Airbus journey towards Zero emission aircraft supported by MBSE

Complex Systems Design and Management conference
16 December 2022 - Paris

Sandrine Rolland - ZeroE A/C Architect for V&V strategy
Marco Ferrogalini - Head of Modelling and Simulation/MBSE - DDMS

AIRBUS

Airbus mission

Pioneering aerospace for safe and sustainable world

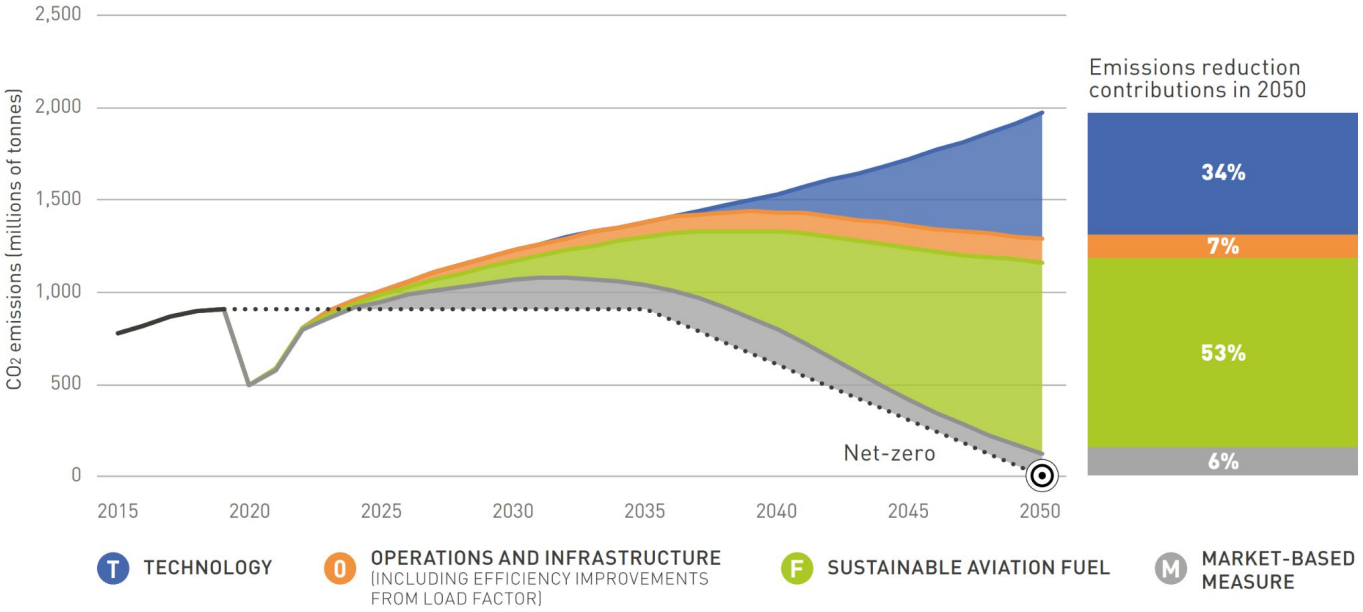
Sustainability!

Airbus strong engagement to a **decarbonized future**: a new Airbus aircraft which will use hydrogen as a primary power source to be the world's first zero-emission commercial aircraft could enter into service by 2035.

Digitalization is key!

"The next generation of Airbus products will be "**digital natives**", in terms of **data generation, connectivity, end-to-end digital backbone,** to enable the design of the product, its industrial system and the support in operation"

