THALES

# Reconciling with the past, embracing the future

## Lessons learned on implementing MBSE in Thales

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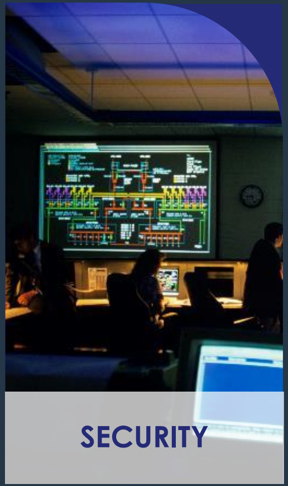
# Thales today

a > 80k employees, > 56 countries company, developing systems for:

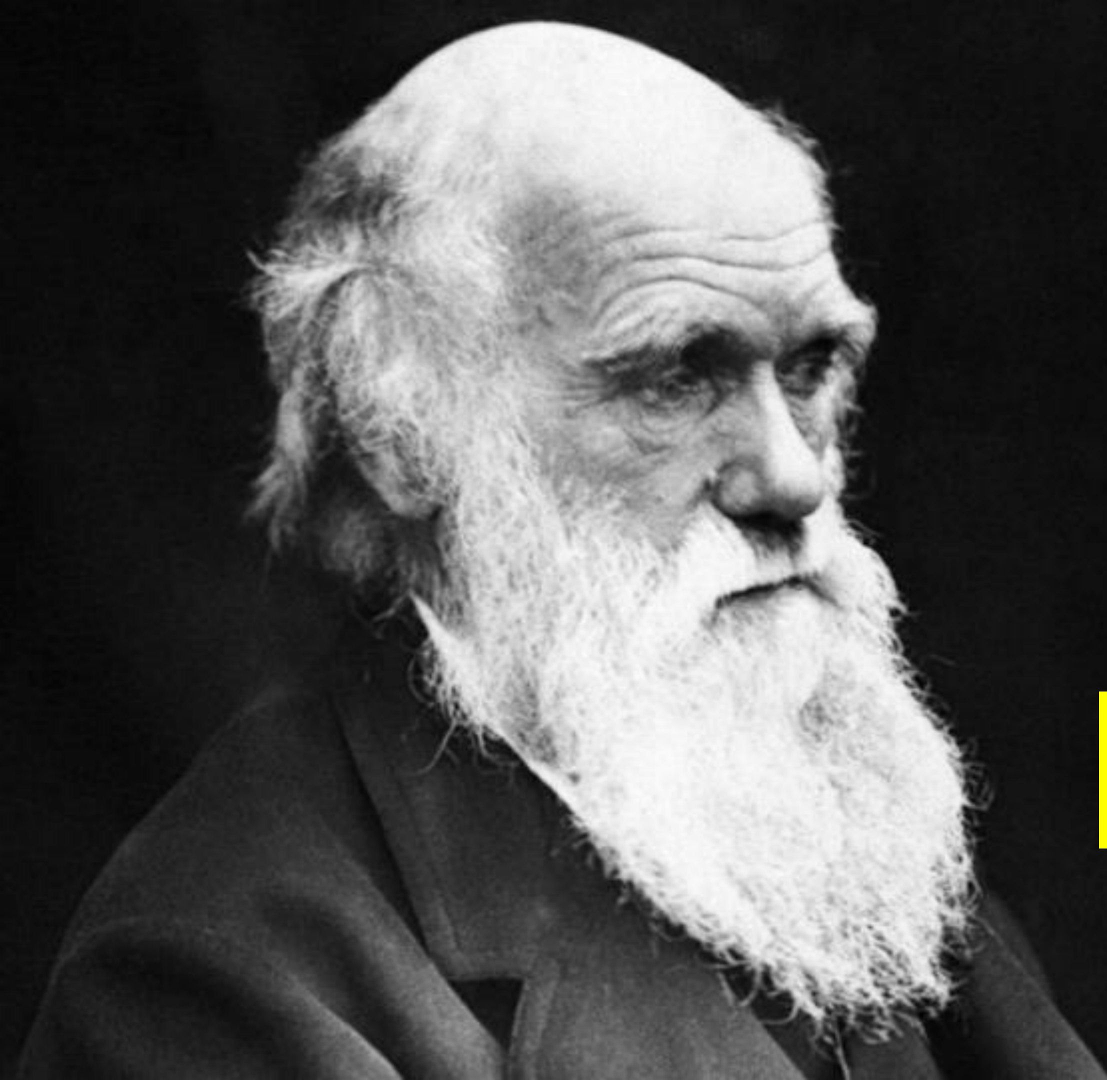




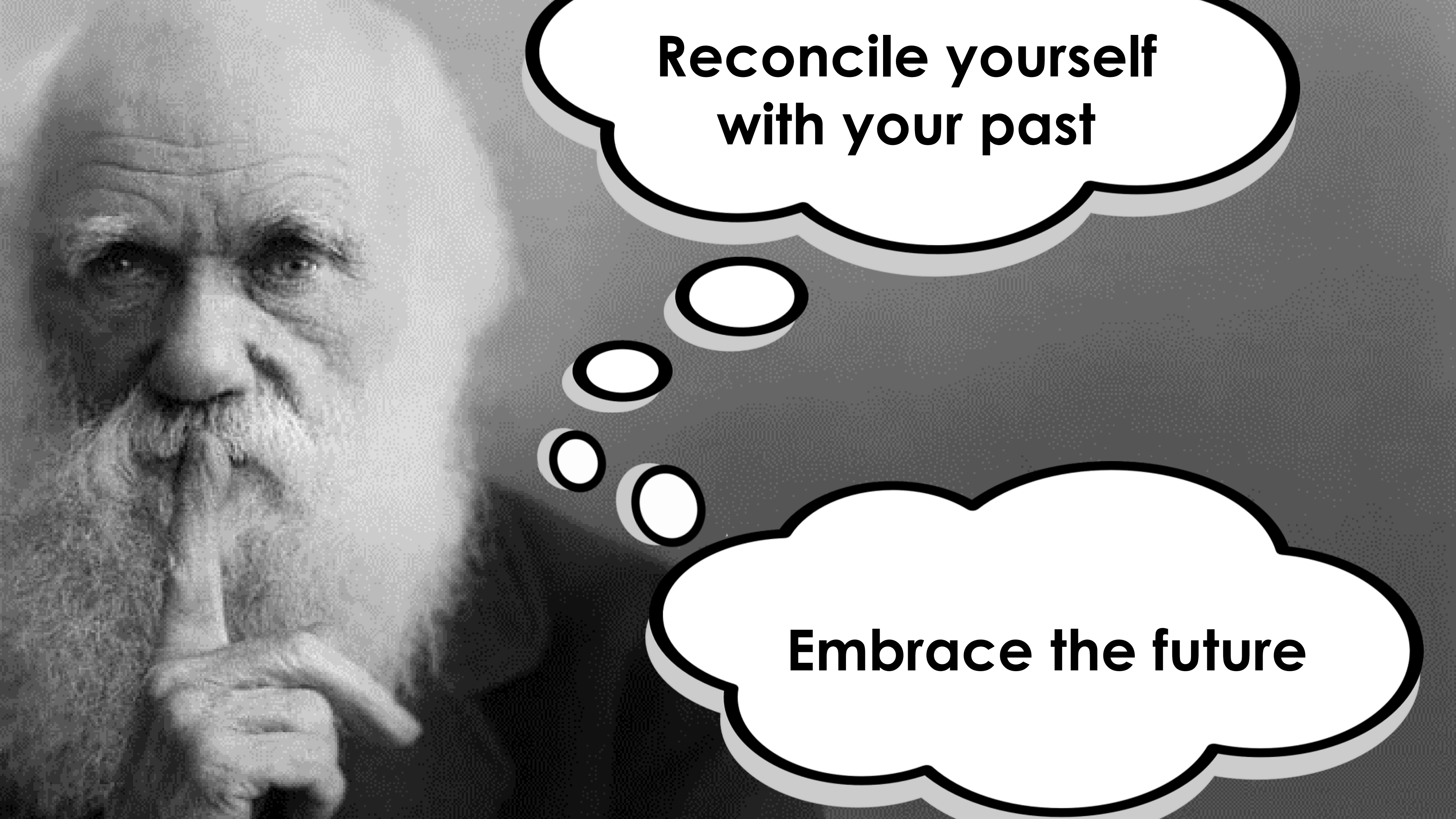



Multi - cultural, multi - industry, multi - background, …

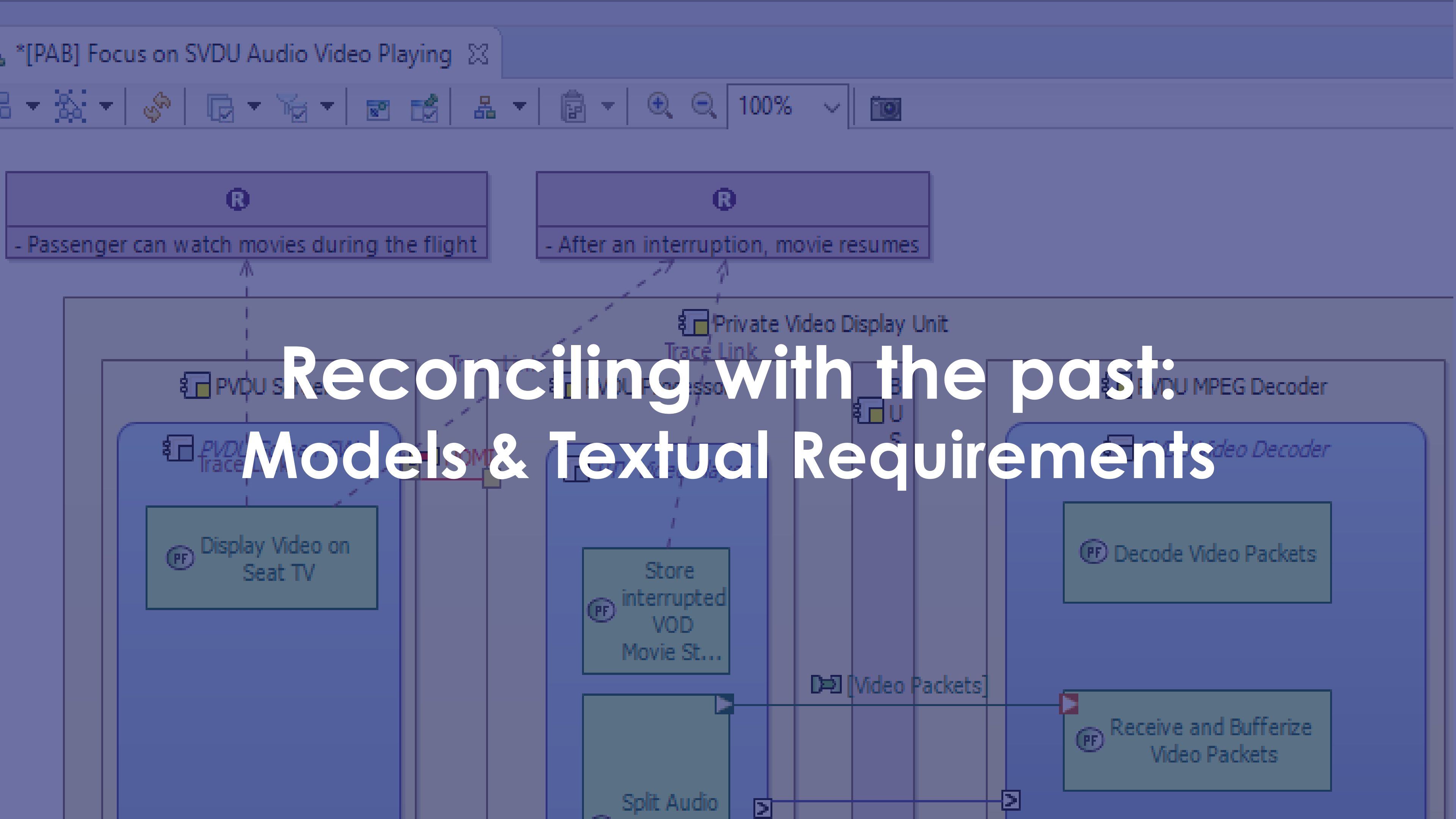
# How to make evolve the engineering practices in a large organization?

