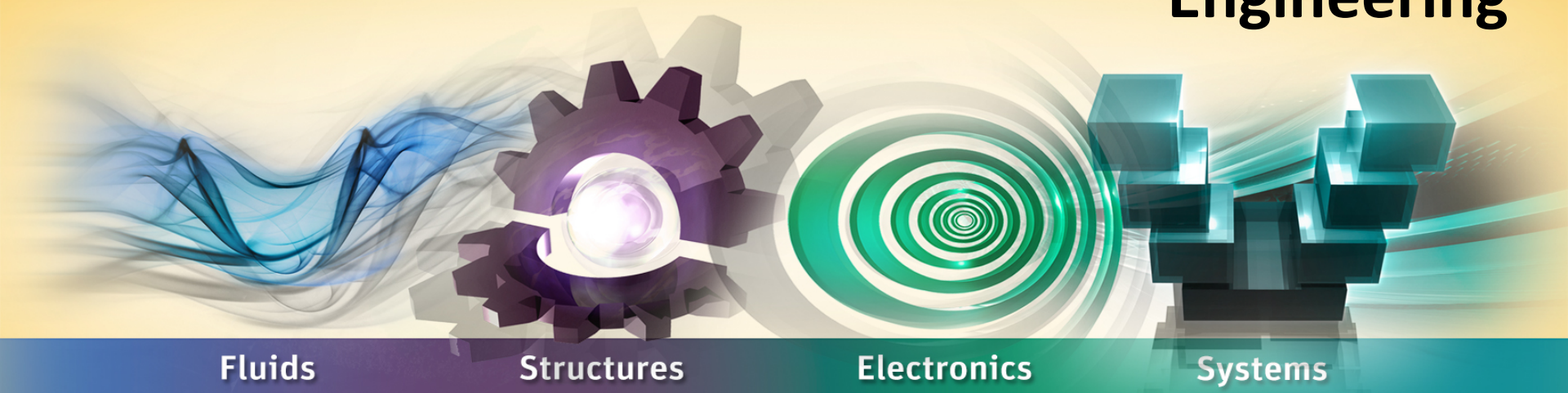


How do SCADE Model-Based Best Practices enhance Requirements Engineering

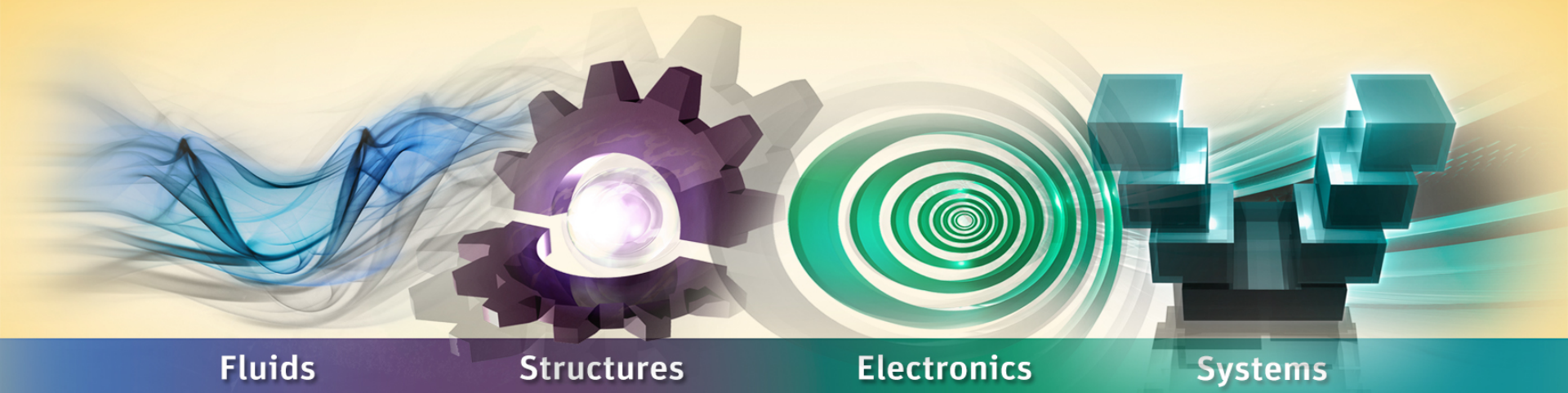


Systems Engineering

Model-Based Systems Engineering

Model-Based System Requirements Engineering

Systems Engineering



What is a System?

Objective

Mission to accomplish
User expectations

Environment

Environment conditions and exposures
Interacting actors and systems
Regulatory rules and other standards...

System Boundary

System

Inputs

C1

C2

C3

Interacting
Components

Outputs

Operators Users
*Including: performance,
met objectives,
met safety objectives...*

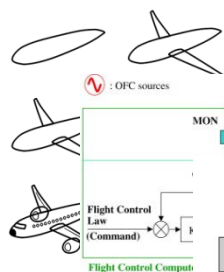
Boundary Crossing

Inputs & outputs
Interferences (electromagnetics...)
Shocks and vibrations
Energy transfer
Thermal flow
...

Interacting
Systems

System

What is Systems Engineering?



