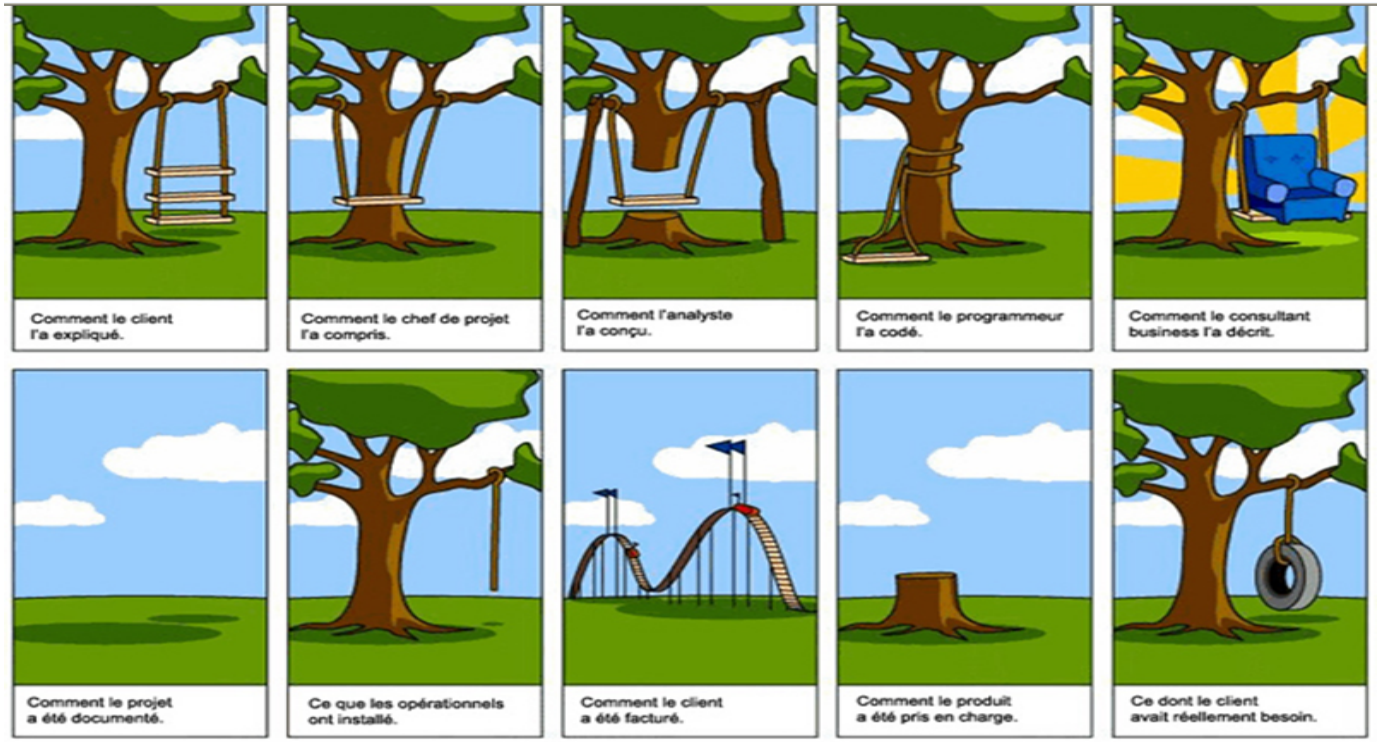
How to use systems architecture to specify the operational perimeter of an innovative product line