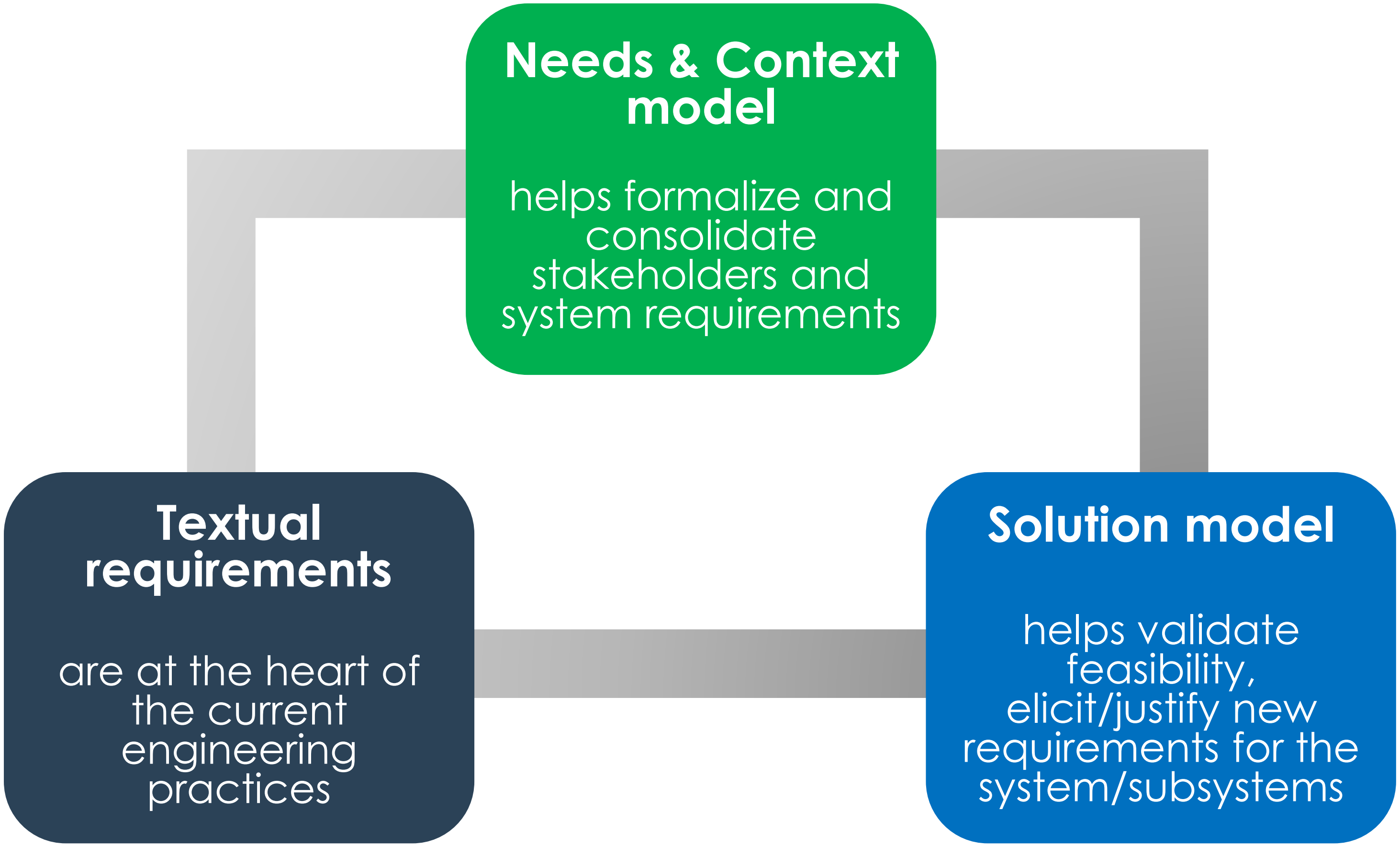


It is not the most intellectual of the species that survives; it is not the strongest that survives; but the species that survives is the one that is able best to **adapt and adjust to the changing environment** in which it finds itself


Reconcile yourself with your past
Embrace the future

# Reconciling with the past: Models & Textual Requirements

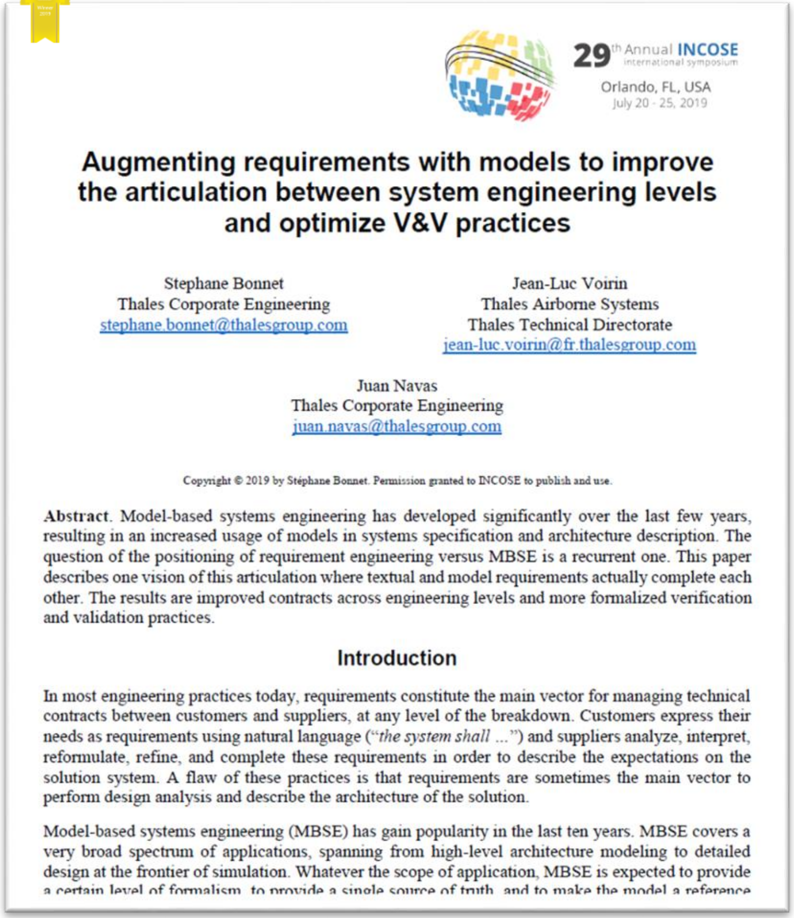



Needs & Context model
helps formalize and consolidate stakeholders and system requirements
Textual requirements
are at the heart of the current engineering practices
Solution model
helps validate feasibility, elicit/justify new requirements for the system/subsystems

**Models add rigor to needs expression / solution description**

**Models can be processed to ensure completeness and consistency**

**… Why not considering that models ARE requirements?**



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# Augmenting requirements with models to improve the articulation between system engineering levels and optimize V&V practices


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**Abstract**. Model-based systems engineering has developed significantly over the last few years, resulting in an increased usage of models in systems specification and architecture description. The question of the positioning of requirement engineering versus MBSE is a recurrent one. This paper describes one vision of this articulation where textual and model requirements actually complete each other. The results are improved contracts across engineering levels and more formalized verification and validation practices.