AIRBUS



Aviation's next big challenge

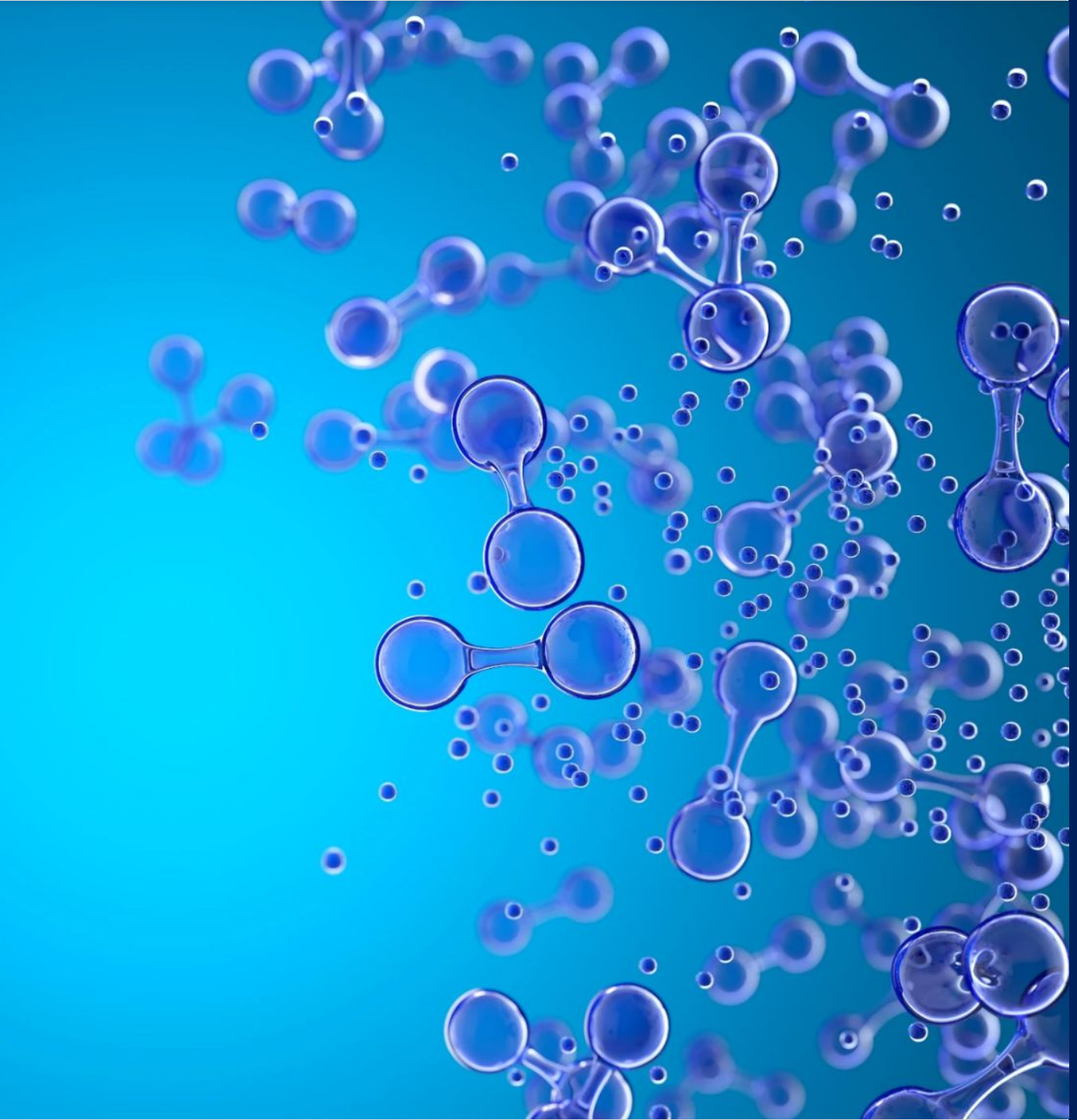
Net Zero in 2050

Multiple solutions are required

Airbus is leading the journey towards clean aerospace

Source: ATAG Waypoint 2050 | Scenario 3: aspirational & aggressive technology perspective