Johanna BERREBI – EADS Innovation Works

Daniel Krob- LIX, École polytechnique, 91128 Palaiseau, France

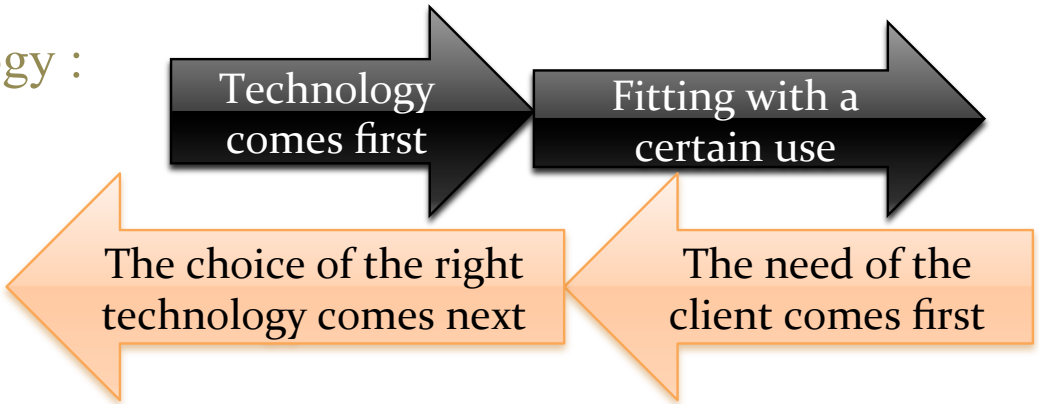
Introduction

The purpose of this presentation is to discuss a systems architecture method which should allow the design of a product family capable of responding to industrial (aeronautic) expectations and constraints.



Introduction: Key issues

•Chronology :



•Misunderstanding and Lack of communication

Selling team	Technical team
+ Knows the market and the customer need	+Technical competencies
+ A commercial vision of a problem	+Creativity
- Technical competencies	-Knows the market and the customer need
- Creativity	- A commercial vision of a problem

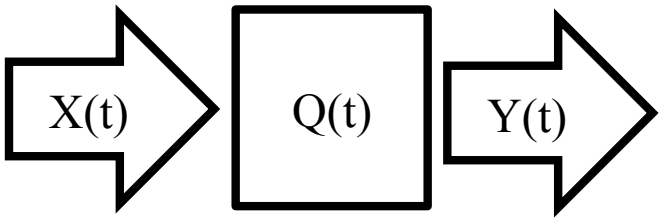
•To specified product which don't really satisfy a large target of client

Introduction: Why a product family around a modular architecture?

- Economies of scale
- Compatibilities
- Feasibility of evolution within the system
- Satisfaction of a large target of clients
- The purpose here is to satisfy all aircrafts

Introduction: Definition of the product family system theory

- System, Subsystem and module



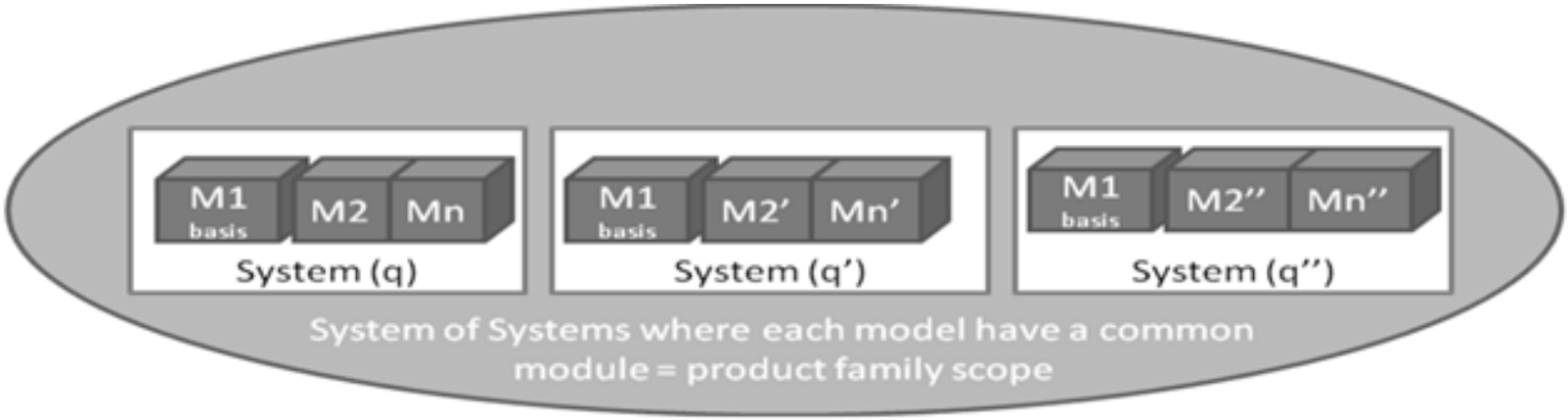
X(t)	**Input to the system**
Y(t)	**Output of the system**
Q(t)	**Internal state of the system**
F(t)	**System's function**

- $Y(t) = F(X(t); Q(t); t)$

Introduction: Definition of the product family
Elements of systems architecture

Operational view					Functional view		Constructional view	
Defining the mission and the purpose	Defining the concepts	Analysis of the environment	Defining the limits	Defining the needs, constrains and translating into requirement	Functional analysis	Functional conception	Constructional analysis	Constructional conception