## Introduction

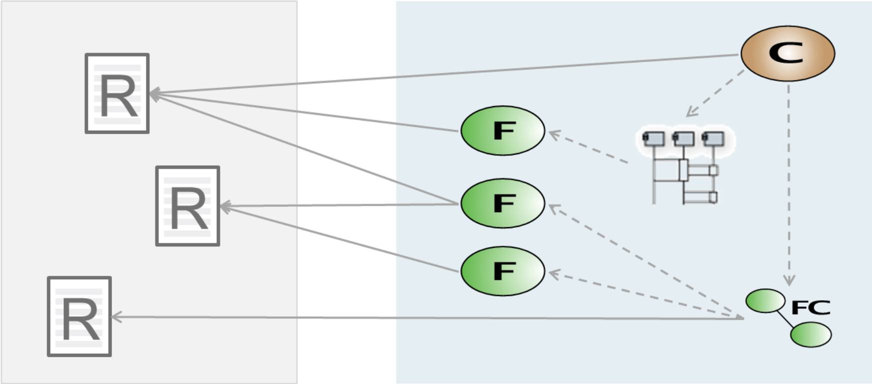
In most engineering practices today, requirements constitute the main vector for managing technical contracts between customers and suppliers, at any level of the breakdown. Customers express their needs as requirements using natural language ("*the system shall* ...") and suppliers analyze, interpret, reformulate, refine, and complete these requirements in order to describe the expectations on the solution system. A flaw of these practices is that requirements are sometimes the main vector to perform design analysis and describe the architecture of the solution.

Model-based systems engineering (MBSE) has gain popularity in the last ten years. MBSE covers a very broad spectrum of applications, spanning from high-level architecture modeling to detailed design at the frontier of simulation. Whatever the scope of application, MBSE is expected to provide a certain level of formalism, to provide a single source of truth, and to make the model a reference

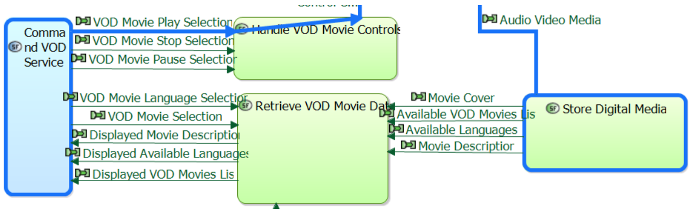
# Requirements can either be textual "shall" statements, either model elements: textual and model requirements actually complete each other

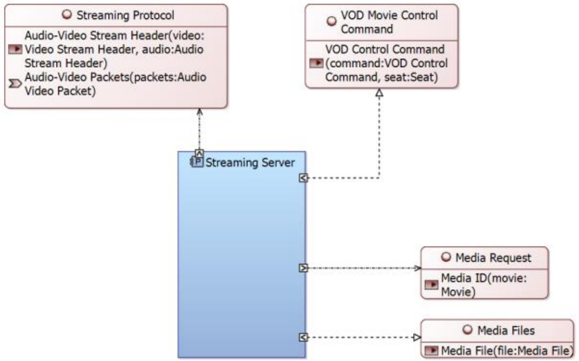
Textual
Requirements

Model ~~elements~~
Requirements



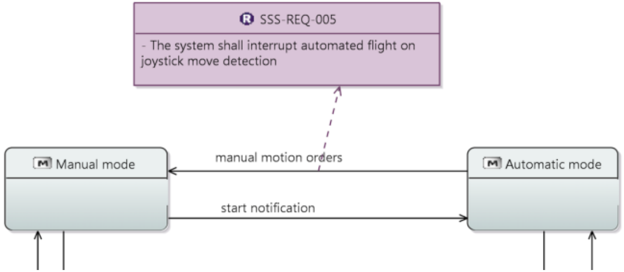
# Model requirements



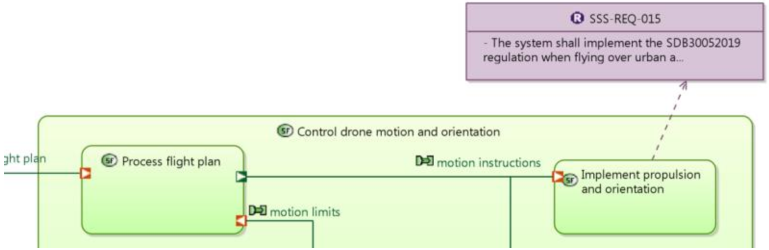




Some of the Arcadia concepts can be considered as **Functional** and **Interfaces** requirements, eventually with related **Performance** requirements.