AIRBUS



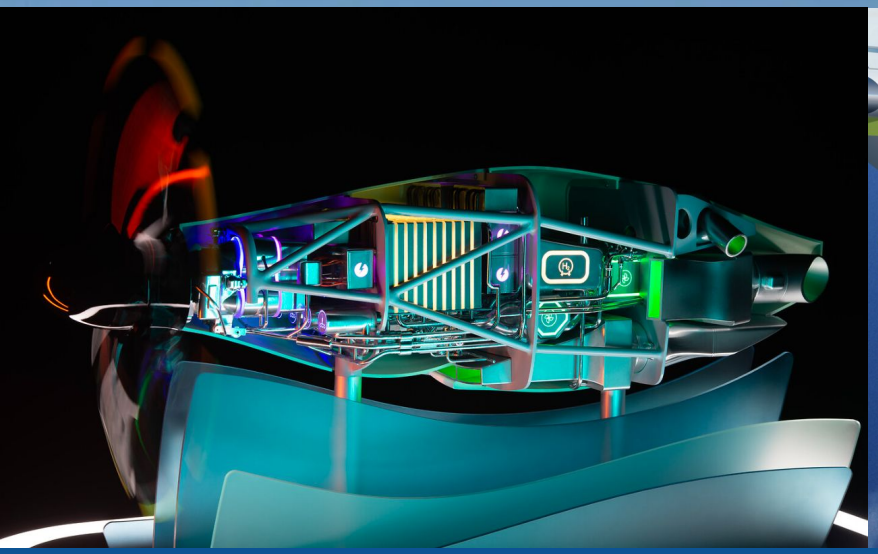
Why hydrogen?

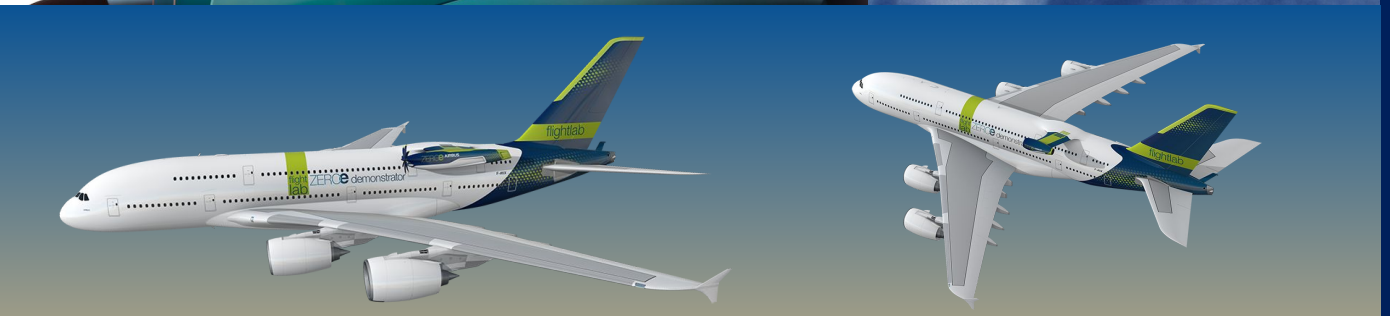
Zero emission: H_2 emits no CO_2^* & has the potential to reduce non-CO_2 emissions (i.e. NOx) & persistent contrails
(*if generated from renewables via electrolysis)

Declining costs: the cost of producing H_2 is likely to decline over the next decades as it gets widely adopted by various industries. This will make zero-emission flying increasingly economical

Energy density & versatility:
H2 is 3X lighter than jet fuel but it has a lower volumetric density.
H_2 could be used as an ingredient of SAF* or directly on-board an aircraft through direct combustion or fuel cells
(*SAF = Sustainable Aviation Fuel
H2 combined with captured CO_2 to produce Power-to-Liquid synthetic fuel)

AIRBUS





H_2 technology for ZEROe

- **Hydrogen storage** at **cryogenic temperature**
- **Hydrogen fuel cells**: converting energy stored in H_2 into electrical energy to power electric motors
- **Hydrogen combustion**: generating thrust by burning hydrogen
- **Flight Test** Demonstrators

AIRBUS

Turboprop

Turbofan

ZEROe aircraft

Turboprop

<100
Passengers

1,000+nm
Range

Turbofan

<200
Passengers

2,000+nm
Range

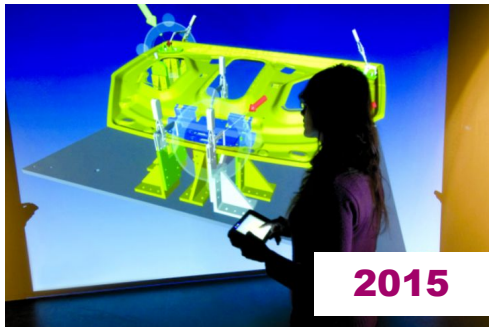
AIRBUS

Digitalization is key!

