



Reliable Sensor Network

A heterogeneous sensor acquisition architecture for future European launcher

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28th of September 2016

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

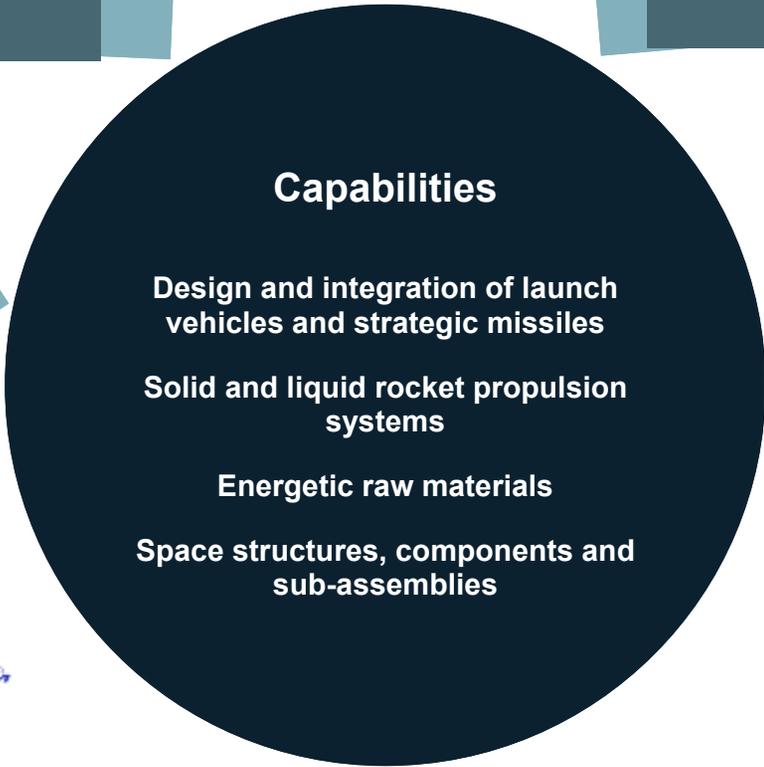


Long-standing industrial partnerships

8,000 employees

11 subsidiaries and affiliates

An integrated production network in France and Germany

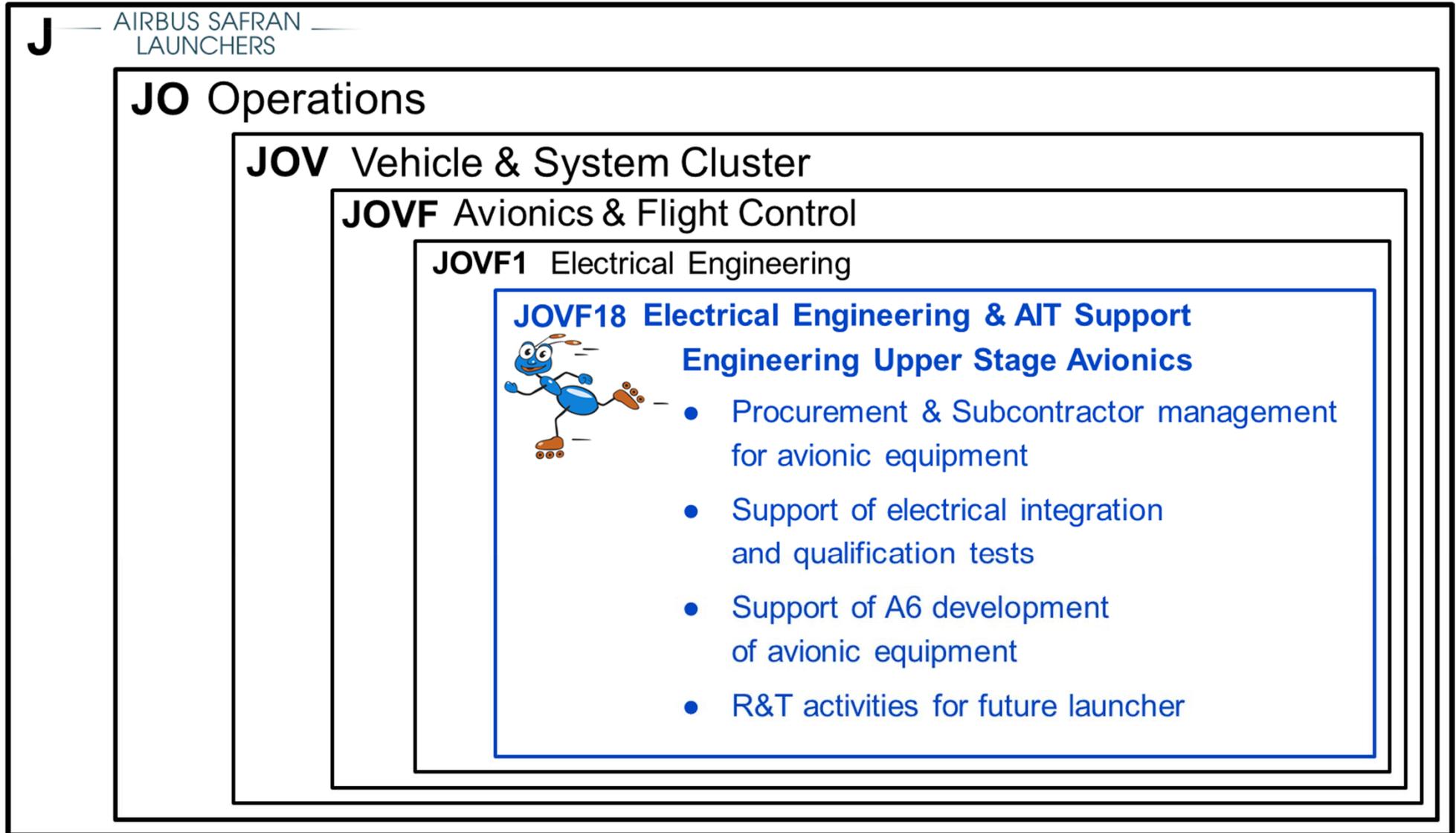


€2.5bn
estimated sales in