# Model + textual requirements

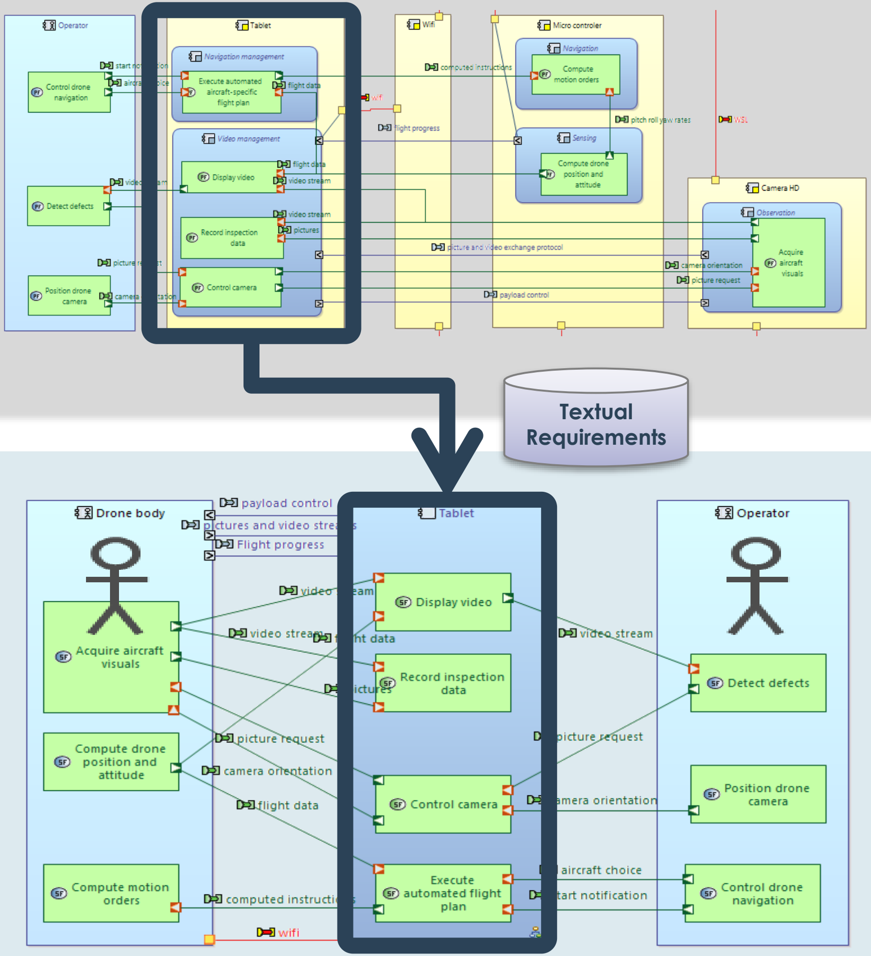



Models formalize **stakeholders** requirements



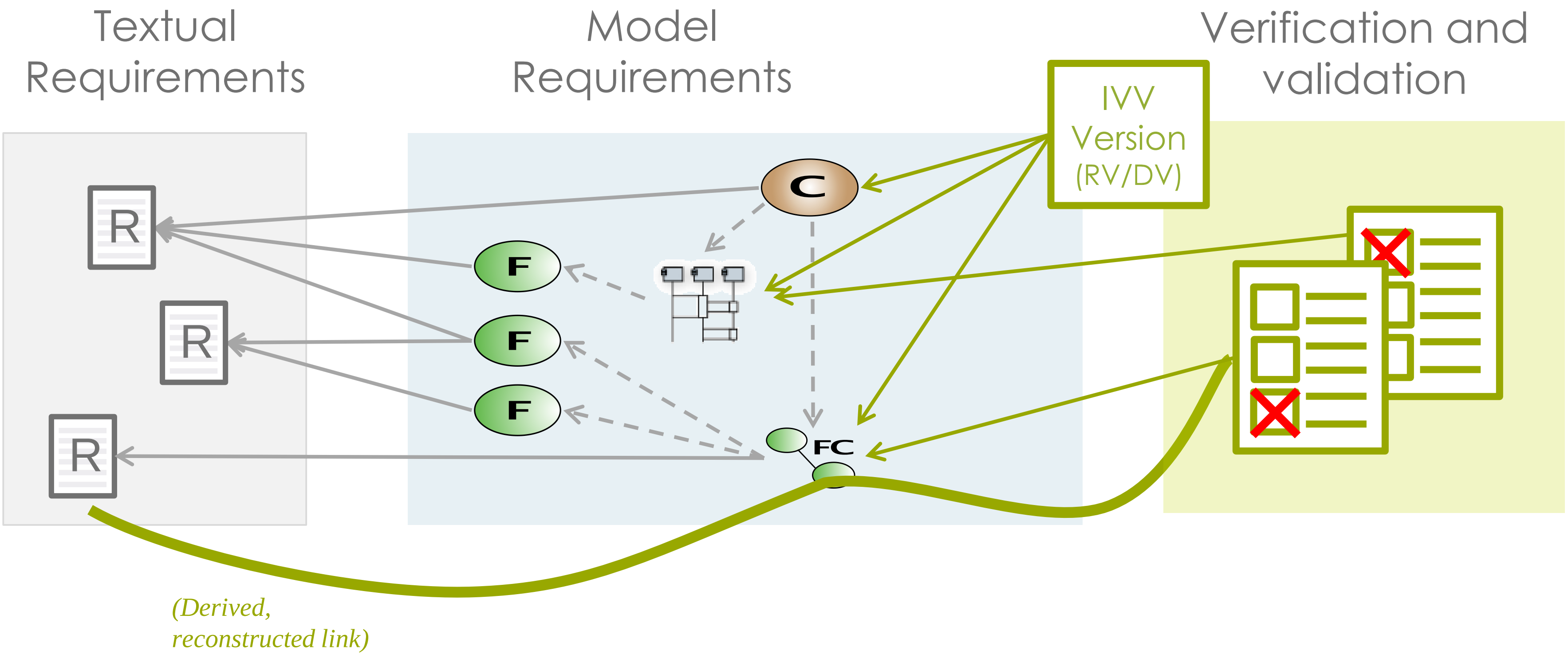

Some expectations (**Environmental**, **Regulations**, etc. ) are easier to express with textual descriptions with traceability links to model elements

