



Reliable Sensor Network

A heterogeneous sensor acquisition architecture for future European launcher

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— AIRBUS SAFRAN —
LAUNCHERS

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1 Introduction (Company and me)

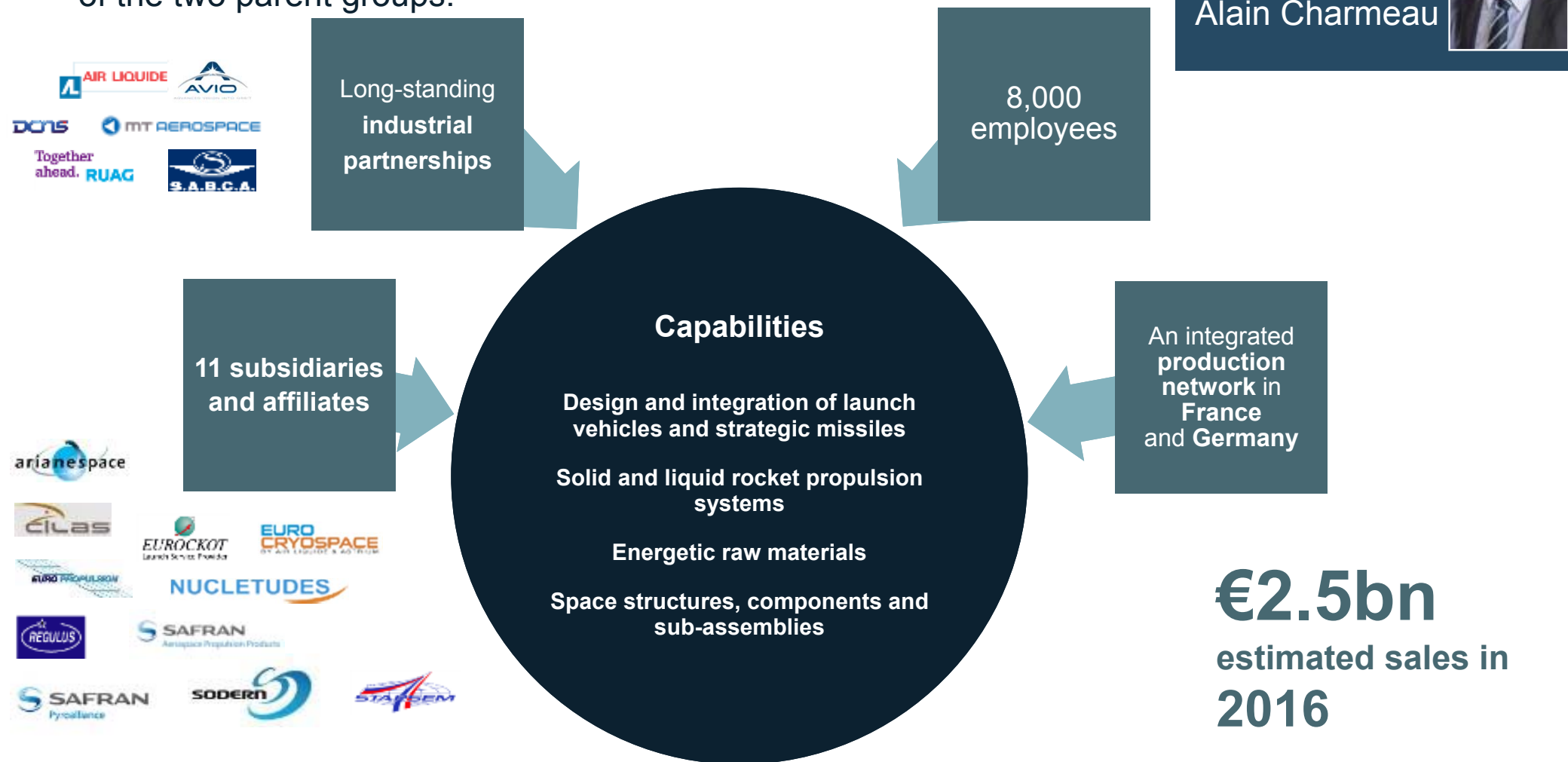
1 / 1 The Company



Created by Airbus Group and Safran as a 50/50 joint company,
Airbus Safran Launchers unites all the assets and skills
of the two parent groups.

CEO

Alain Charmeau



€2.5bn
estimated sales in
2016

1 / 2 The Organization



Our organization:

J

AIRBUS SAFRAN
LAUNCHERS

JO Operations

JOV Vehicle & System Cluster

JOVF Avionics & Flight Control

JOVF1 Electrical Engineering

JOVF18 Electrical Engineering & AIT Support Engineering Upper Stage Avionics



- Procurement & Subcontractor management for avionic equipment
- Support of electrical integration and qualification tests
- Support of A6 development of avionic equipment
- R&T activities for future launcher

1 / 3 The Site

Site Bremen (together with Airbus)