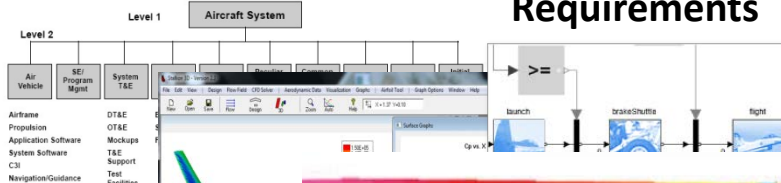
Concept

Control Laws Analysis

Requirements

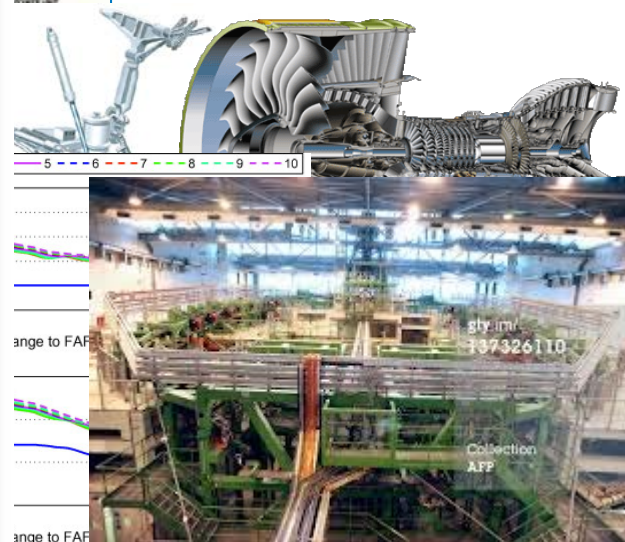
Prototyping

Simulation



Architecture

Systems Development



Integration & Testing

Systems Engineering: an extremely complex process

Both a technical and a management process

Organizing the technical efforts in the appropriate lifecycle

Iterative and incremental

Managing complexity

Problem Solving oriented and Decision Making centered

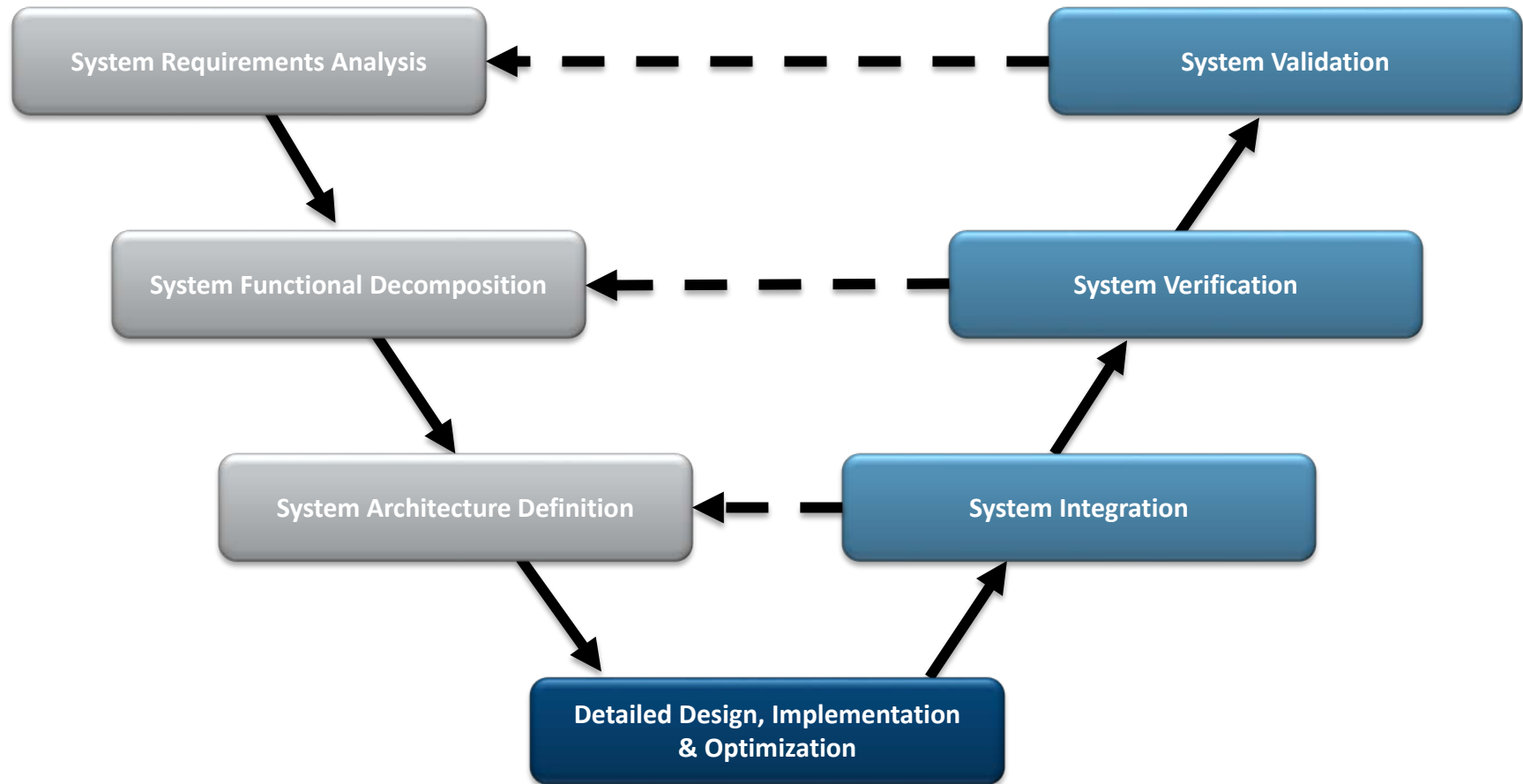
Constantly looking to increase the probability of success