Definition of the product family product families and commonalities



Pi	System belonging to the considered family of systems
Mc	Common module to all the family of systems
Mj	Specific modules to each system of the family

		Module driven by technological choices			
Product family driven by the customer needs		MC	M1	…	Mm
	P1	1	1	0	0
	.	1	0	1	1
	Pn	1	0	1	1

Proposed Methodology

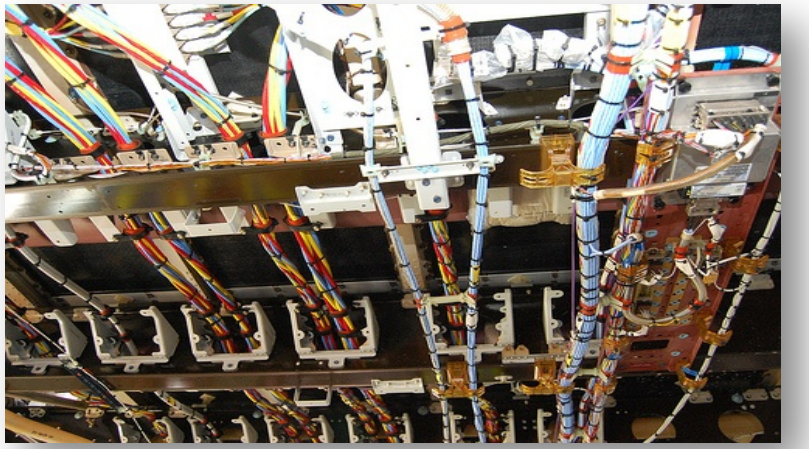
Proposed Methodology

- Step1: Exposing the context and key issues
- Step 2: Analyzing the possible solutions and sketching out the contour of a final product
- Step 3: Modeling the environment
- Step 4: Gathering all the specifications of the systems
- Step 5: Drawing the map of the operational architecture.
- Step 6: Highlight commonalities, and choosing the level of abstraction
- Step7: Materializing a modular architecture with the common and the specific modules

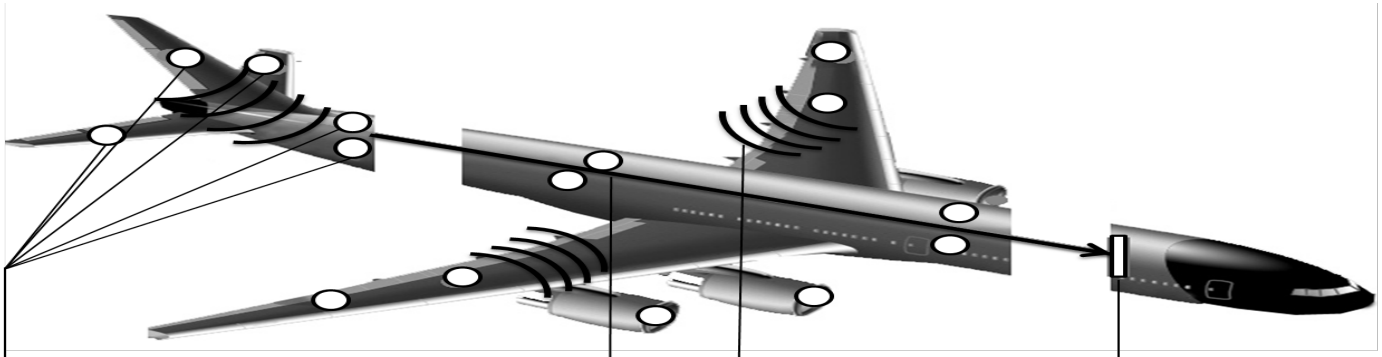
Illustration on a case study

Case study:
Step1: General context and the associated key issues.