Integration of Ariane 5 **Upper Composite**



containing the Upper Stage
and the **Vehicle Equipment Bay (VEB)**



1 / 4 The Speaker

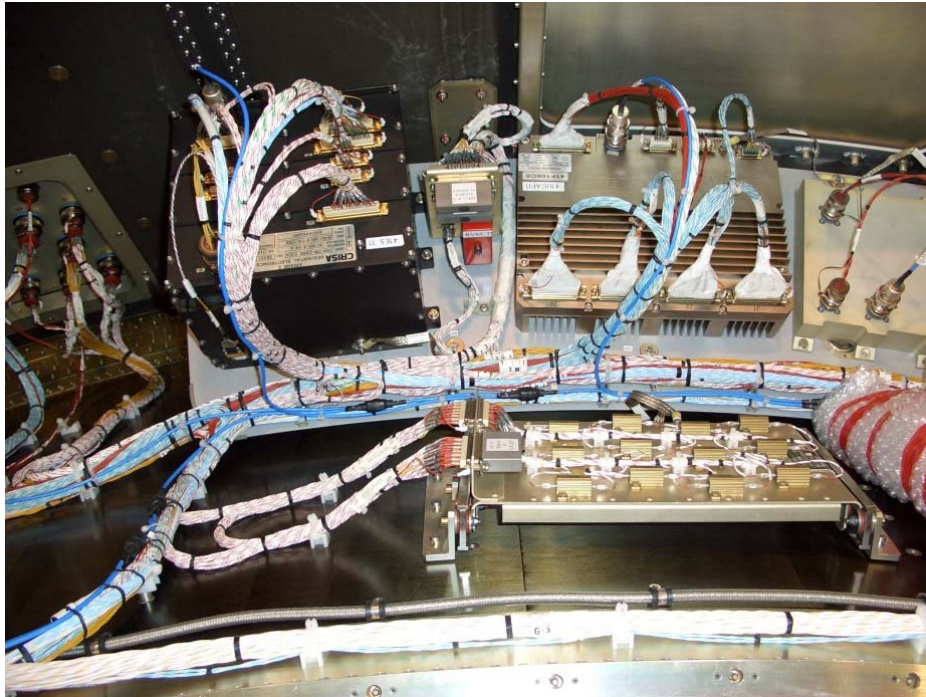


- I am 55 years old, married and live near Bremen
- I am an:
 - Dipl. Ing. Electronics (Communication Engineering)
 - Dipl. Chem.
- I am working with Airbus Safran Launcher
(before Airbus Defence & Space, before Astrium)
since 2009
in the department JOVF18 (Engineering Upper Stage Avionics) in the area of:
 - Electrical Integration Test support (Vehicle Equipment Bay = VEB)
 - Predevelopment of Avionic Subsystems and Technologies
- Before I have been working with
 - Airbus in the area of System Safety and Reliability
 - and in the automotive industry in the area of Software Development