2016





Our organization:



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

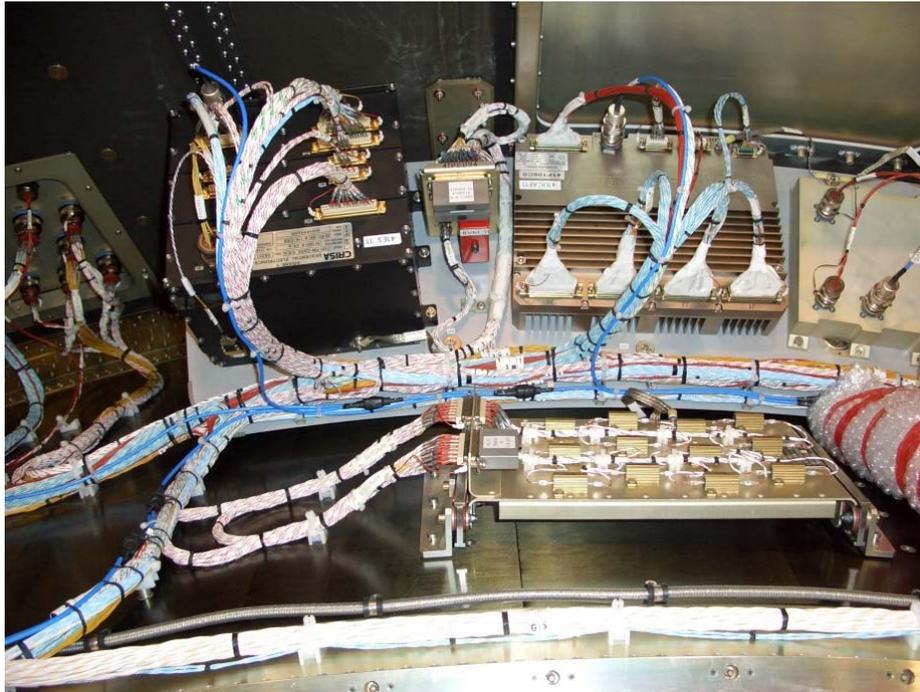


- I am 55 years old, married and live near Bremen
- I am an:
 - Dipl. Ing. Electronics (Communication Engineering)
 - Dipl. Chem.
- I am working with Airbus Safran Launcher
(before Airbus Defence & Space, before Astrium)
since 2009
in the department JOVF18 (Engineering Upper Stage Avionics) in the area 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