- **Product family allows**
  - Reduction of costs by saving production time, saving fuel and increasing payloads.
  - Competitiveness by getting a more intelligent navigation and a lighter plane
- **Product family ease up**
  - Organization of the actual network
  - Aircraft maintenance
  - Installation of the devices
- **Product family contributes to**
  - Reorganize the present network
  - Minimize the number of procedures and devices
  - Replace cables by wireless networks, and make lighter aircrafts
  - Allow measures in inaccessible places on the aircraft

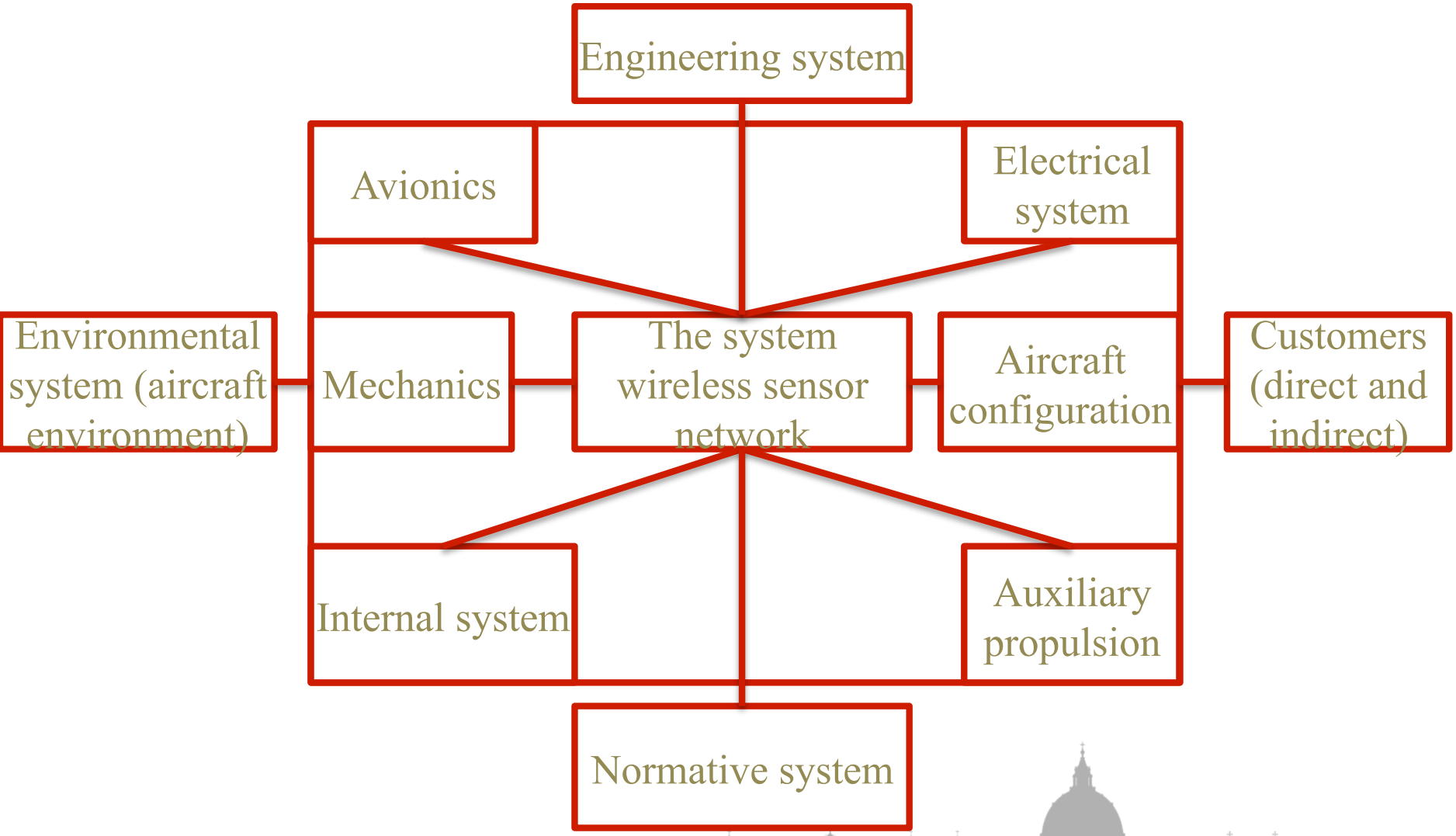


Case study:
Step 2: The perimeter of the product, systems definition



Specific sensors + signal processing+ emission antenna+ alimentation	Transmission channel+ reception antenna+ concentrator (on a optic fiber)	Signal processing device + alarm
All the sensors will broadcast a signal to the nearest concentrator	The signal will be transmitted via a wireless transmission protocol to a concentrator	The signal is transmitted to the decisional unit and activates an alarm to aware the pilot