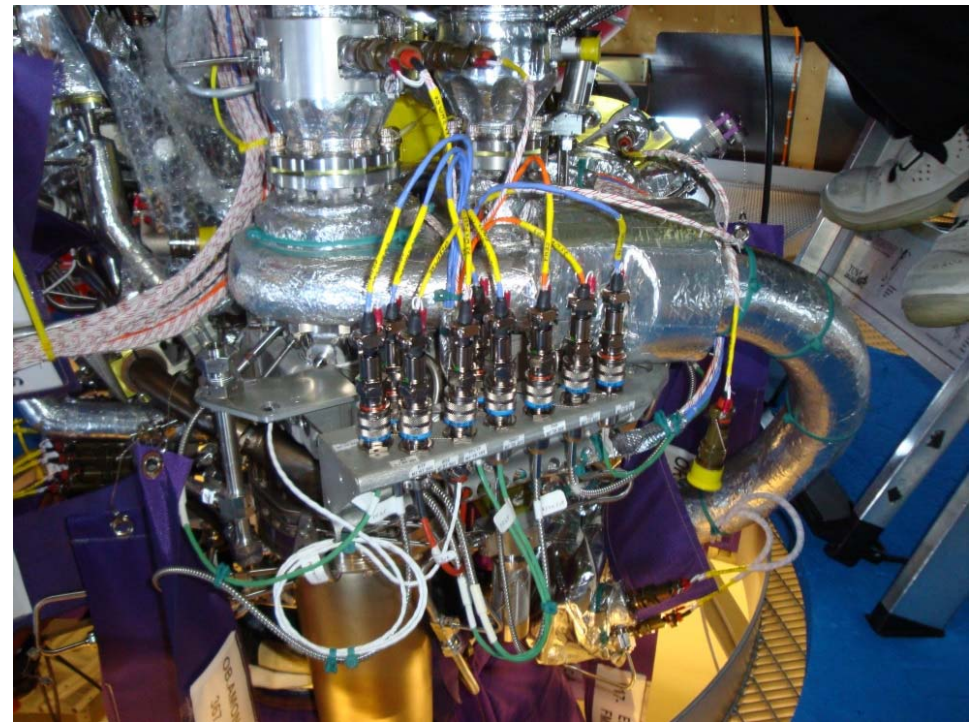
2 Motivation

2 / 1 Current Sensor Acquisition Status in Space

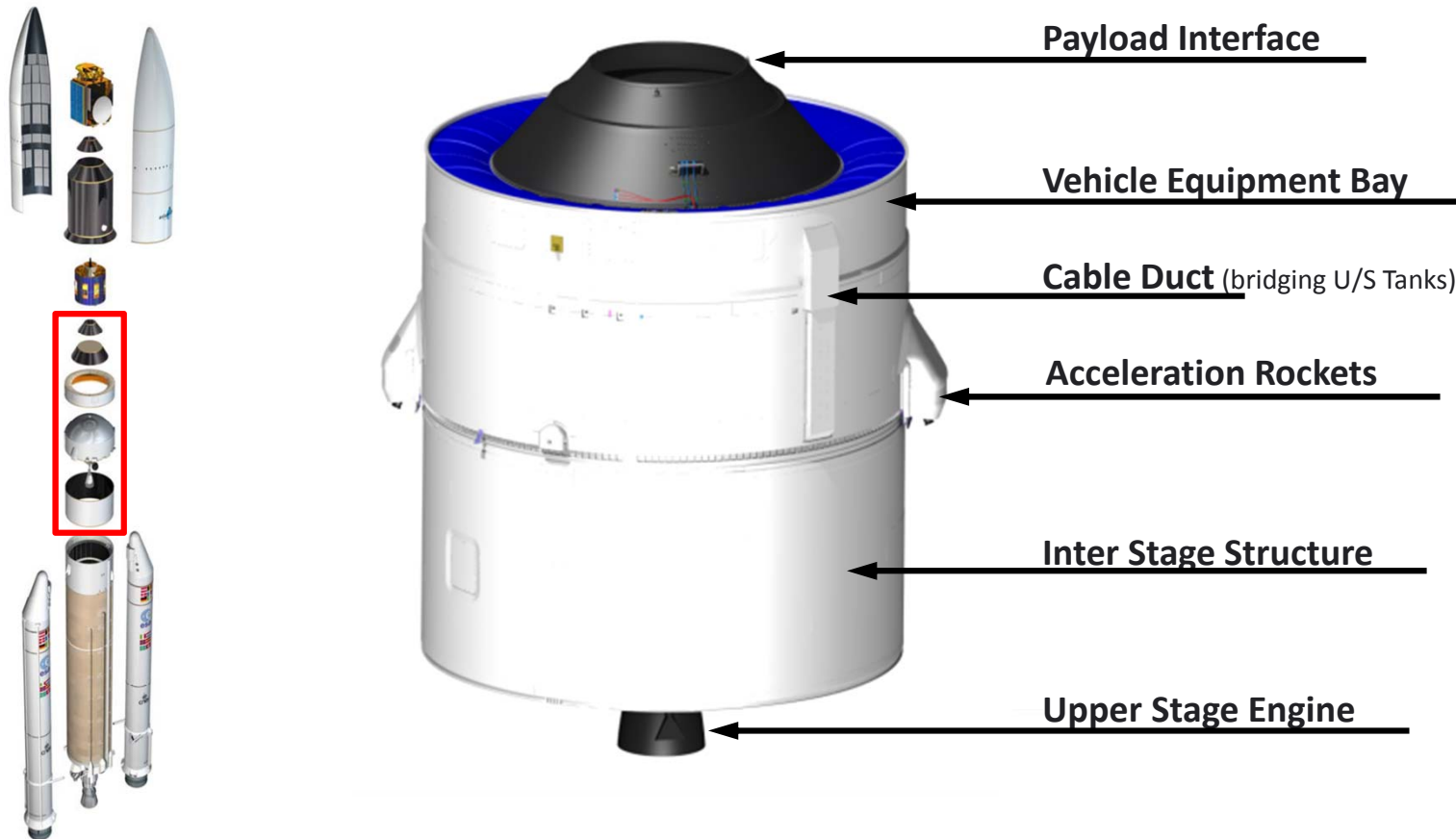


**Ariane 5 ESC-A
Vehicle Equipment Bay**

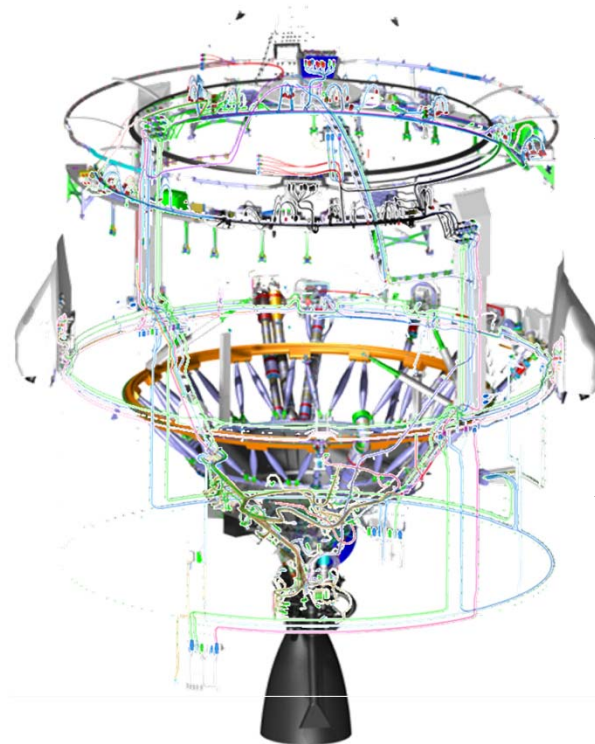
**Ariane 5 ESC-A
Engine Thrust Frame**



2 / 2 Ariane 5 ESC-A Upper Composite



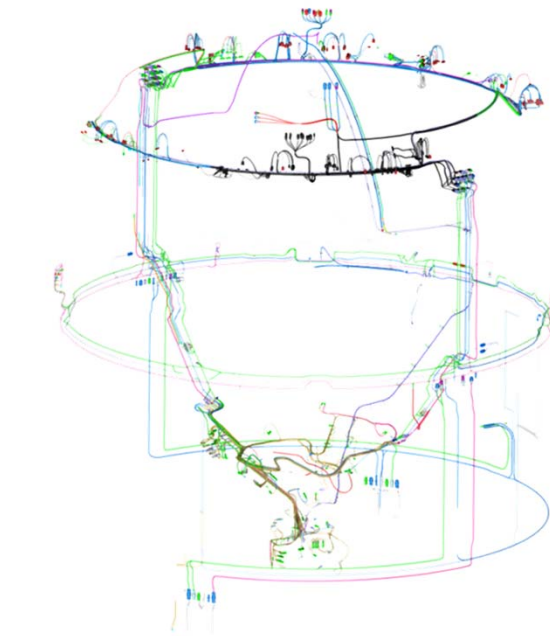
2 / 3 Ariane 5 ESC-A Upper Stage Avionics