Reducing risks

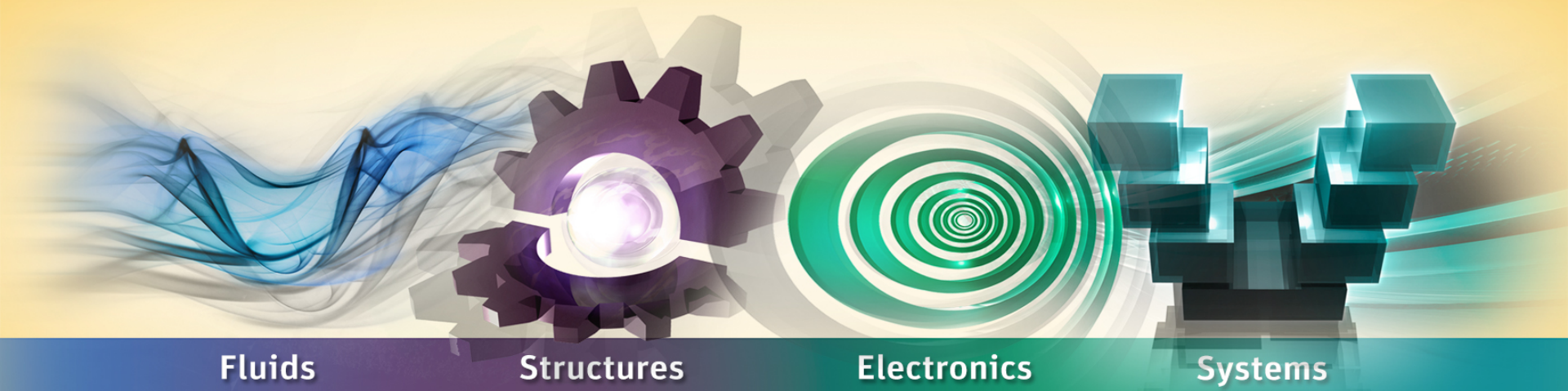
Managing safety and reliability

Optimizing the global life cycle cost

A Generic Systems Engineering Process V-Cycle



Model-Based Systems Engineering

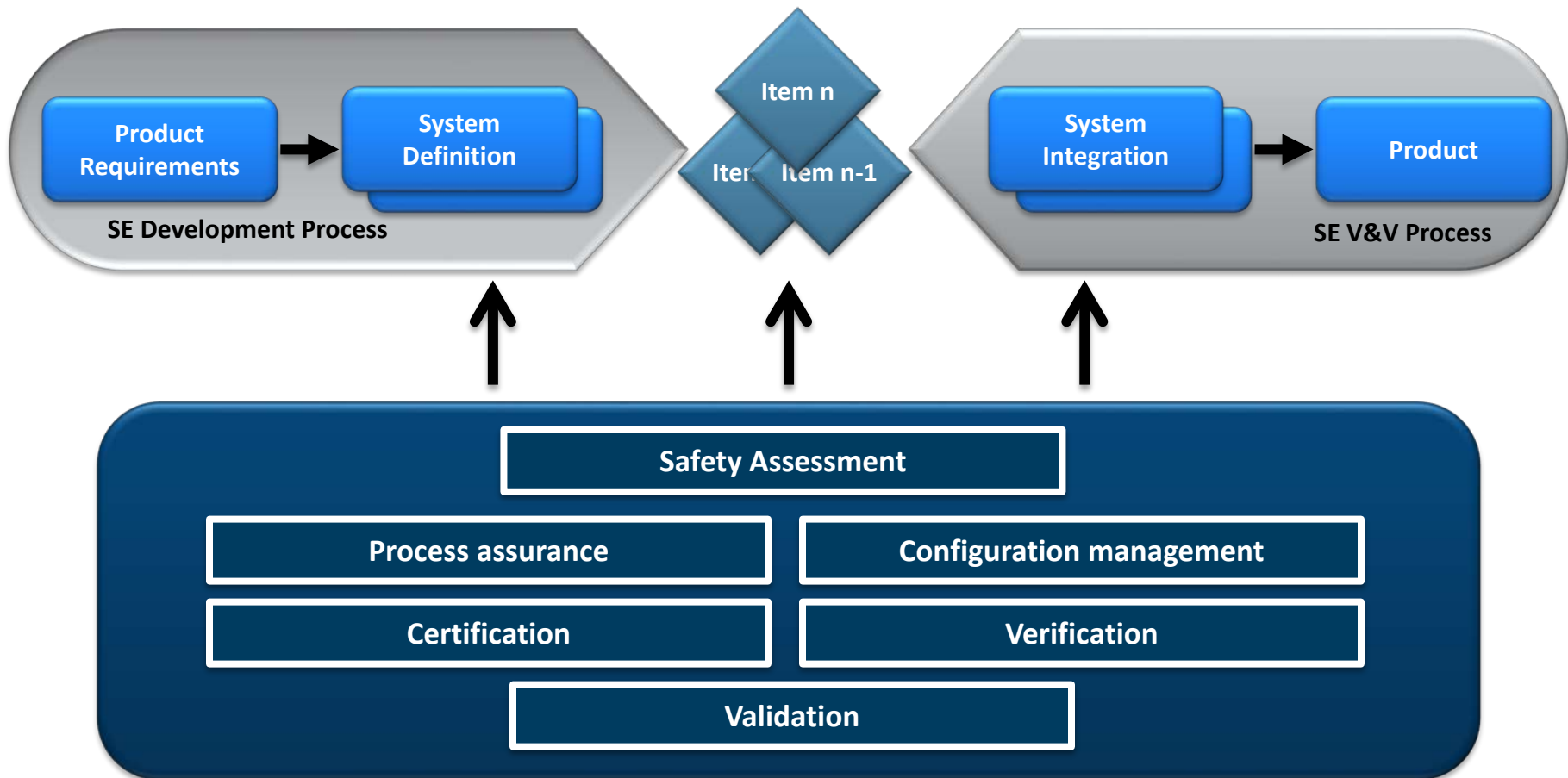


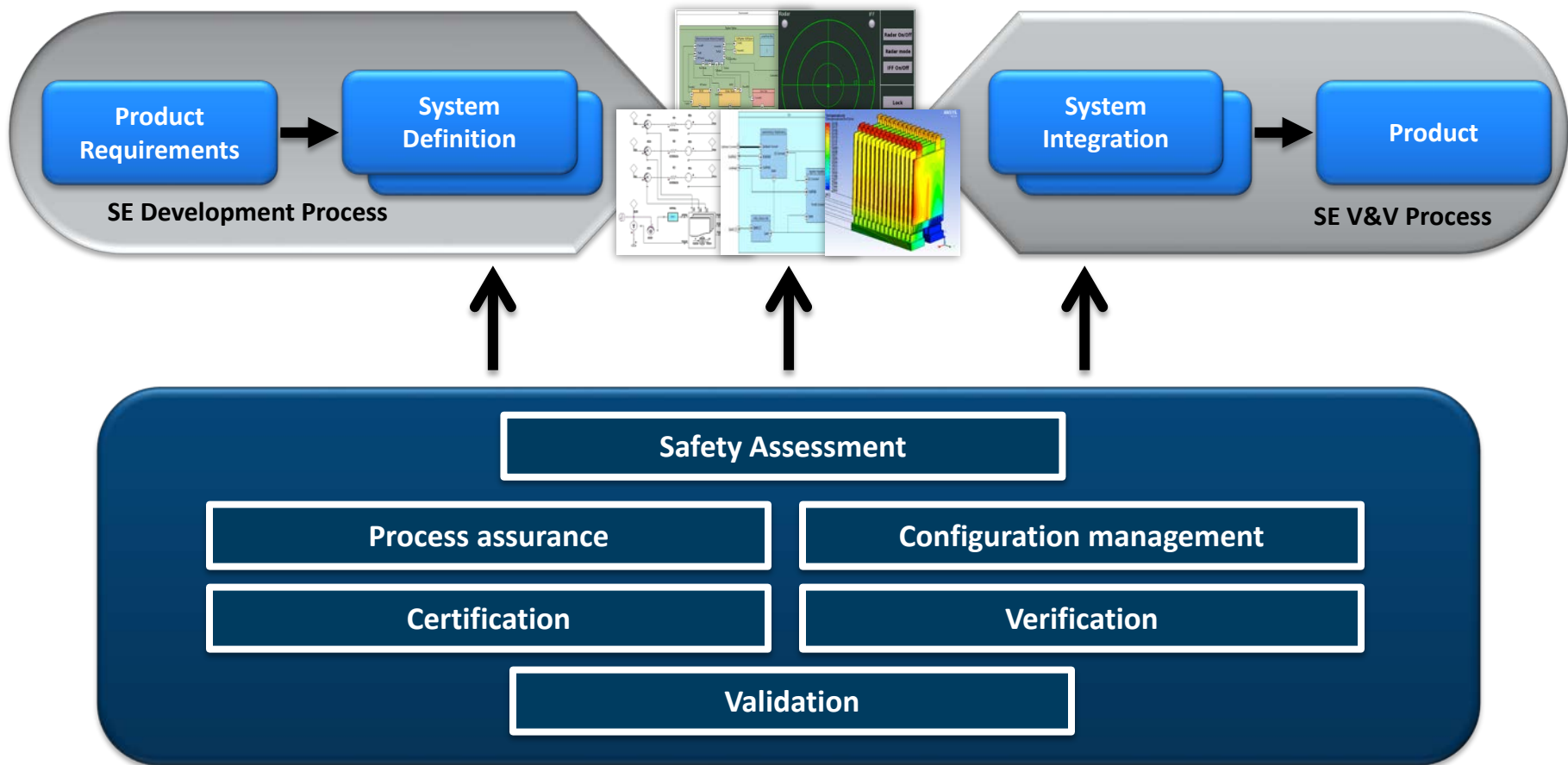
MBSE formalizes the practices of Systems Engineering through the use of models and organizes **models-centric activities **instead of documents-centric** activities**

*“Systems engineers use modeling and simulation on large complex projects to **manage the risk of failure** to meet system mission and performance requirements.”*