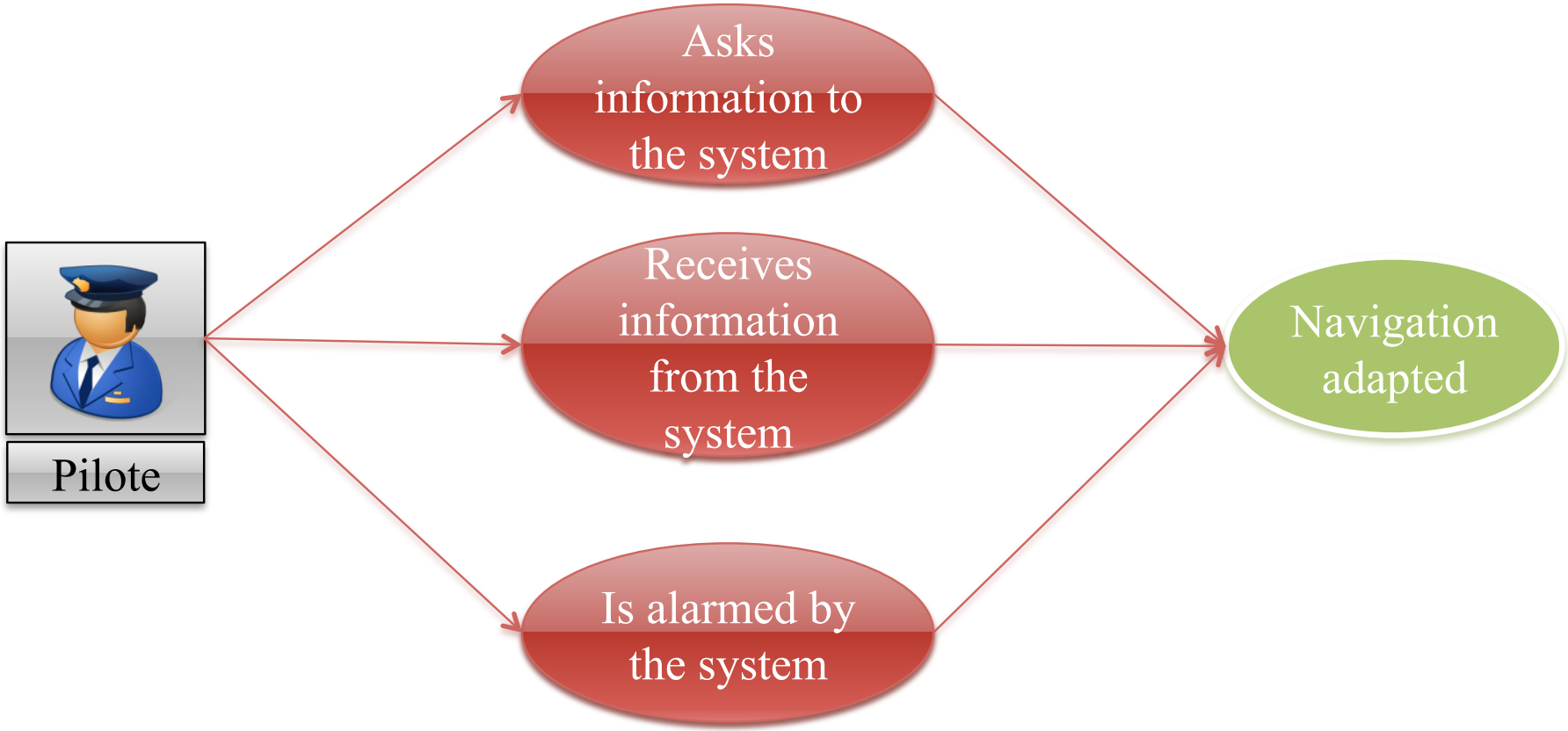
Case study:
Step 3: Modeling the environment



Case study:
Step 4: Needs analysis

Macro needs	Zoom on need n°1
(1) The customer (company airline) expects the product to be more economical	**The customer wants the product to be composed of fairly simple components, to be installed faster and easier**
(2) The customer (company airline) needs the product to be safe, reliable, and secure	**The customer wants the product to be lighter than the existing cable network, and to use less fuel**
(3) The customer (the maintenance staff) needs the product to be easy to maintain	**The customer expects the product to increase aircrafts usable weight capacity**
(4) The customer (the passenger) expects the product to respect sanitary norms	**The customer expects the product to reduce the time of maintenance**
(5) The customer wants the product to be compatible with the rest of the avionics	
(6) The customer expects the product to be at least as efficient as the wired existing network has proven to be	