**Avionic Equipment Bay
with Batteries**

**Avionic Equipment Box and
Batteries**

2 / 4 Ariane 5 ESC-A Upper Stage Harness



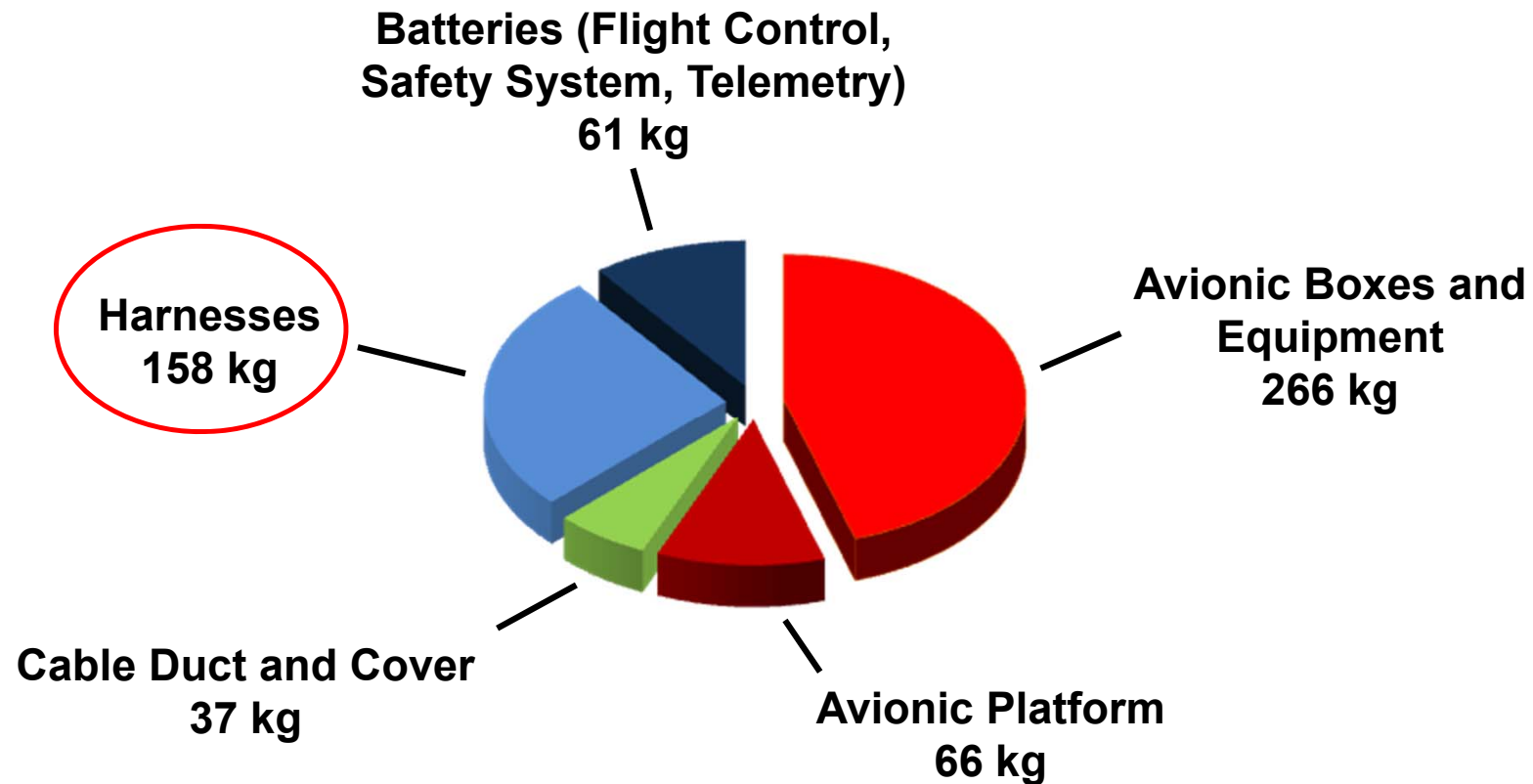
← **Power Harness**

← **Pyro Harness**

← **Equipment Bay Harness**

← **Signal Harness**

2 / 5 Mass Break Down Ariane 5 ESC-A Upper Stage Avionics

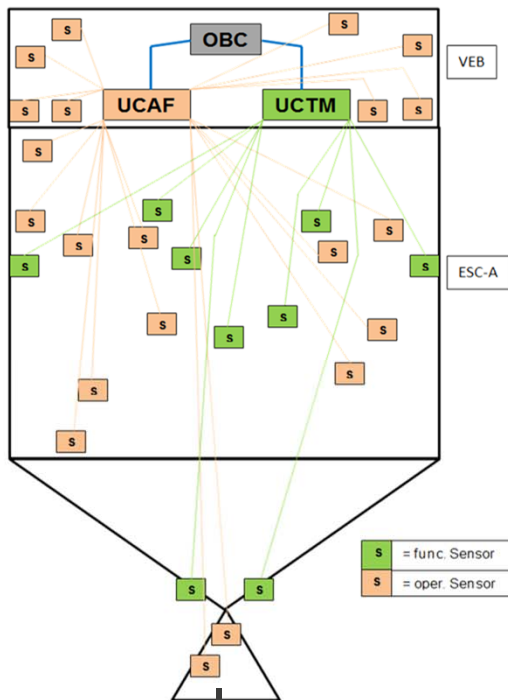


1 kg mass reduction = 1 kg payload increase ≈ 25000 € revenue

2 / 6 Sensor Network Concepts for Launcher Avionics