## N-Level: Tablet is a constituent of a drone-based system



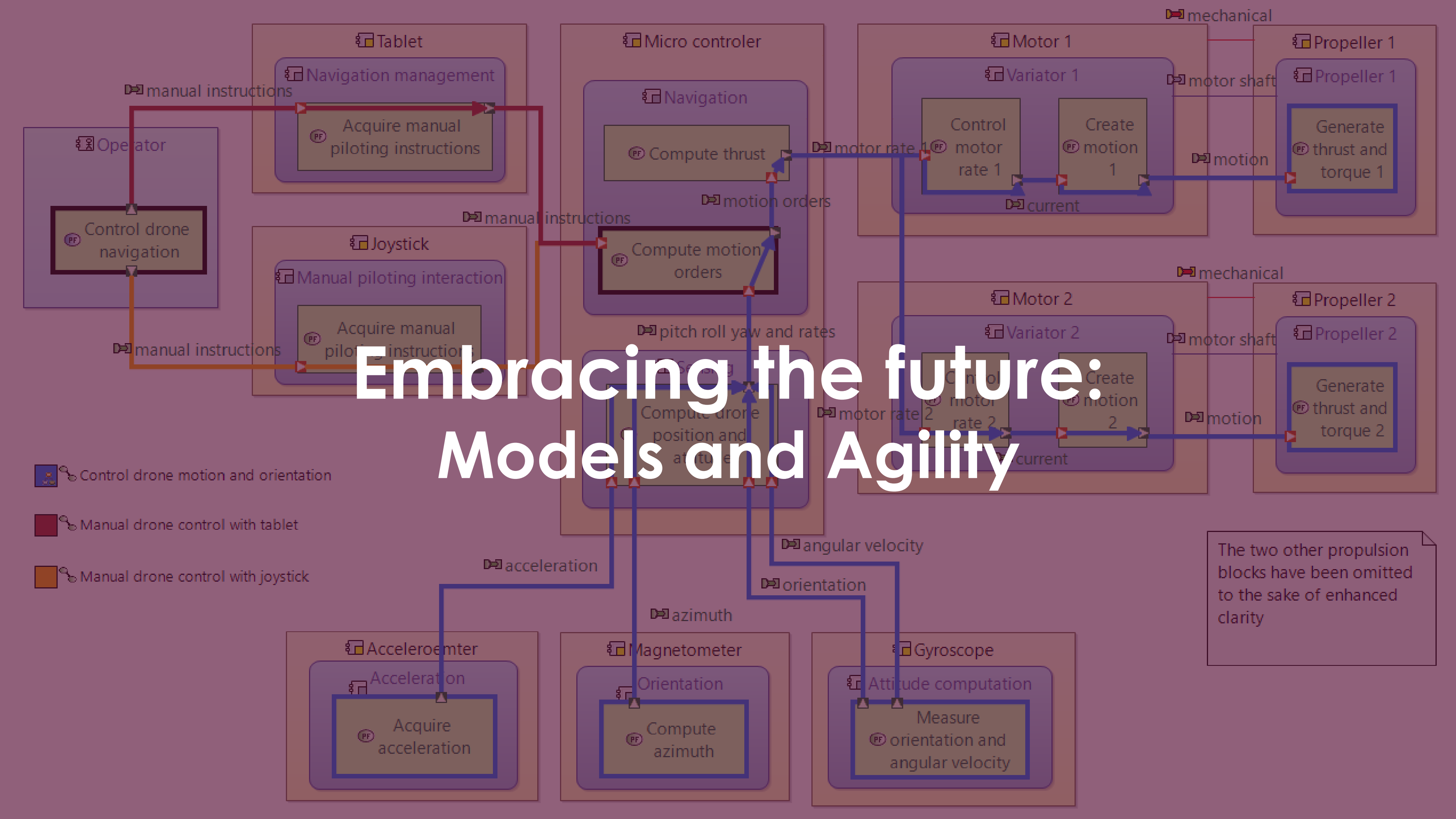

## N+1 Level: Tablet is the (sub)system of interest

**Models + Textual requirements bring clarity and rigor to “contracts” between engineering levels**




**Models + Textual requirements enable a better coordination and planning of IVV activities**

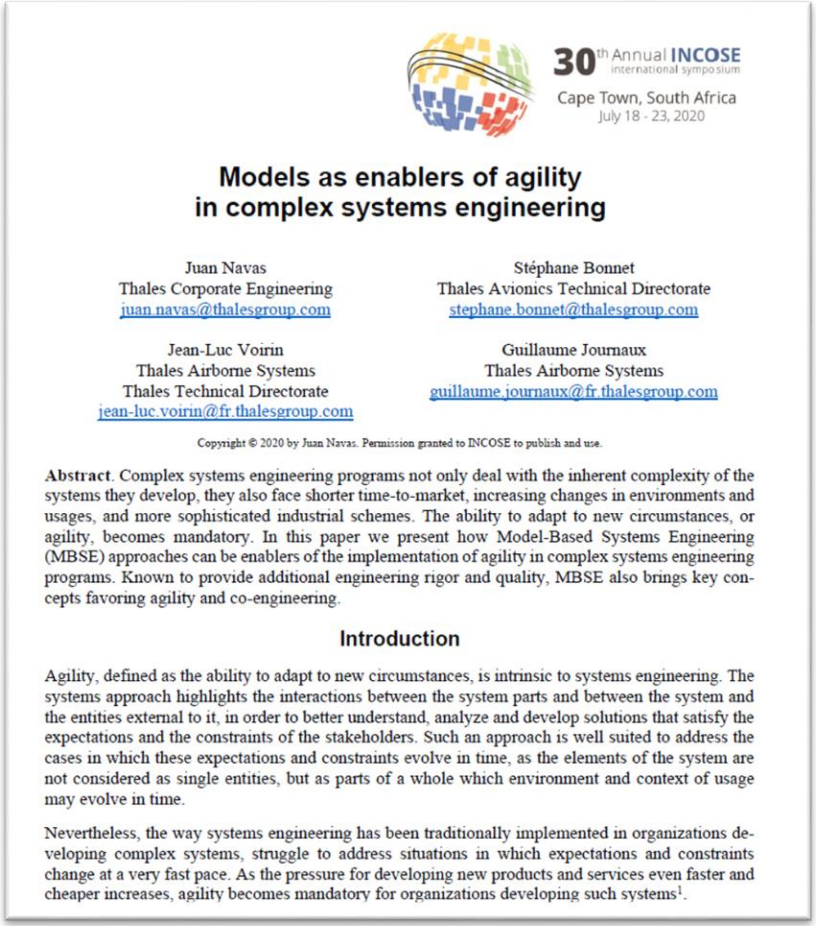
# Embracing the future: Models and Agility



**Models add rigor to needs expression / solution description**

**Agility on systems engineering is required to cope with customers' expectations**

**… Why not implementing Model-Based Agility?**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## Models as enablers of agility in complex systems engineering

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**Abstract**. Complex systems engineering programs not only deal with the inherent complexity of the systems they develop, they also face shorter time-to-market, increasing changes in environments and usages, and more sophisticated industrial schemes. The ability to adapt to new circumstances, or agility, becomes mandatory. In this paper we present how Model-Based Systems Engineering (MBSE) approaches can be enablers of the implementation of agility in complex systems engineering programs. Known to provide additional engineering rigor and quality, MBSE also brings key concepts favoring agility and co-engineering.

