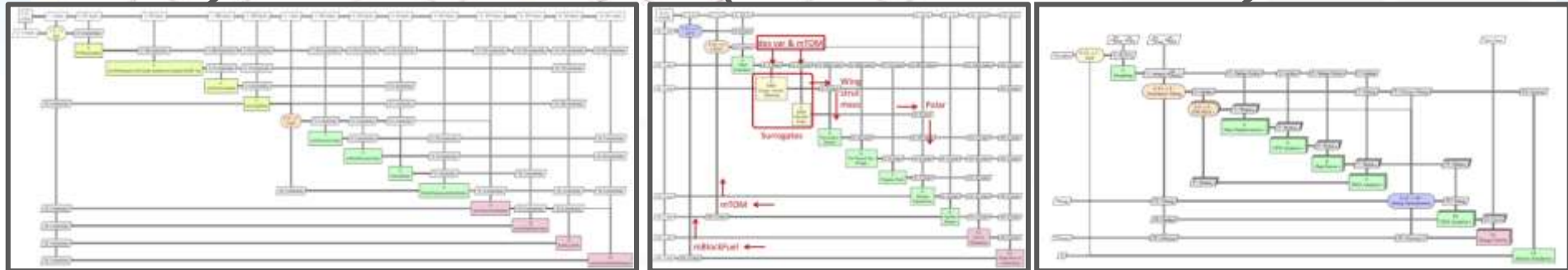
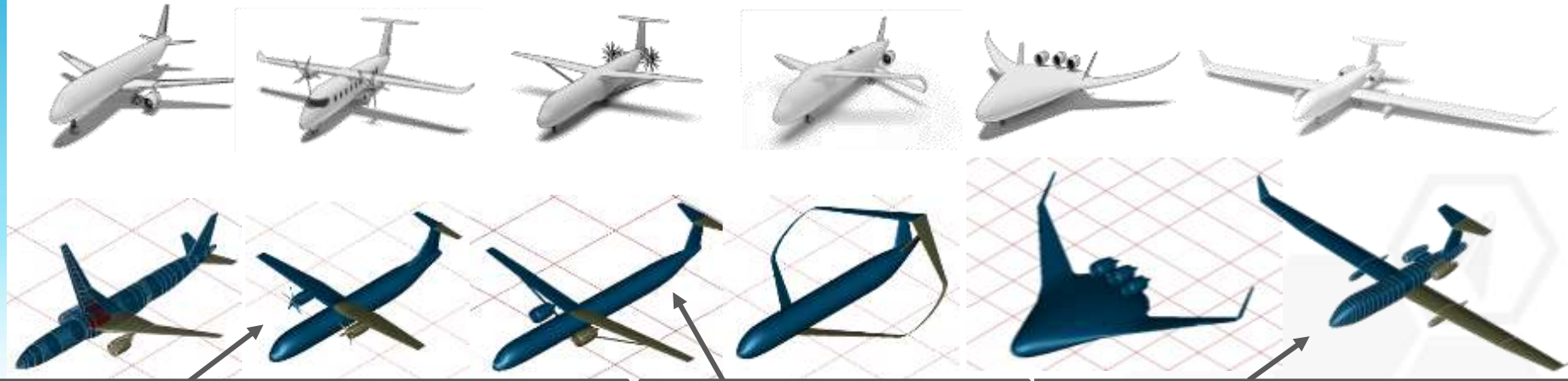
On-board systems Architectures



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# AGILE Phase 3 “Ongoing” - *6 aircraft in 15 months*

## AGILE Configurations



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# AGILE Phase 3 “Ongoing” - *6 aircraft in 15 months*

## AGILE Configurations



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# AGILE Project Outcome

## AGILE Achievements:

- Accelerating the deployment of **design and optimization processes**
- Large-scale **cross-organizational MDO processes of tools and people**
- AGILE Framework operational with **19 partners**

1

### AGILE Aircraft Database:

- Database of novel configurations for follow-on projects
- **6 novel aircraft configurations** accessible (data and models)
- Current aircraft results are **already exploited** in running projects



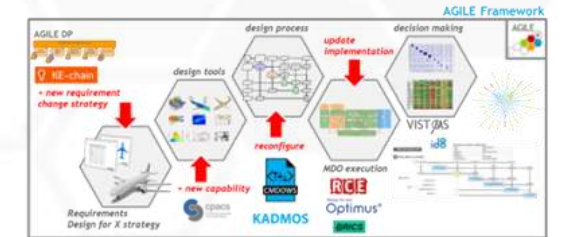
2

### AGILE Technologies:

- The AGILE framework released as *open-source*
- **Prototypes already exploited** in internal and external projects
- *AGILE Paradigm a “blueprint for collaborative MDO”*