"The next generation of planes will be "**digital natives**", in terms of **data generation, connectivity, end-to-end digital backbone,** to enable the design of the product, its industrial system and the support in operation"

DDMS

Full 3D Digital Mockup



Virtual reality

What's next?

ACCELERATION

AIRBUS

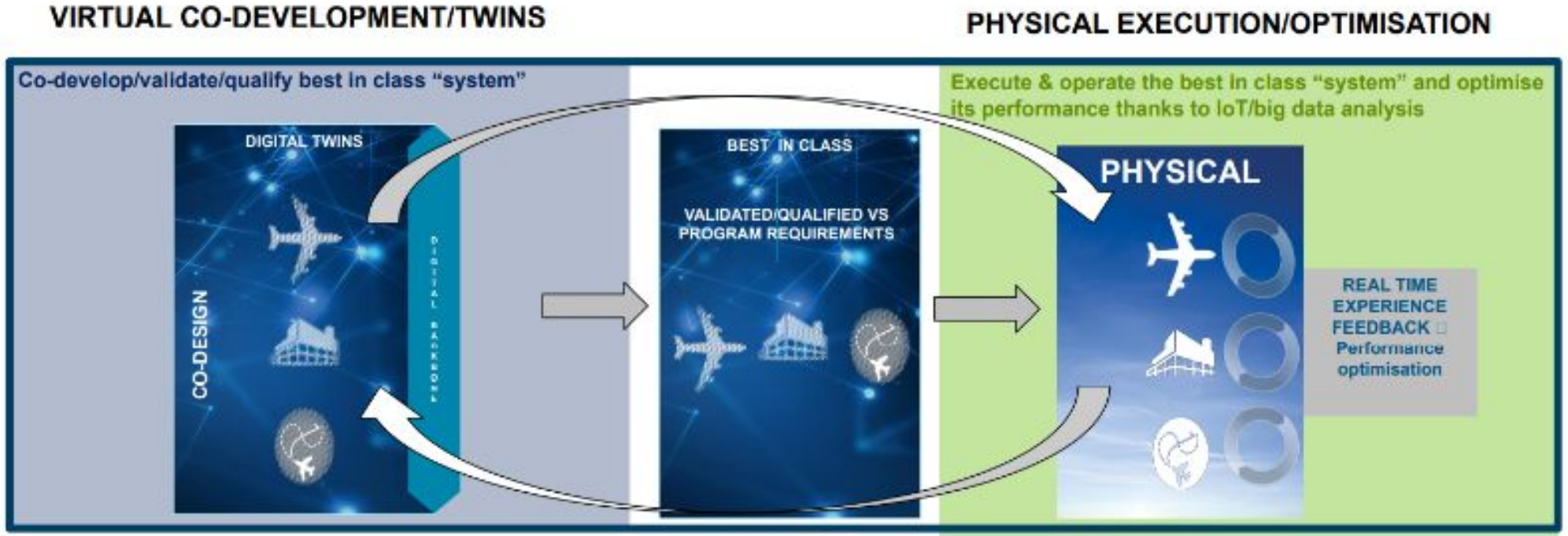
Airbus Digital Transformation program: DDMS

AIRBUS

Digital **D**esign
Manufacturing and **S**ervices

- leverage advances in digital technologies
- modeling standards to enable rapid exploration
- provide seamless exchange of information with other disciplines and their tool environments
- Systems engineers partner with machines to combine creativity and automation in a robust and agile design process.