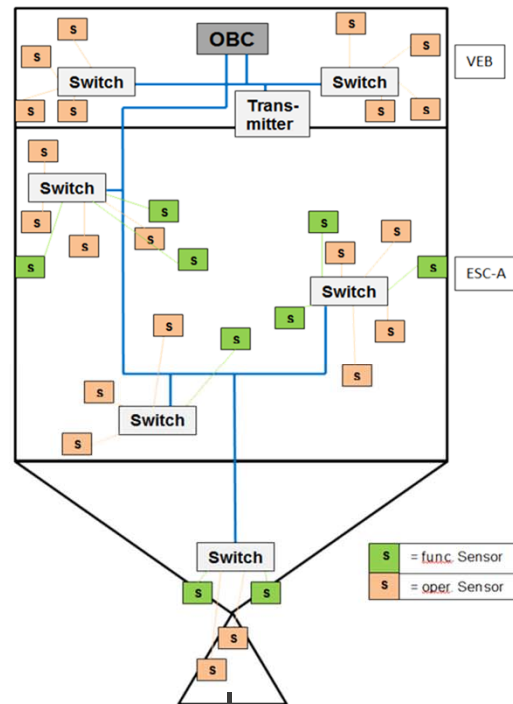


Principle of **centralized** measurement acquisition



**Today
(Ariane 5)**

Principle of **decentralized** measurement acquisition

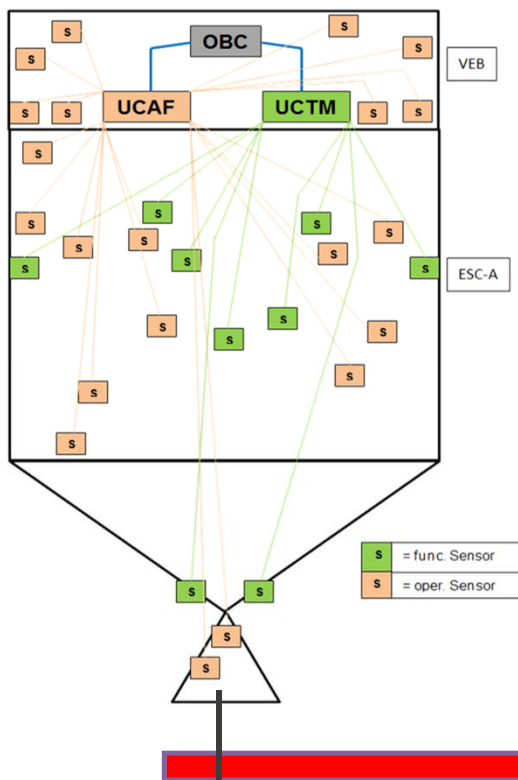


State of the Art

2 / 7 Sensor Network Concepts for Launcher Avionics

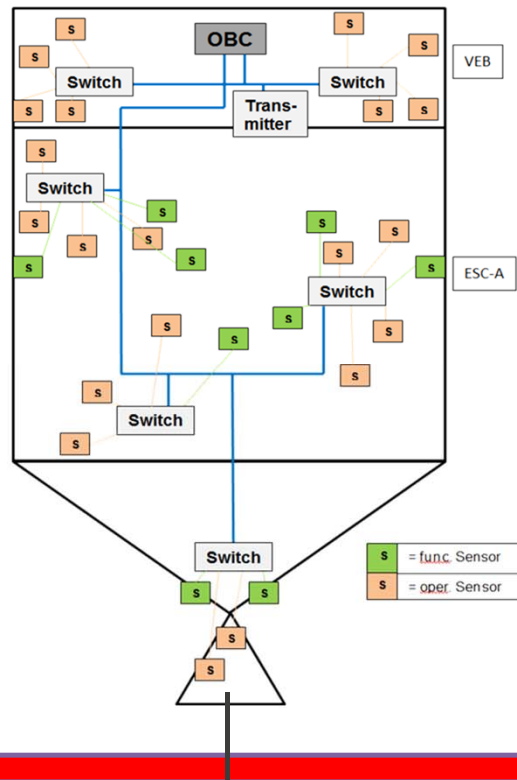


Principle of **centralized** measurement acquisition



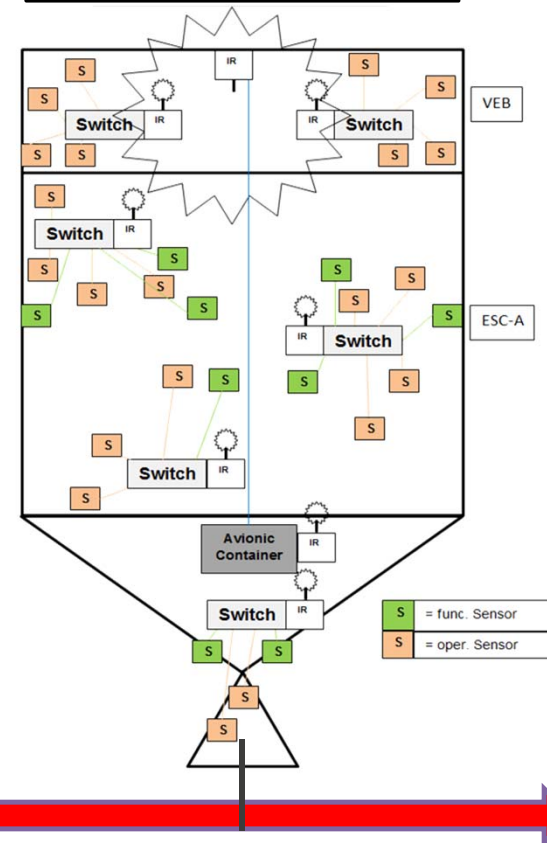
Today
(Ariane 5)

Principle of **decentralized** measurement acquisition



State of the Art