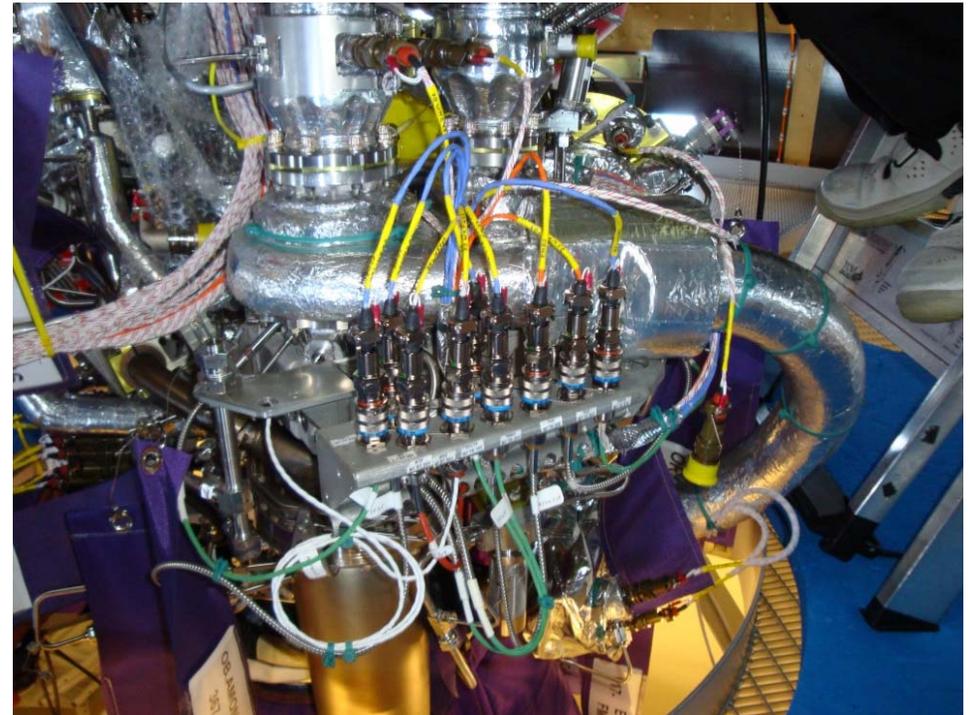
2 Motivation

2 / 1 Current Sensor Acquisition Status in Space

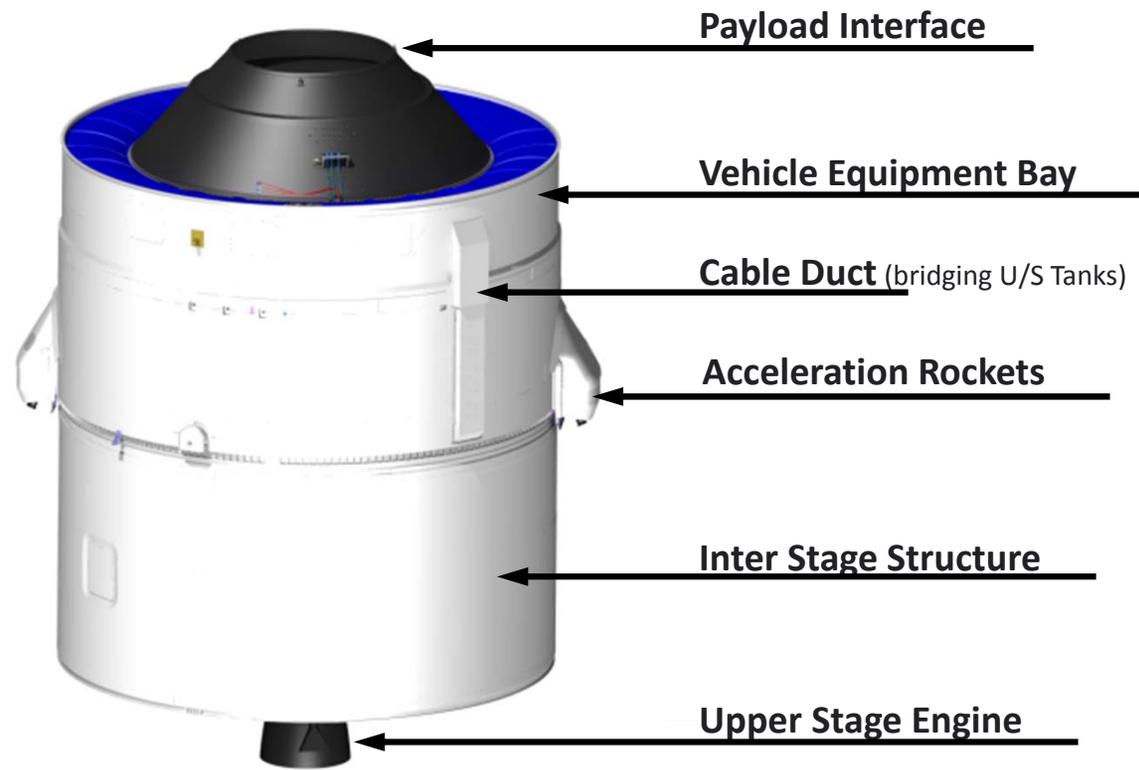


← Ariane 5 ESC-A
Vehicle Equipment Bay