Rethinking the way we are designing and operating our products ensuring the co-development of the product/the industrial system/the ways to operate with customer satisfaction & services ambition at the heart of DDMS



AIRBUS

MBSE to enable Multi-disciplinary optimization

I architect my system

MBSE

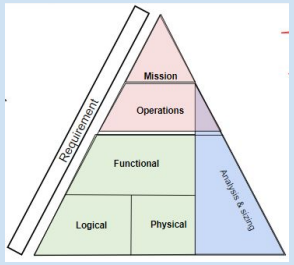
Mission & **O**perations Analysis

Requirement

Functional & **L**ogical architecture

3D **p**hysical architecture

Variability



I execute behavioral models to understand and optimize the system

MDAO

MDA/O execution tool

Surrogate models

Data Ontology

Physical sources (tests, operations)

Digital sources - (Simulations)

Data Management

I analyse, I explore, I decide

Analysis

MDAO User Interface (pre)

DSE (post)

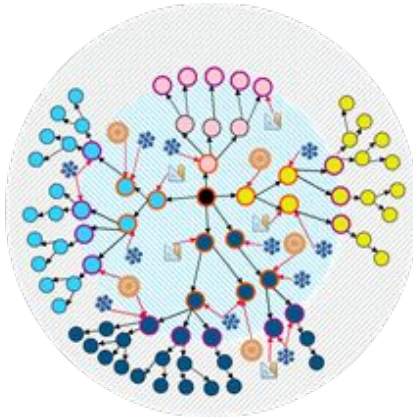
Smart Components / Ontology / Extended Enterprise