Principle of **wireless** measurement acquisition



Tomorrow



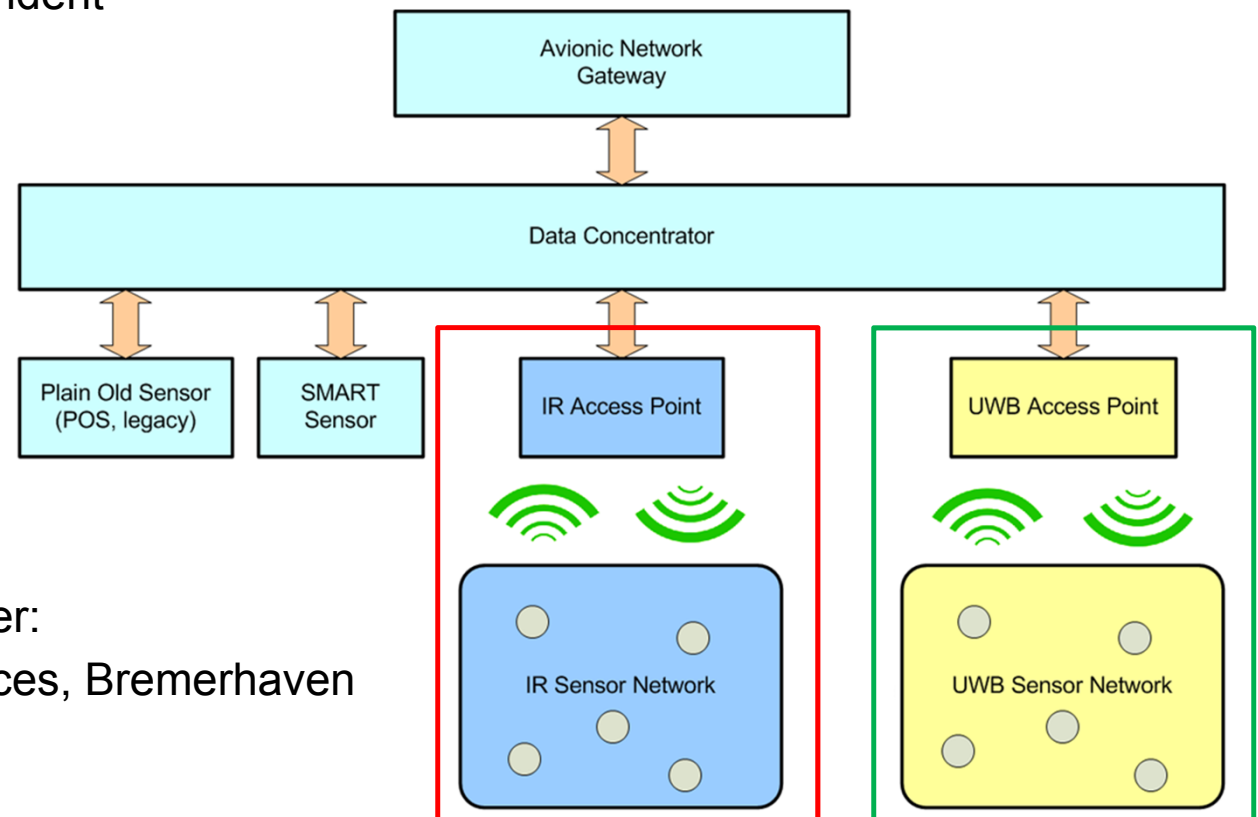
3 Project Setup

3 / 1 Reliable Sensor Network Project Setup



- The Reliable Sensor Network (RSN) project
 - **is funded by the ESA**
 - in the frame of the Future Launchers Preparatory Program (FLPP)
 - and lasts from 2014 to 2016
- RSN is dealing with a **Functional Demonstrator** of an **Avionic Telemetry** subsystem including two dissimilar independent wireless technologies:

- **Ultra-wide Band (UWB)**
- **Infrared (IR)**



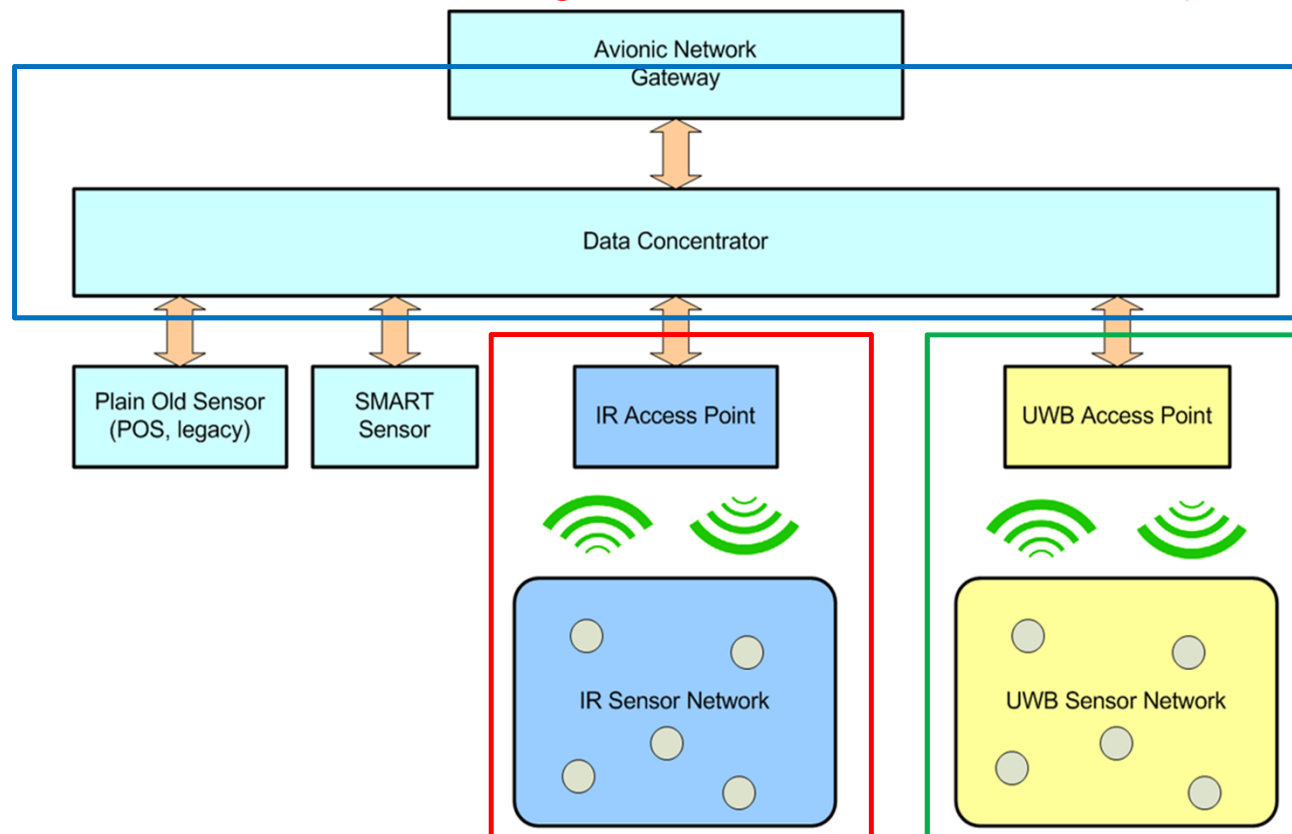
- Airbus Safran Launcher acts as the project leader with the following project partner:
 - University of Applied Sciences, Bremerhaven
 - University Bremen
 - IMEC, Netherlands



4 Technologies

4 / 1 The RSN architecture

- 100 Mbit/s Real Time POWERLINK Network (Ethernet based), Data Concentrators and the Avionic Gateway developed by University of Applied Science Bremerhaven hosting two dissimilar independent wireless technologies:
 - Ultra-wide Band (UWB) according IEEE 802.15.4a (Impulse Radio) developed by IMEC
 - Infrared wireless communication developed by University Bremen (see talk “Low Power ASIC Design for Infrared Sensor Network”)