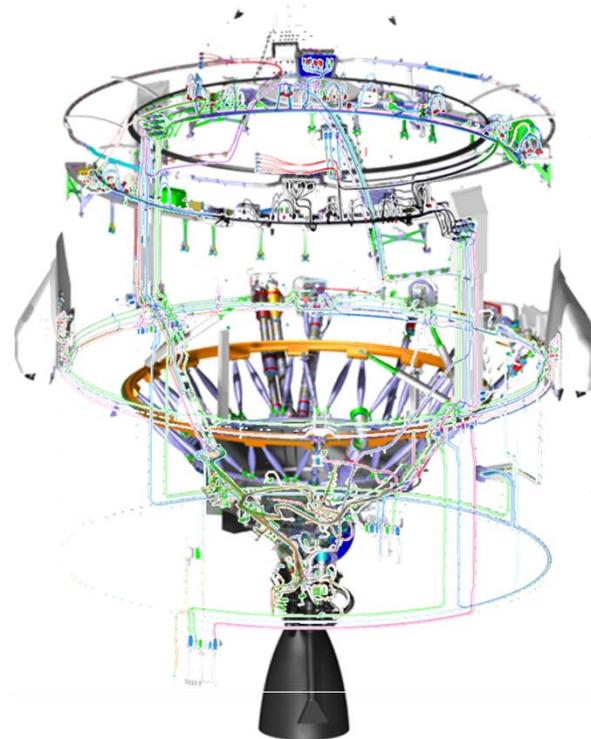
Ariane 5 ESC-A
Engine Thrust Frame



2 / 2 Ariane 5 ESC-A Upper Composite



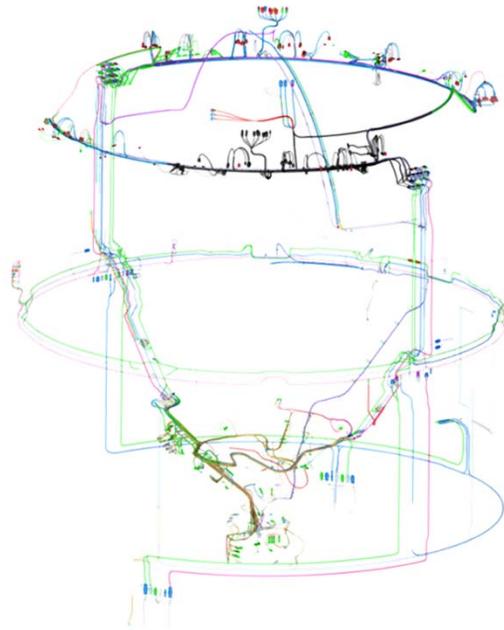
2 / 3 Ariane 5 ESC-A Upper Stage Avionics