For a Globally optimised product

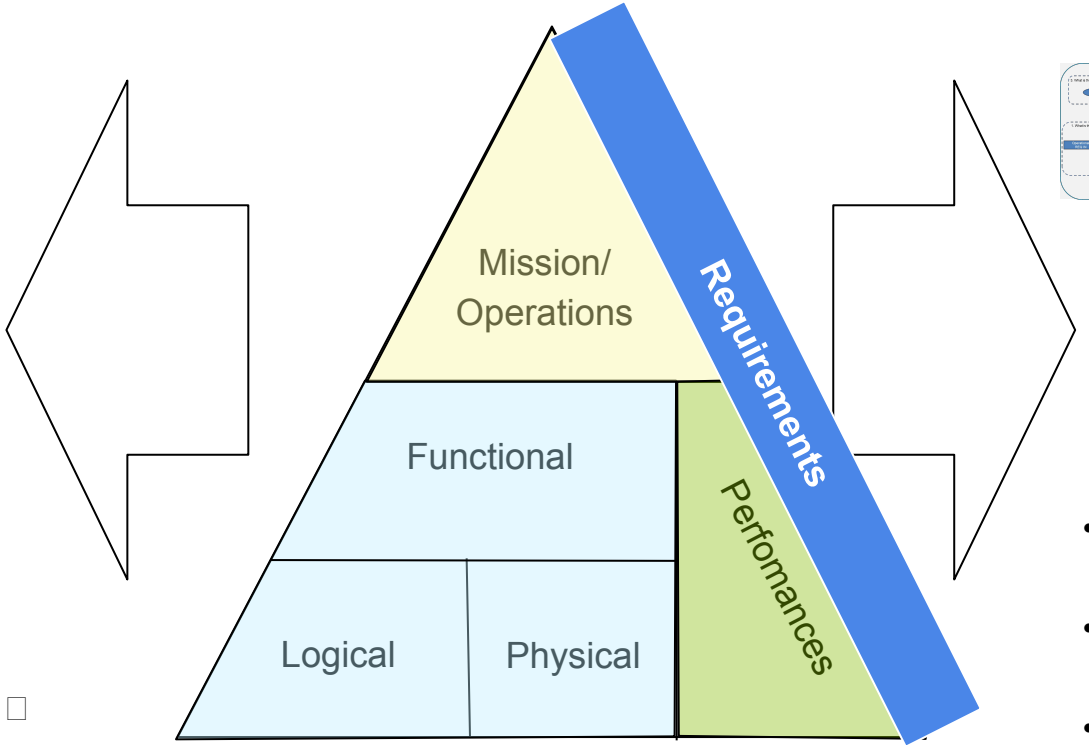
AIRBUS

MBSE generic pattern based on SE decomposition

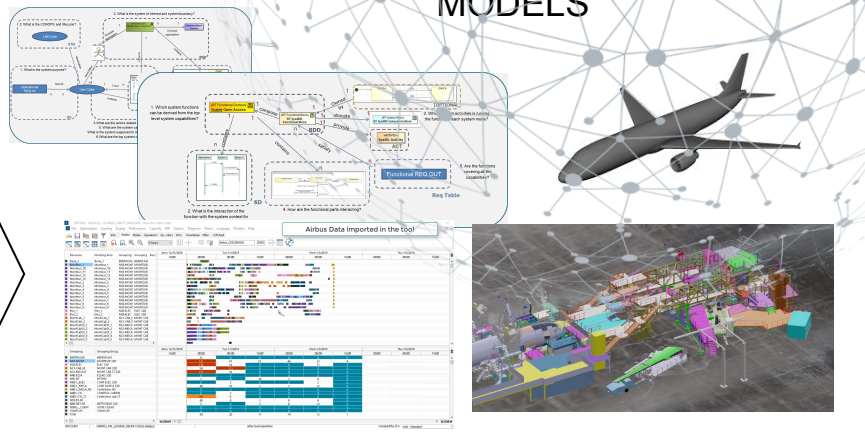
PARAMETRIC VIEW



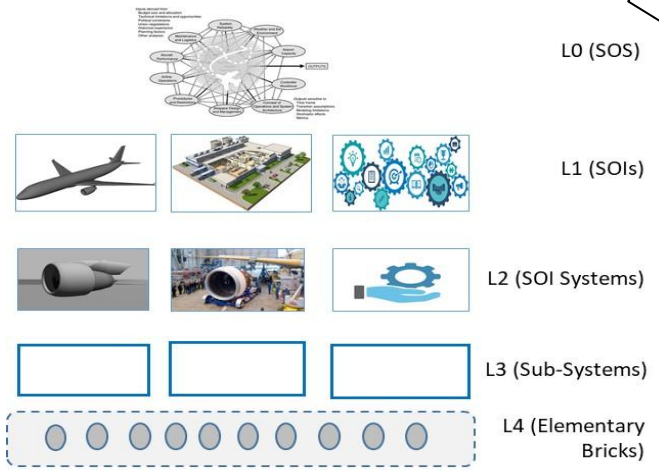
- Generic breakdown structure (per cluster)
- Key parameters
- Parameters interdependencies □ Ontology (semantic model)



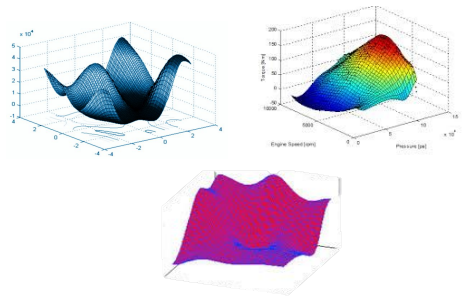
MODELS



- models (modelling approaches) for each cluster (purpose/scope)
- Which parameters are generated and consumed by each model
- toolchain architecture following the overall M&S framework