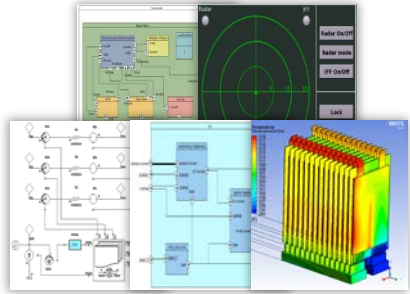
[INCOSE]

The Main Risk of the SE Process: Huge Gap between SE Development Process and SE V&V Process



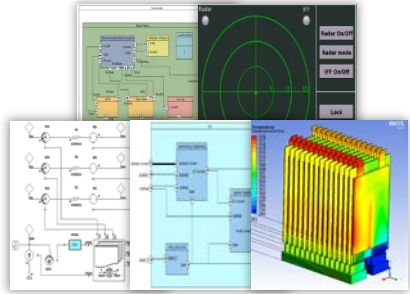


MBSE: Improve Quality and Productivity

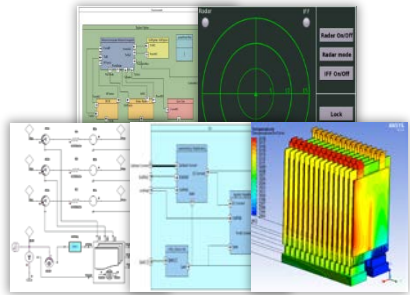


- Enable early **validation of concepts**
- Enable identification of **requirements issues**
- Validate the **correctness** of the requirements
- Improve the **allocation** of requirements to items
- Establish rigorous requirements **traceability**, facilitating early verification of requirements **completeness**
- Speed up safe **impact analysis** of requirements changes

MBSE: Insure Integrity and Reliable Communication

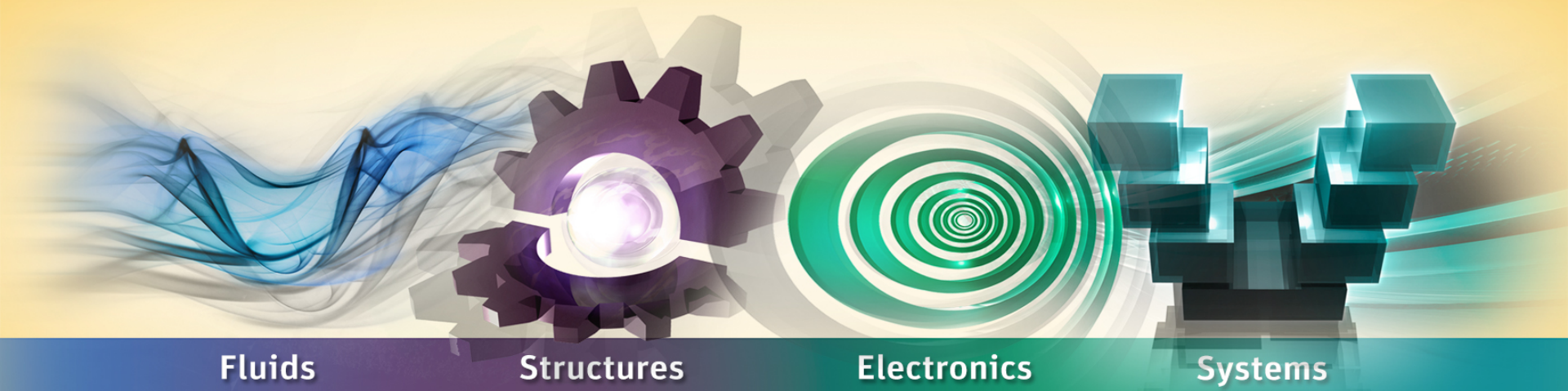


- Create a single **reference point** that aggregates views and key data of the project
 - Integrating views from different disciplines into models naturally forces focus on the **system and components boundaries**
 - Key data are managed for an early dependable **Interface Control Documentation (ICD)**
- Enable early design **verification**
- Auto-generate **documentation**



- Facilitate the **reuse** of existing valid models
- Enable optimized **iterations** and valuable **increments**
- Allow early **problem solving** activities
- Improve **cost estimates**