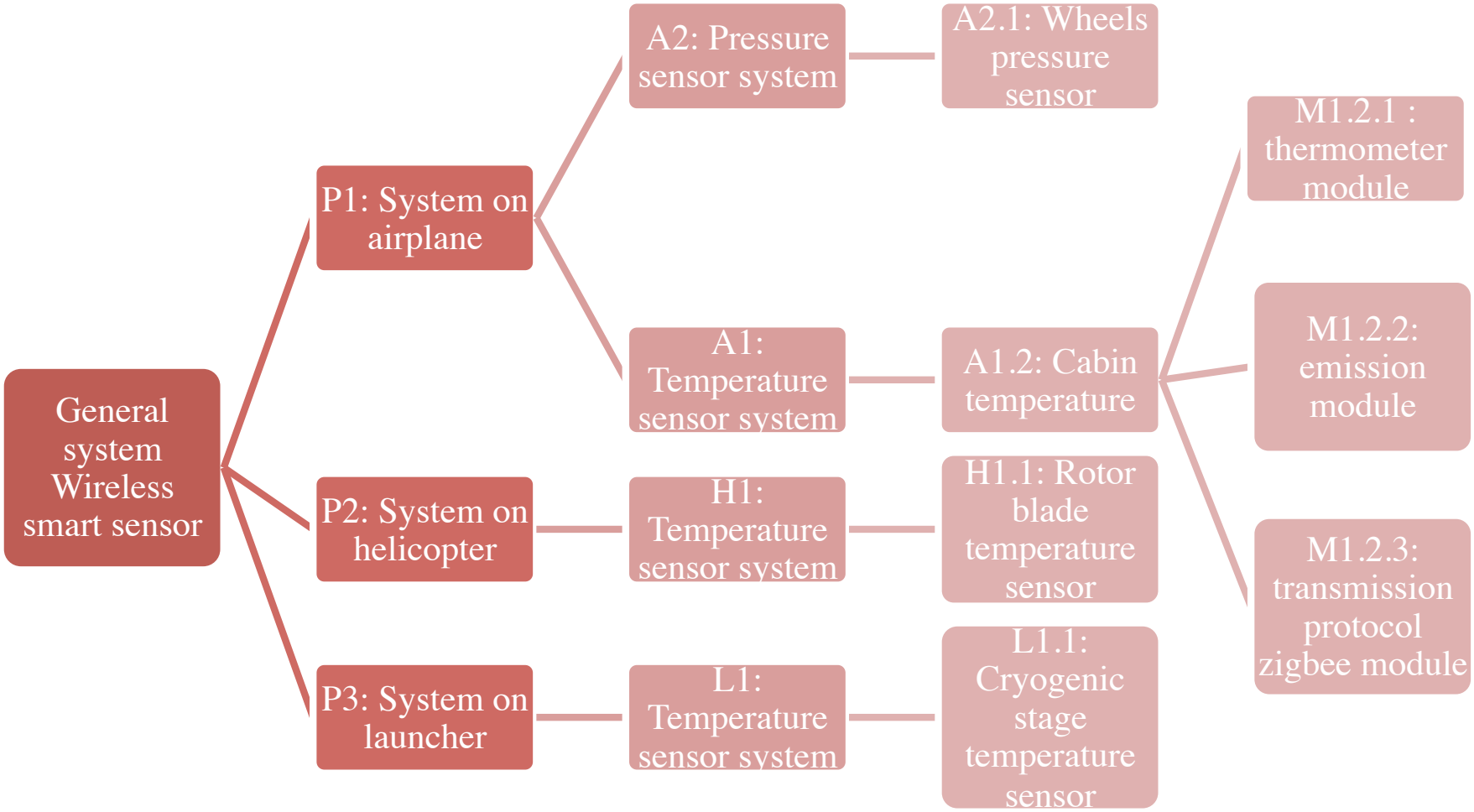
Case study:
Step 5: Operational analysis



Case study: Step 6: Commonalities highlighting

Functional requirements	Physical requirements	Quality requirements	Operational requirements
Getting a physical stimulus converted into electrical signals	Systems composition	Safety	Verification and validation requirements
Broadcast wirelessly the electrical signal	Physical characteristics	Security	Operational requirement: Life duration
Analyze the signal	Environment	Reliability	
Receives requests and sends answers	Price	Maintainability	

Case study: Step7: Synthesis, the modular architecture of our product family



Conclusion

Thank you for your attention

Question?