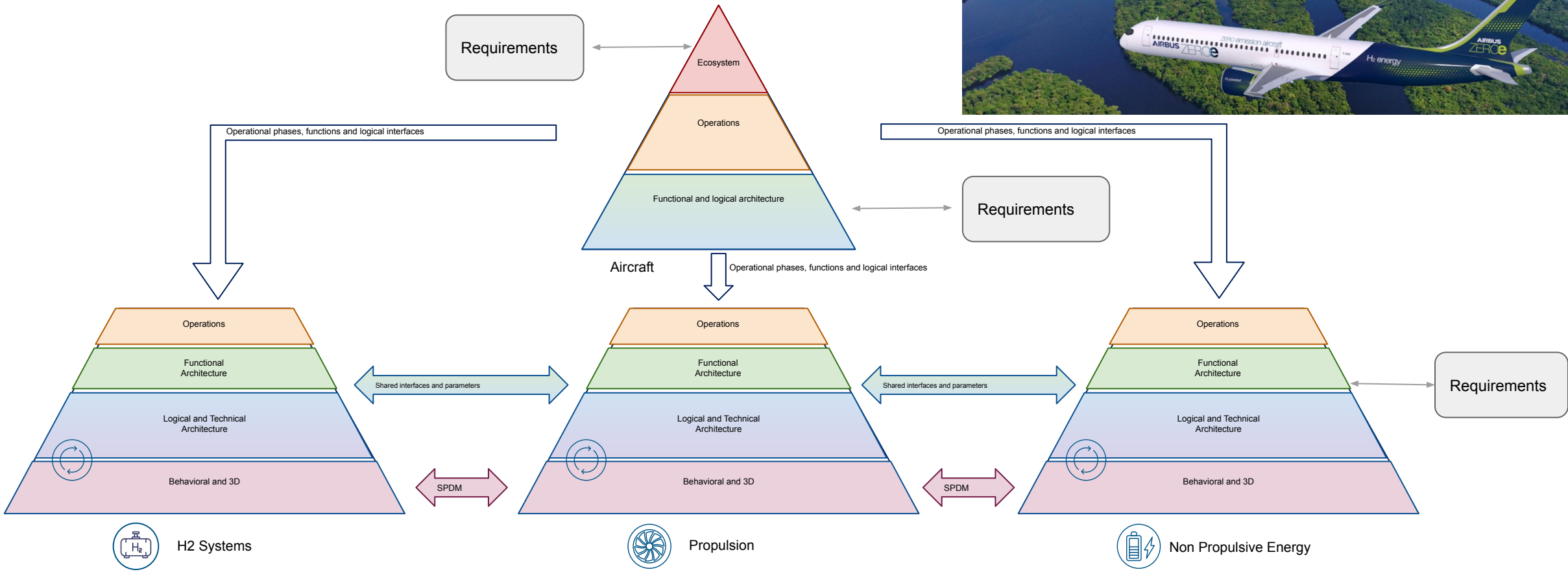
Same pattern applied to each logical item within the logical breakdown