Model-Based Systems Engineering and Requirements Engineering



Fluids

Structures

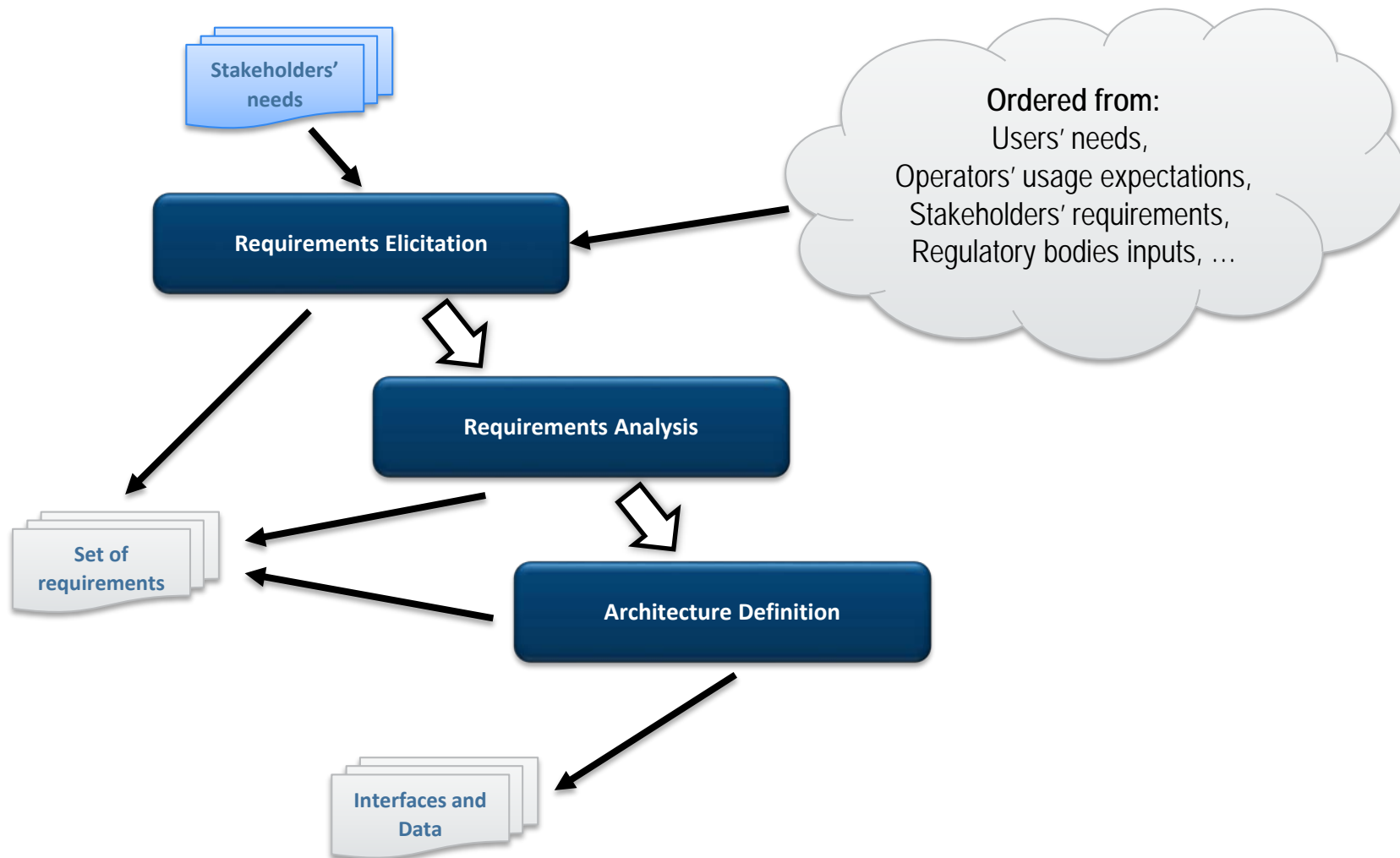
Electronics

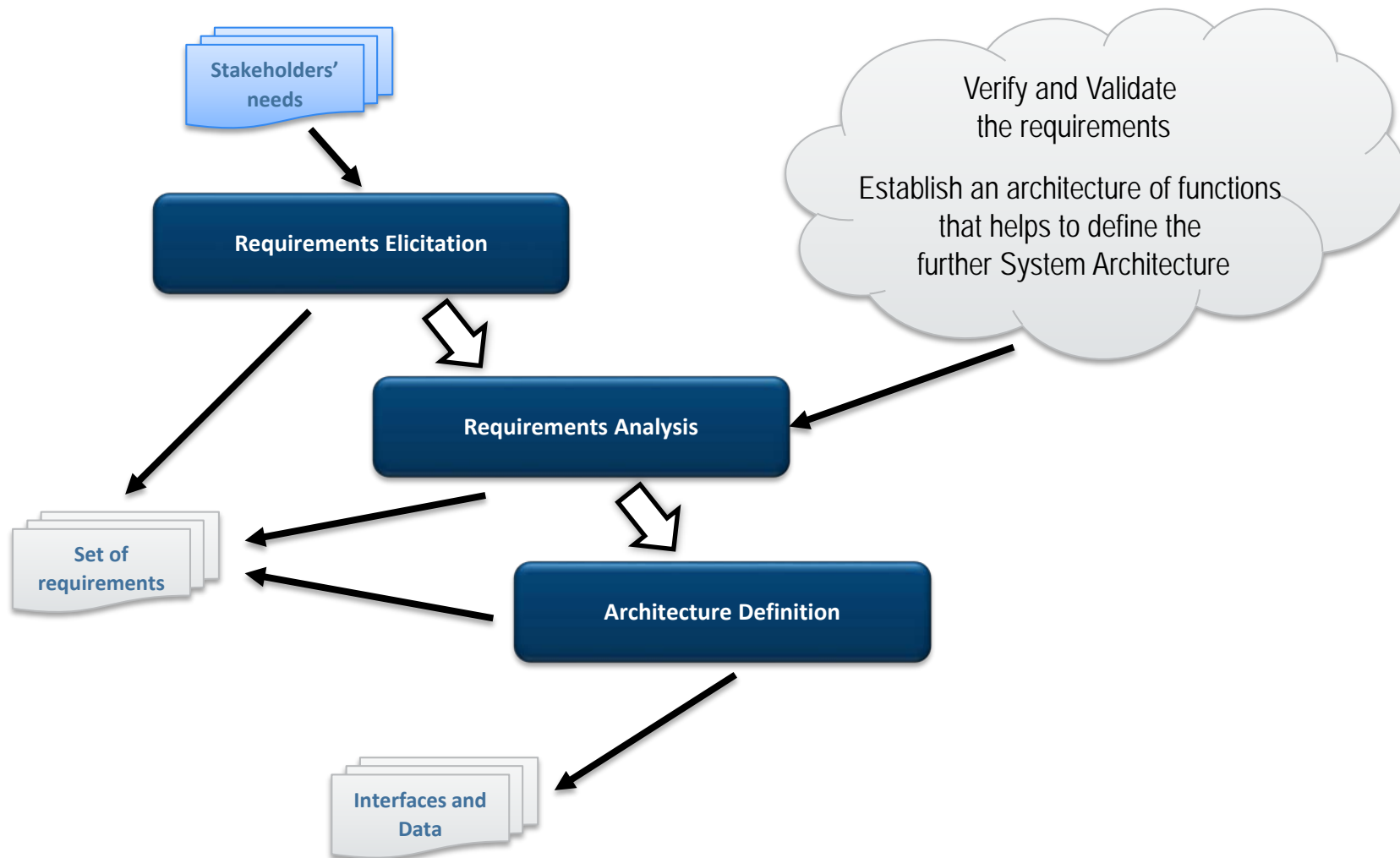
Systems

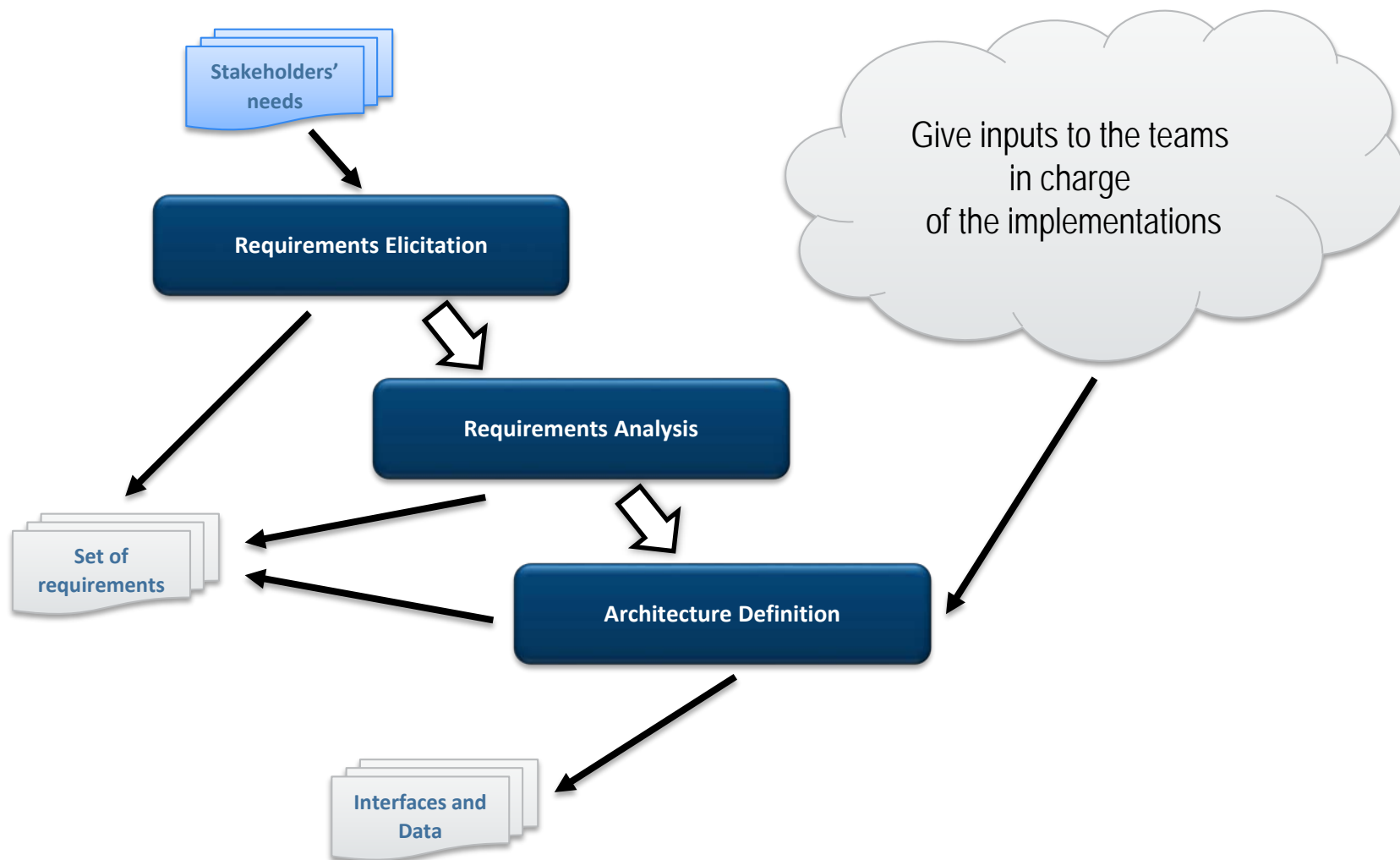
Questions that drive the early stages of the Systems Engineering process