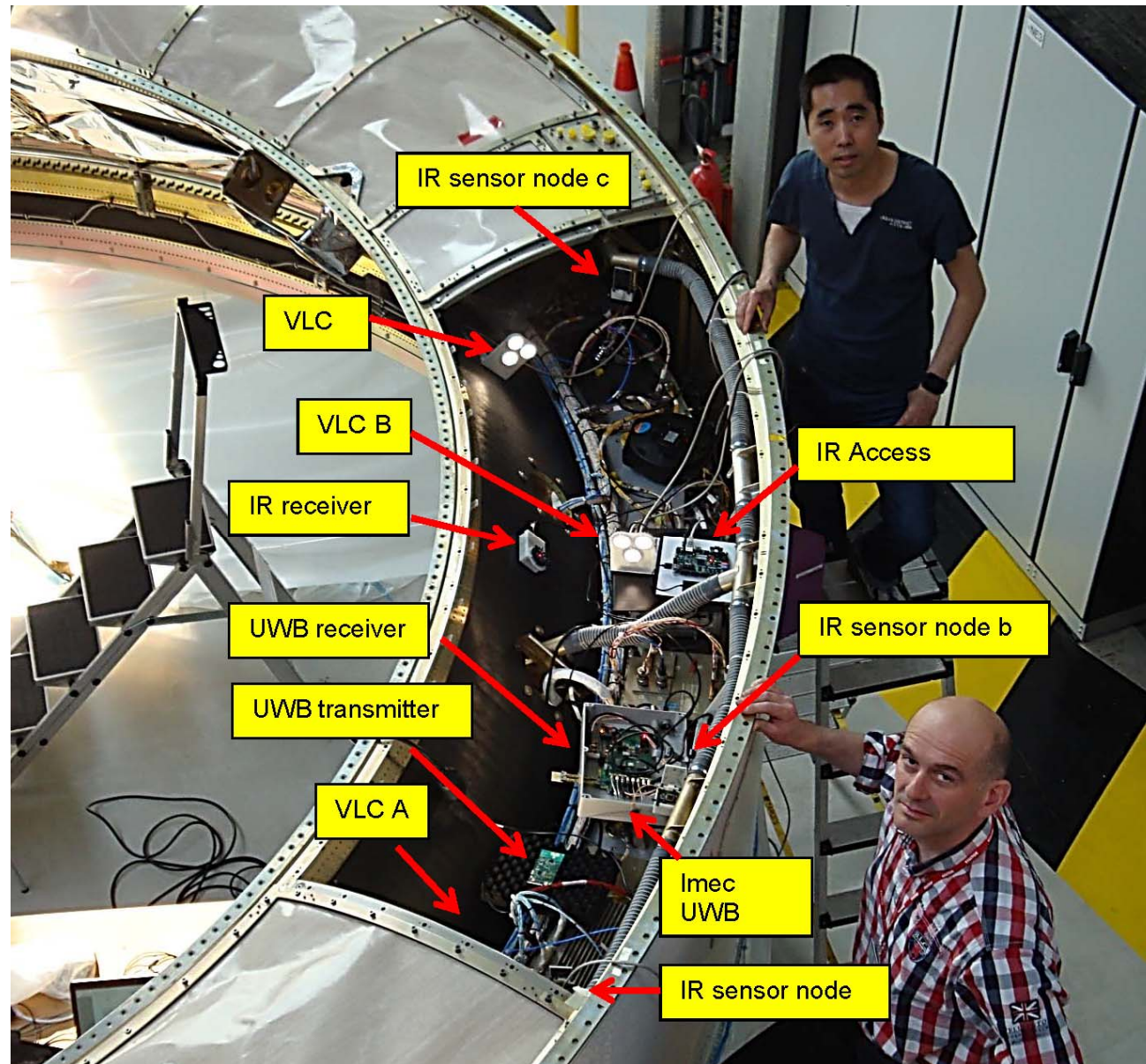


5

First Results

5 / 1 Wireless campaign inside the VEB

- Test Setup inside the VEB
(Wireless Subsystems only)





- UWB Subsystem
 - Packet Error Rates are close to zero (max 0,08%) for a data rate of 110 kbit/s
 - Only at one of four sensor positions packet errors occur at all
- Infrared Subsystem
 - Line of Sight (LOS) communication without error for a data rate of 9600 bit/s
 - Non Line of Sight (NLOS) communication with large obstacles (tanks) in between are not possible
however
NLOS communication is possible using MLI reflections, see [1].

[1] "Bit-Error-Rate Measurement of Infrared Physical Channel using reflection via Multi Layer Insulation inside in Ariane 5 Vehicle Equipment Bay for Wireless Sensor Network communication", Hendra Kesuma, Awais Ahmed, Steffen Paul, Johannes Sebald, IEEE International Conference on Wireless for Space and Extreme Environments 2015



6 Outlook



- Second test campaign (complete system) will start beginning of October 2016
- Ariane 6 Business Cases for wireless technologies have been established
- Some Cases are promising and currently under discussion with the Ariane 6 Project
- Further development activities necessary for industrialization of technologies



7

Conclusions

7 / 1 What is important



- High potential for replacement of sensor wiring by wireless technologies
- Dissimilar wireless technologies (UWB and Infrared) under investigation
- Feasibility of both wireless technologies shown inside electromagnetic flight representative environment of Ariane 5
- Further effort necessary for industrialization (Radiation Environment!)

Thank you for your attention!



Height	up to 56 m
Diameter	5.4 m
Mass	770 000 kg
Stages	2

Payload to	ES*:	20,000 kg
	<u>LEO</u>	
	260 km	

Payload to	ECA**:	10,800 kg
	<u>GTO</u>	
	36000 km	

*ES
Storable Propellant
(Hydrazine/ N_2O_4)
re-ignitable

**ECA
Cryogenic stage
 LOx/LH_2

For the curious: “Ariane 5 User’s Manual”:

http://www.arianespace.com/wp-content/uploads/2015/09/Ariane5_users_manual_Issue5_July2011.pdf