Surrogates models

AIRBUS

MBSE Product to support Co-Design

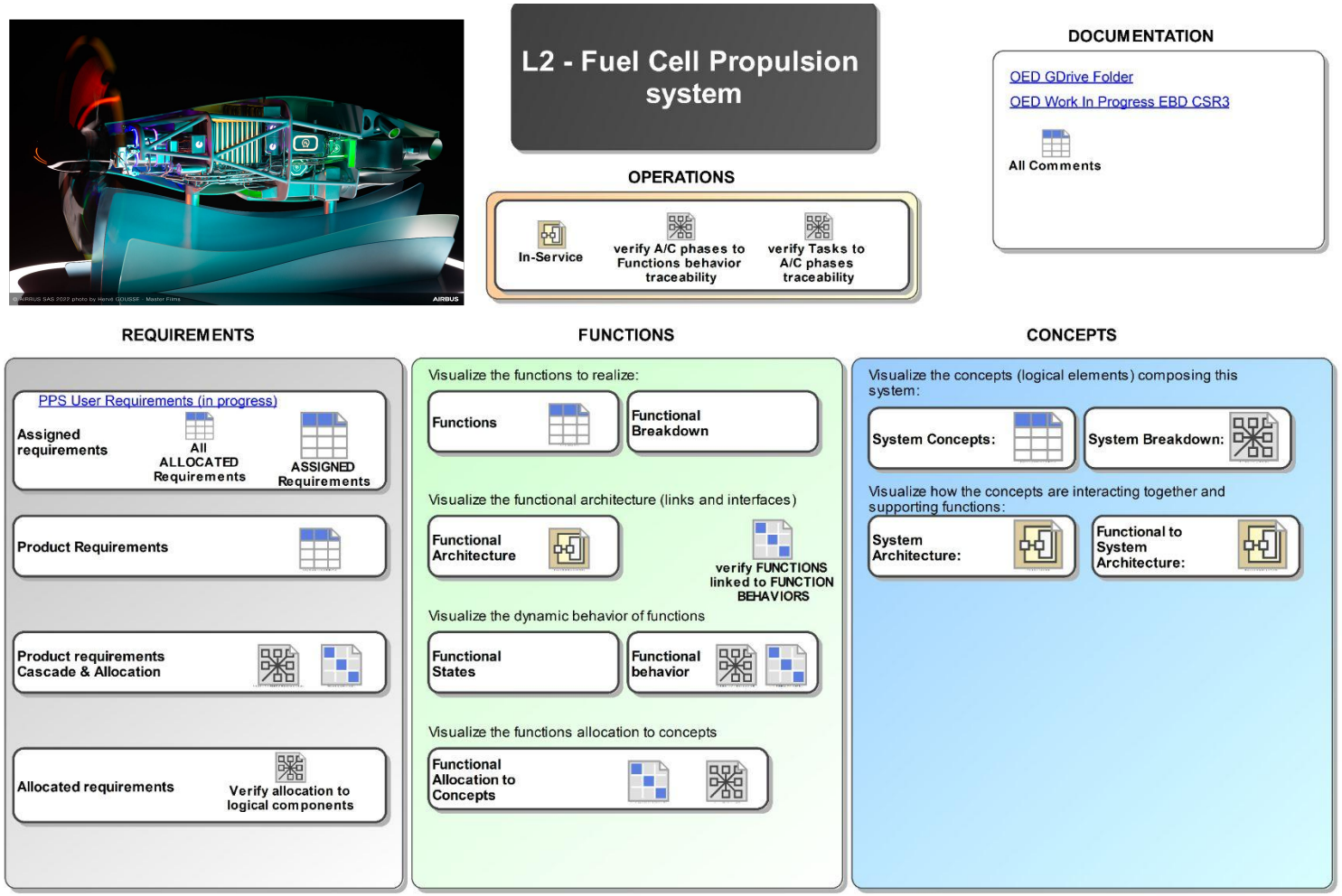


Product CoDesign supported by Top Down application of Model Based System Engineering

- Common aircraft architecture (operations to be supported, definition of main interfaces)
- Collaborative design of the propulsion, H2 and non propulsive energy systems
- Continuity with behavioral models and requirements

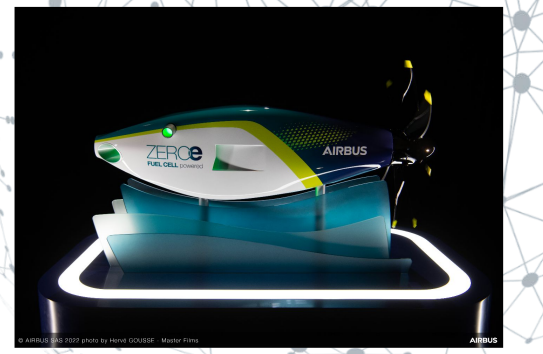
MBSE Product to support Co-Design

A unique MBSE **referential** for the system architecture with view point and **easy navigation across views** and layers to **federate engineering work** and to enable **consistent design** across disciplines



AIRBUS

Conclusions - key take aways



- **ZEROe project** ambition is to **make zero-emission flight a reality**. We are exploring **all challenges related to hydrogen** and **proposing solutions at technology brick level** and **aircraft concept level**.

- We've already made concrete steps and we **rely on our Modelling & Simulations capabilities** to meet our ambition!

- Modelling & Simulations is one of the five pillars of the Airbus Digital Transformation

- **MBSE in particular is at the heart of the Airbus Digital transformation** enabling consistent co-development in multi-SoI and multi-discipline to find the global technical optimum

AIRBUS

AIRBUS