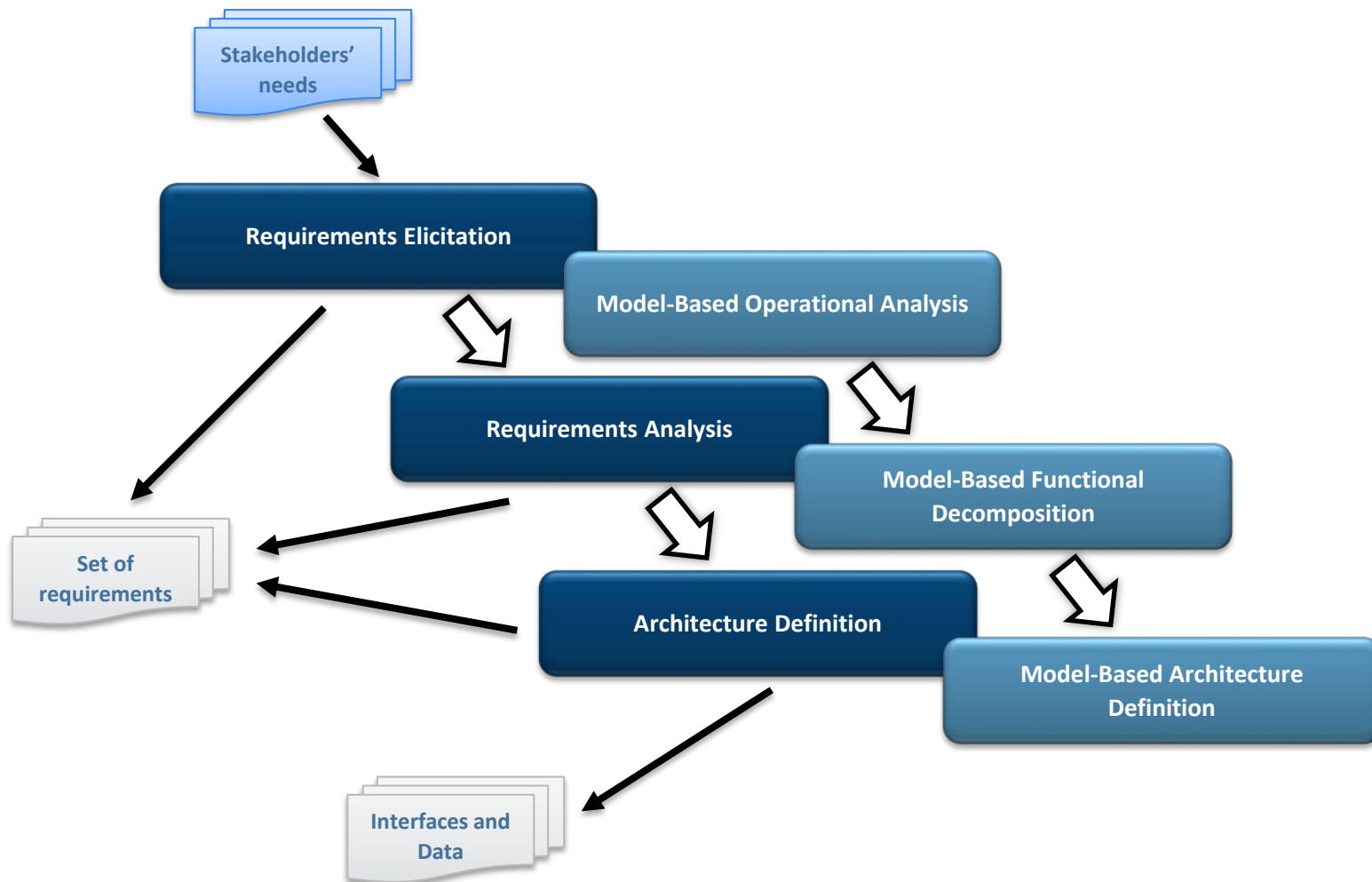
1. What is the system supposed to do?
2. How well must it do what it does?
3. What is available and allowable to build the system?
4. What are the criteria for judging how well resources have been utilized?
5. What are the trades-offs between performance and cost?
6. How can it be proven that the as-built system meets expectations?

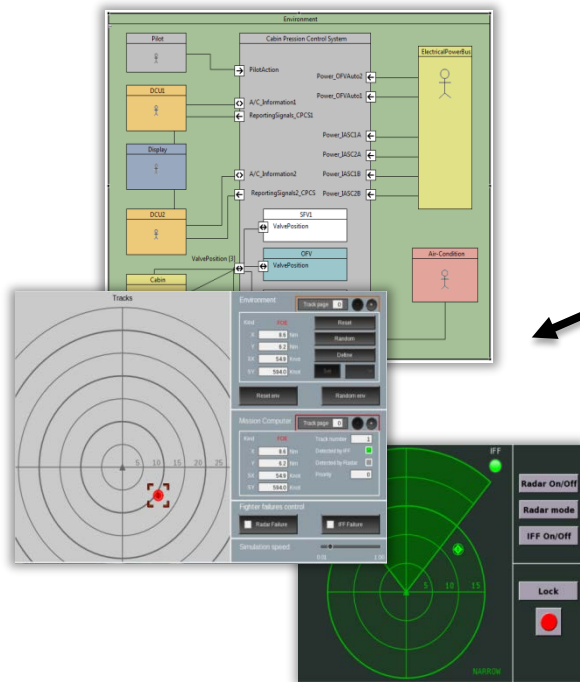
[Albert W. Wymore]