### Introduction

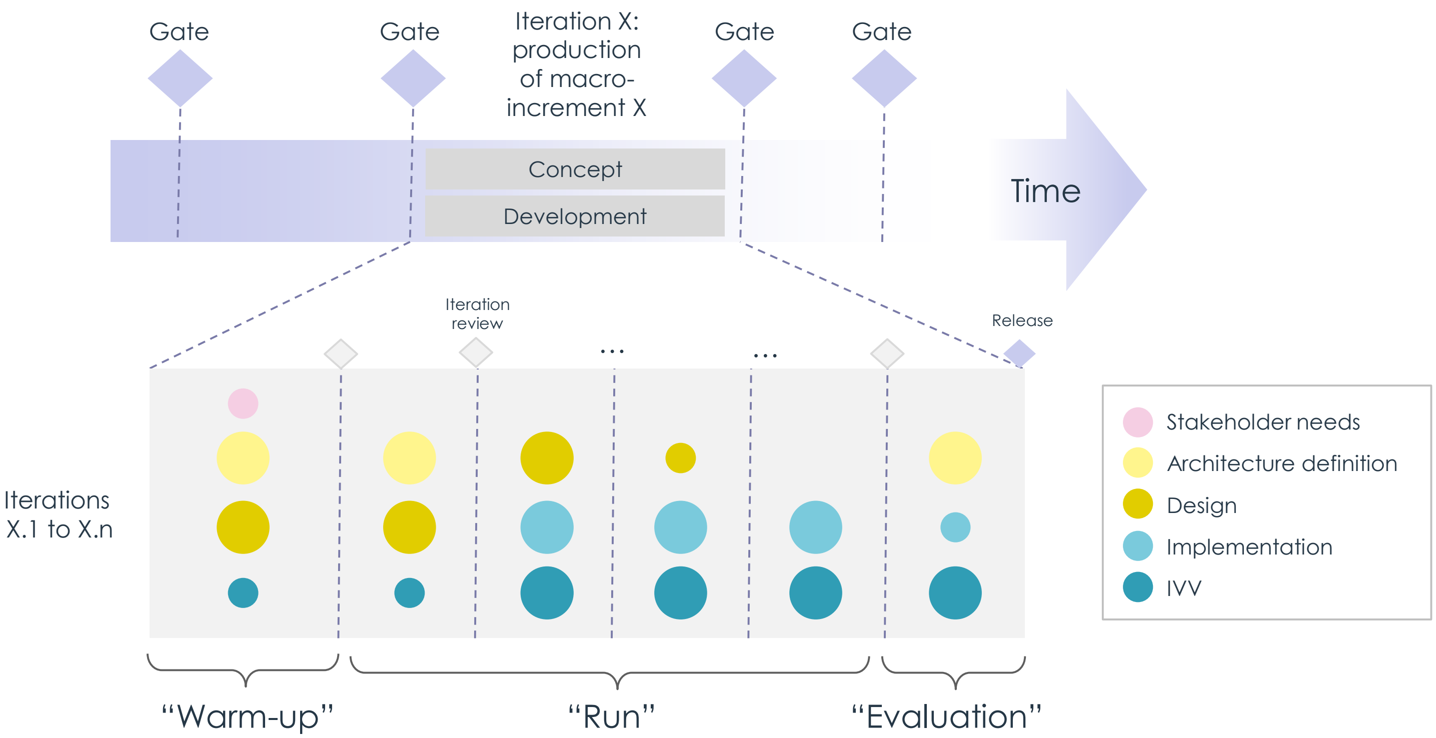
Agility, defined as the ability to adapt to new circumstances, is intrinsic to systems engineering. The systems approach highlights the interactions between the system parts and between the system and the entities external to it, in order to better understand, analyze and develop solutions that satisfy the expectations and the constraints of the stakeholders. Such an approach is well suited to address the cases in which these expectations and constraints evolve in time, as the elements of the system are not considered as single entities, but as parts of a whole which environment and context of usage may evolve in time.

Nevertheless, the way systems engineering has been traditionally implemented in organizations developing complex systems, struggle to address situations in which expectations and constraints change at a very fast pace. As the pressure for developing new products and services even faster and cheaper increases, agility becomes mandatory for organizations developing such systems[1].

# Model-based practices are effective enablers of systems engineering agility

Build the solution in an incremental way based on value creation, using system-level **Capabilities** and end-to-end **Functional Chains** and **Scenarios**

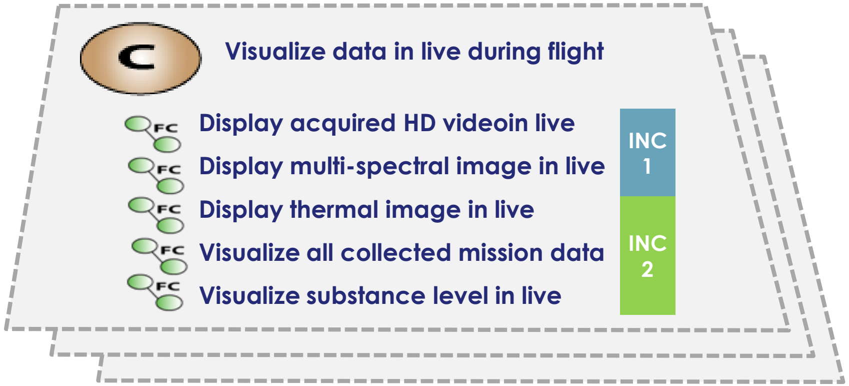
# Between 2 Gates, teams go through phases that can be iterated: increments at the team level




**Warm-up** - collaborative definition of the detailed scope, goals an schedule of the increment and of the necessary resources

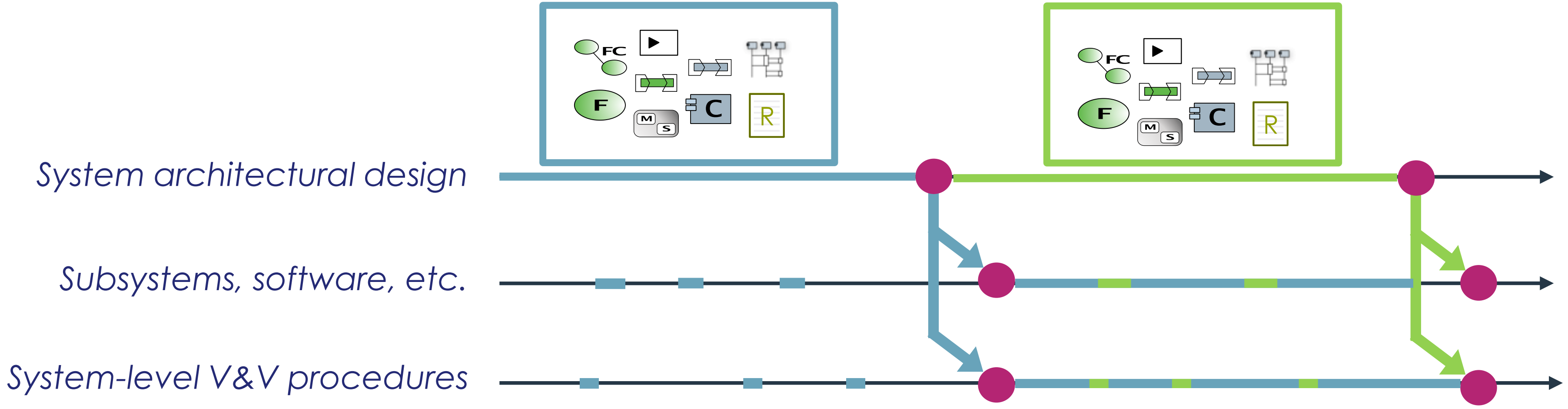
**Run** - iterative effort punctuated by iteration reviews