**AGILE Academy:**  
**15 International Organizations**  
**NOT in AGILE using the AGILE framework!**



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# AGILE ACADEMY



<https://agile-project.eu/agile-academy>

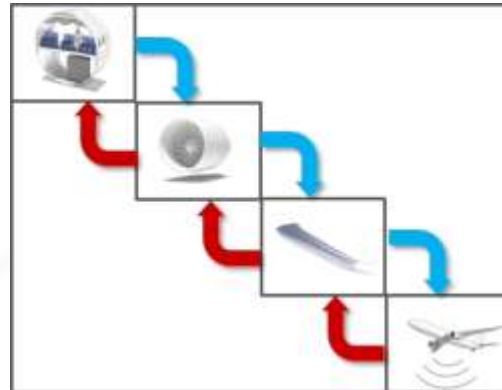
## Objectives of the Initiative:

1. Introduce the “**AGILE Paradigm**” in Education\Research
2. Release the AGILE technologies **outside the Consortium**
3. **Enable “effective” Collaboration** among multiple institutions



1) *Distributed Competence*    2) *Collaborative aircraft design*

## 3 Teams



*1<sup>st</sup> AGILE Academy Workshop in Hamburg*

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# Innovation via Education

*founder of:*



1946



1950



*CASIMIRO MONTENEGRO*

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# AGILE - Next generation collaborative development

The screenshot displays the KE-chain software interface. The main window is titled "1.2 Define Competences & Parameters". It features a sidebar on the left with navigation options like "Task", "Work Breakdown", "Planning", "Editor", "Data Model", "Workspace", "Model Debugger", "Properties", and "Service Task Tools". The main content area shows a "Task Description" and a table of "Requirements".

Requirement	Description	Type	Needs to be planned	Responsible role
Real-time	The real-time operation of the system is guaranteed at all times by the system's design.	System	Yes	System
Design change flexibility	The design team requires an automated code generation process to support the design of the system.	System	Yes	System
Compliance to standards	The design team requires an automated code generation process to support the design of the system.	System	Yes	System
Change flexibility	The design team requires an automated code generation process to support the design of the system.	System	Yes	System
Modelling this program as well	The design team requires an automated code generation process to support the design of the system.	System	Yes	System

Below the table, there is a section for "Specify the required Parameters and Extensions" and a table of "Parameters".

Parameter	Type	Value	Type of parameter	Role in application	Unit type
Design	Design parameter	Design parameter	Design parameter	Design parameter	Design parameter



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# AGILE Team

Fernass Daoud	Airbus
Reinhold Maierl	Airbus
Arthur Rizzi	Airinnova
Tomas Melin	Airinnova
Mengmeng Zhang	Airinnova
Bruno Tranchero	Leonardo
Giovanni Cerino	Leonardo
Giuseppe Piscopo	Leonardo
Luciana Loverde	Leonardo
Roberto Labruto	Leonardo
Nicola Catino	Leonardo
Fassi Kafyeke	Bombardier
Graham Potter	Bombardier
Balaji Periyapatna	Bombardier
Hugo Gagnon	Bombardier
Jasveer Singh	Bombardier
Stephane Dufresne	Bombardier
Aidan Jungo	CFSE
Dominique Charbonnier	CFSE
Jan Vos	CFSE
Aleksander Lanshin	CIAM
Alik Isyanov	CIAM
Artur Mirzoyan	CIAM
Pavel Toktaliev	CIAM

Björn Nagel
Erwin Moerland
Francesco Torrigiani
Jan-Niclas Walther
Jonas Jepsen
Kathrin Althaus
Olaf Brodersen
Pier Davide Ciampa
Prajwal Shiva Prakasha
Stefan Keye
Xiangyu Gu
Sascha Zur
Luc Hootsmans
Ton van der Laan
David Cooper
Joost Schut
Bastiaan Beijer
Stefan van der Elst
Erik Baalbergen
Huib Timmermans
Jos Vankan
Bert de Wit
Onno Bartels
Wim Lammen
Marco Panzeri
Riccardo Lombardi
Roberto d'Ippolito

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GenWorks
Ke-Works
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NOESIS Solutions
NOESIS Solutions
NOESIS Solutions

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Luca Boggero
Marco Fioriti
Francesca Tomasella
Sabrina Corpino
Benedikt Aigner
Eike Stumpf
Martin Spieck
Sabine Spieck
Alexander Lysenkov
Andrey Savelyev
Kirill Anisimov
Maria Sakharova
Darwin Rajpal
Gianfranco La Rocca
Imco van Gent
Mark Voskuil
Roeland de Breuker
Agostino De Marco
Danilo Ciliberti
Fabrizio Nicolosi
Luca Stingo
Pierluigi Della Vecchia
Vincenzo Cusati

ONERA
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**19 Partners**  
**25 Sites**  
**>110 Members**



**>70 Tools**  
**8 Platforms**  
**9 Aircraft**



**>120 papers**  
**~40 thesis**  
**~15 sessions**  
**2 Academy**

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ICAS CASIMIRO MONTENEGRO FILHO LECTURE FOR INNOVATION IN AERONAUTICS  
 AWARD FOR INNOVATION IN AERONAUTICS  
 11<sup>TH</sup> SEPTEMBER 2018



More information about AGILE:  
[www.agile-project.eu](http://www.agile-project.eu)