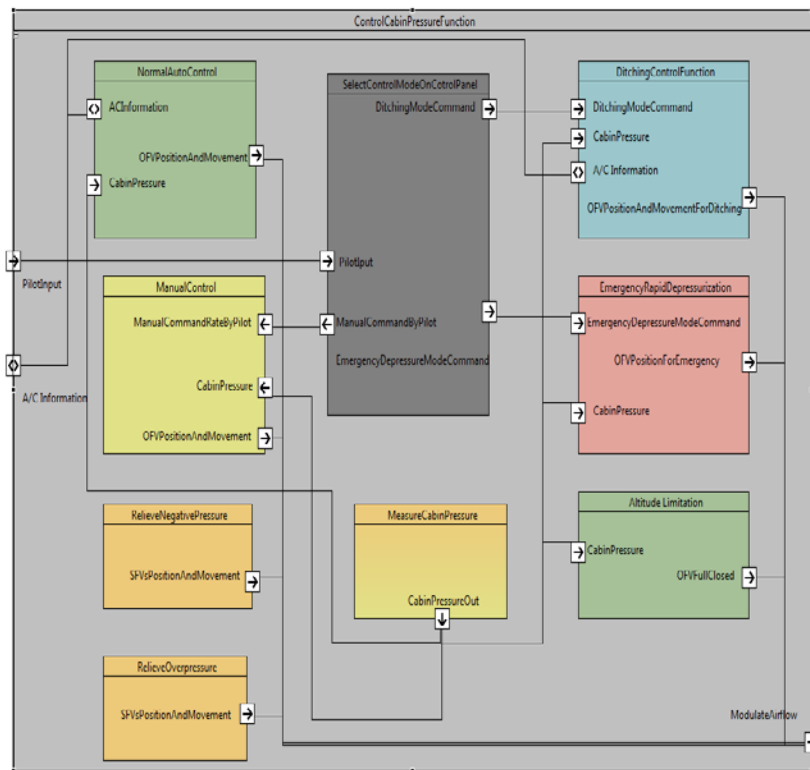
Model-Based Operational Analysis

Model-Based Functional
Decomposition

Model-Based Architecture
Definition

Requirements Engineering

Model-Based Requirements Engineering



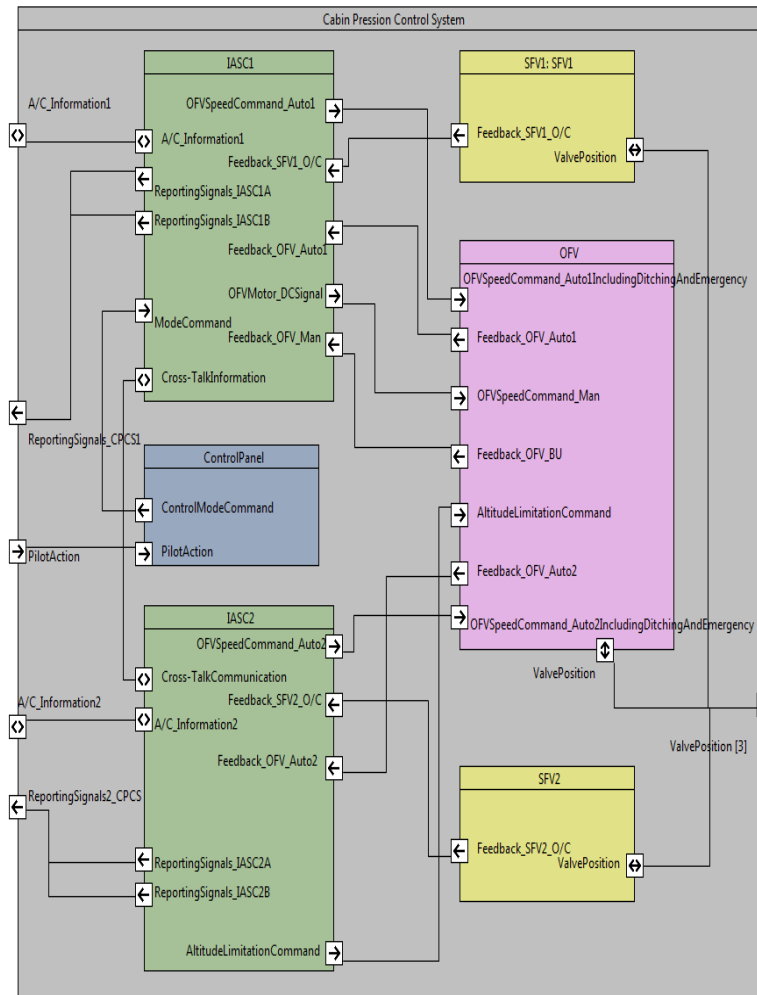
Model-Based Operational Analysis

Model-Based Functional
Decomposition

Model-Based Architecture
Definition

Requirements Engineering

Model-Based Requirements Engineering



Model-Based Operational Analysis

Model-Based Functional
Decomposition

Model-Based Architecture
Definition

Requirements Correctness

5. Functional Requirements

SelectControlModeOnControl Panel Function

REQ_PANEL_FUNC_01

The Cabin Pressure Control Panel function shall give the following functional commands selected by a pilot:

- Manual cabin pressure altitude rate of change = MAN RATE command,
- Manual switch ON or OFF = MAN ON or OFF command,
- Emergency depressure switch ON or OFF = EMER DEPRESS ON or OFF command,
- Ditching switch ON or OFF = DITCHING ON or OFF command.



Correctness

Is the requirement unambiguous?

Is it clearly stated as a requirement?

Is it not redundant?

On the other hand, does it conflict with other requirements?

Is it feasible to serve it?