**Evaluate** - assess how the engineering was performed, that the expected outcomes are there and that conditions for pursuing are met

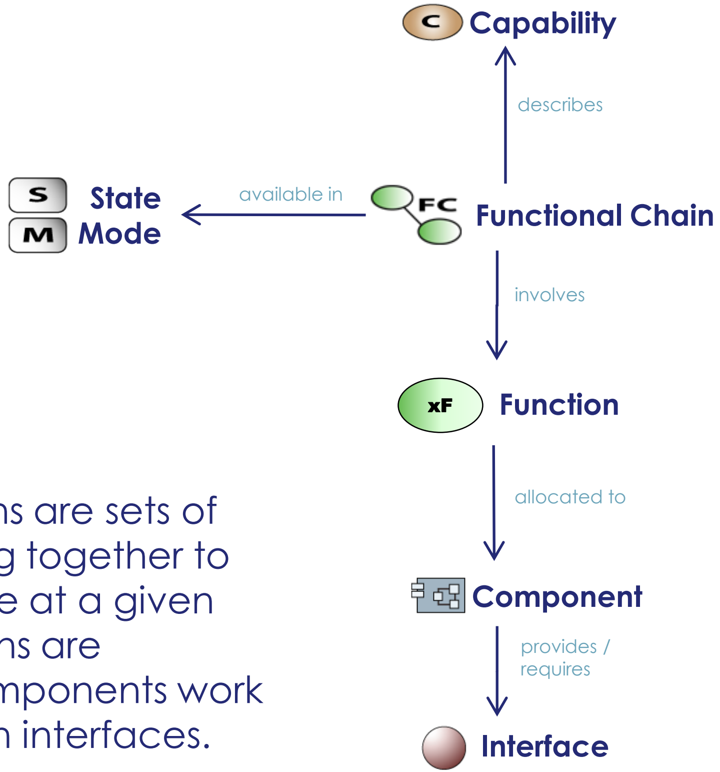



Definition of increments with expected Functional Chains

Vertical slices of architectural design across need and solution models

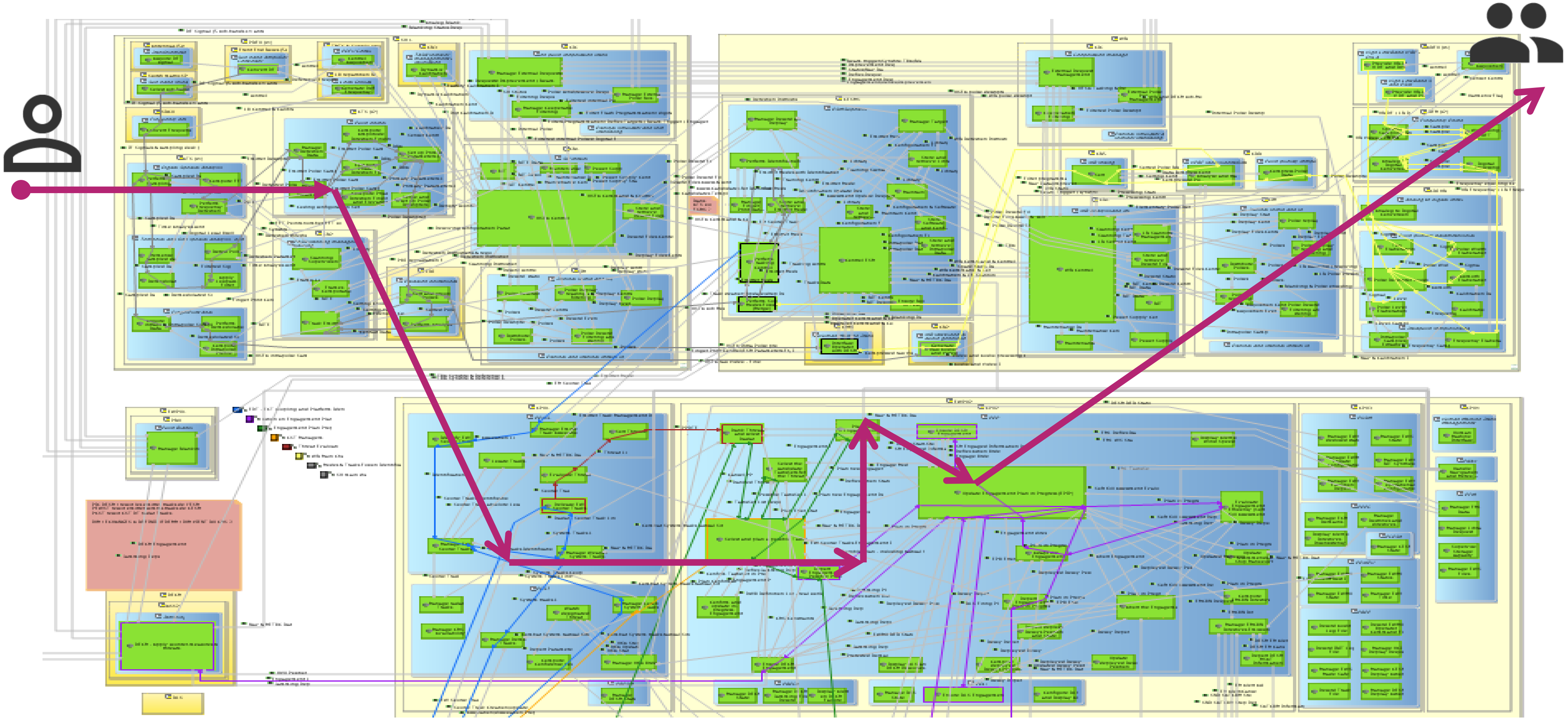


# A key concept: **Functional Chains**




Functional Chains represent different contexts of usage of a given capability of the system. Examples: real-time visualization, visualization from recorded data, …
Capabilities are high-level services for which the customer is paying for.

Functional Chains are sets of functions working together to perform a service at a given context. Functions are allocated to components work together through interfaces.



**Functional Chains** describing transverse, end-to-end system-level capabilities at physical architecture level


**Model elements such as Capabilities and Functional Chains provide meaning to what SW developers are doing**


The road to Digital Engineering is in front of us

# Thank you

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