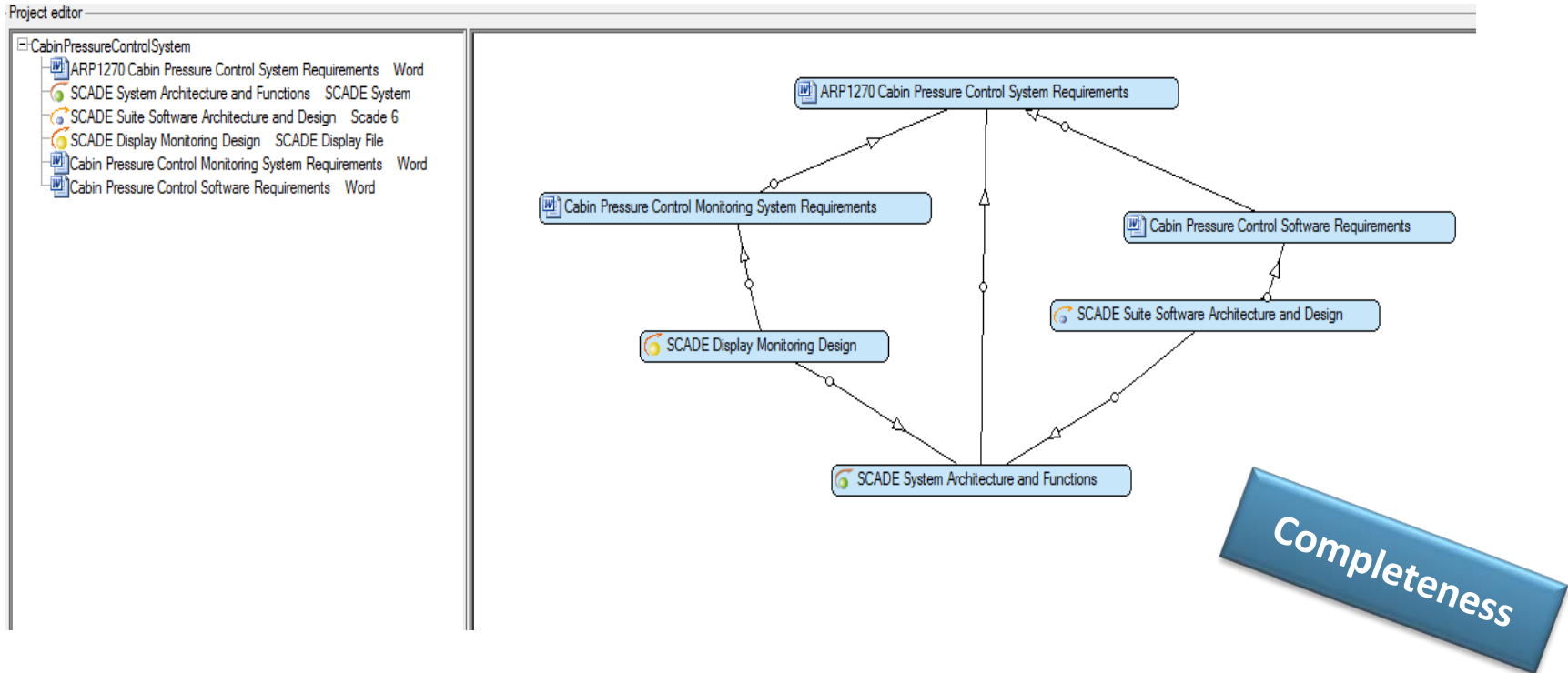
Is it verifiable? (Testable?)

If it is a derived requirement: is it justified?

Is it necessary?

Requirements Completeness

Traceability Management is key



Are all Parent Requirements covered (aka Stakeholders')?

Are all Functions of the Function Decomposition traced back to Requirements?

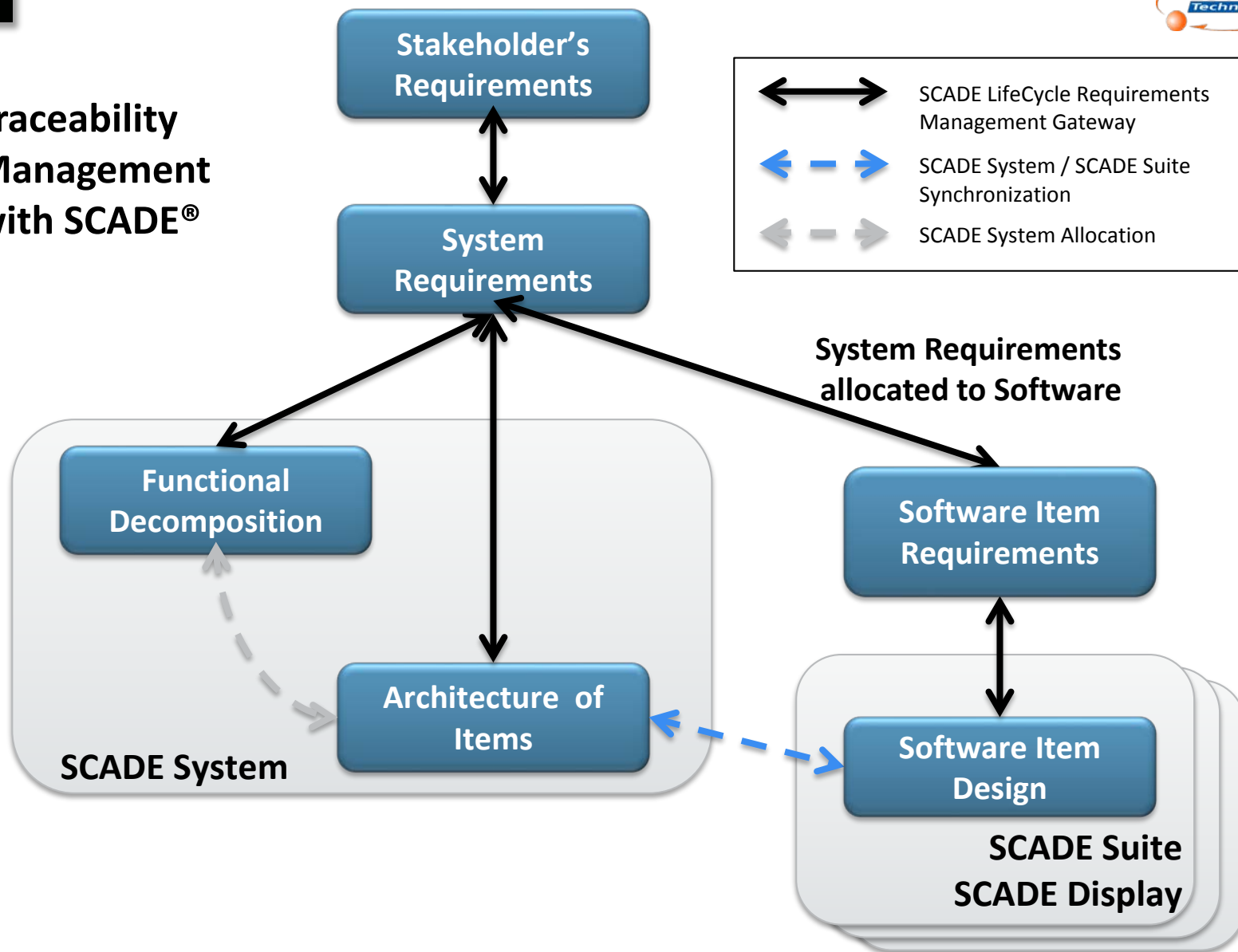
Are all scenarios of use (Operations) and of maintenance represented?

Are all types of requirements represented: Safety, Regulatory, Company standards?

Are all interfaces to other systems, actors, and processes embodied?

For a defined use, is the prohibited use defined as well?

Traceability Management with SCADE®



- Creating a set of complete and correct Requirements is the primary responsibility of Systems Engineers, from the point of view of other teams involved in the construction of a system.
- The Model-Based approach, as well as Data-Based representation, help System Engineers to implement a true Requirements Engineering process.
- This approach includes the use of the Rapid Prototyping capability to simulate, early in the development process, the Systems operations.
- Functional Decomposition, synthesis of Architecture exploration and Interface Control Document are created and maintained through safe iterations, all tightly linked to the set of requirements.