**Avionic Equipment Bay
with Batteries**

**Avionic Equipment Box and
Batteries**

2 / 4 Ariane 5 ESC-A Upper Stage Harness



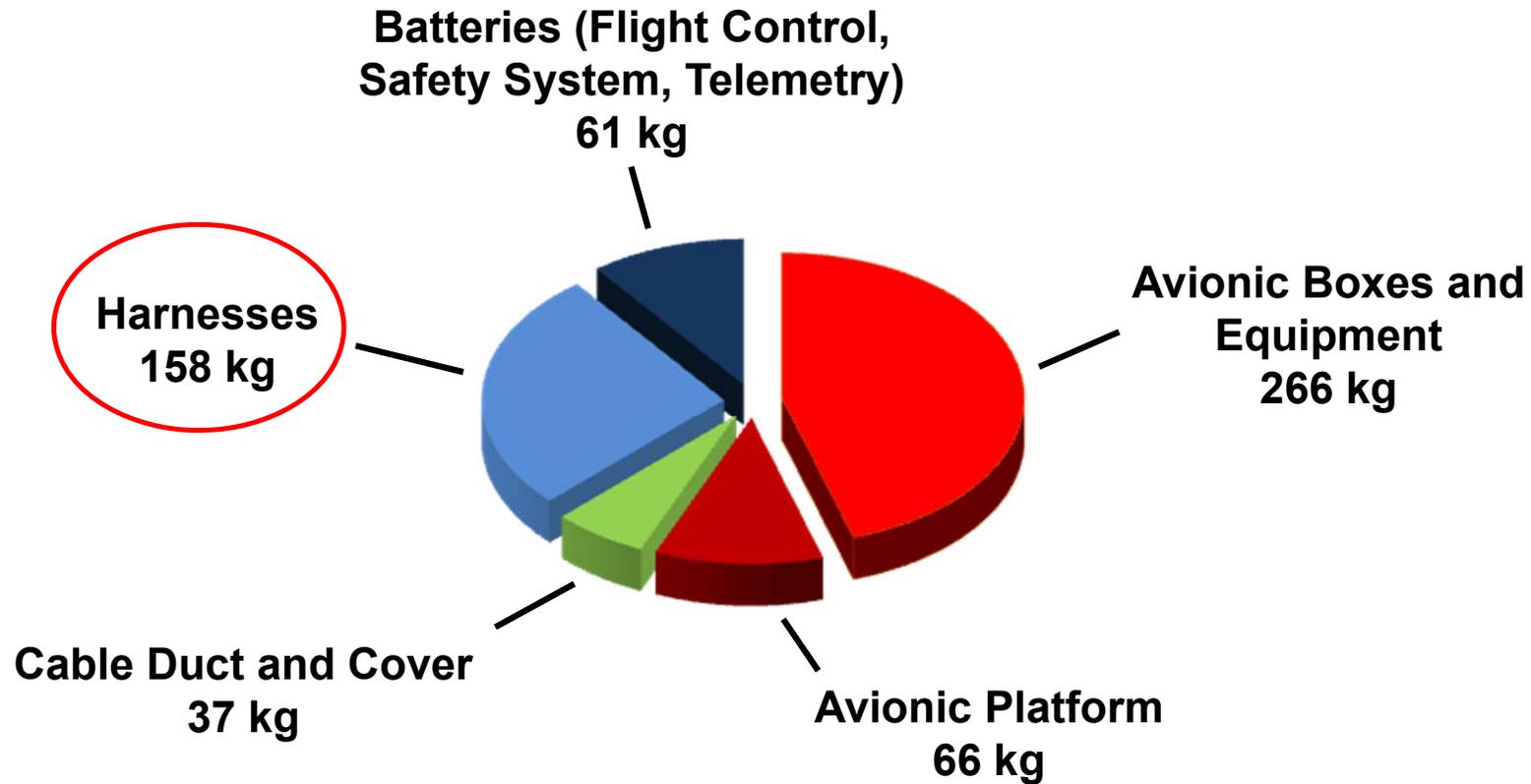
← **Power Harness**

← **Pyro Harness**

← **Equipment Bay Harness**

← **Signal Harness**

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

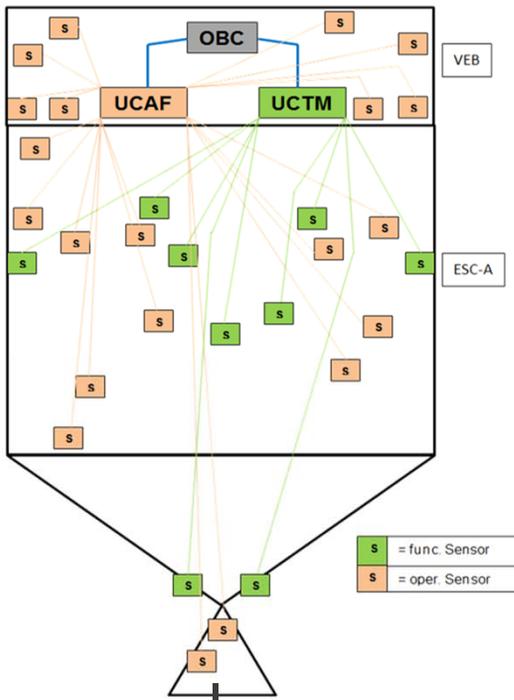


1 kg mass reduction = 1 kg payload increase ≈ 25000 € revenue

2 / 6 Sensor Network Concepts for Launcher Avionics

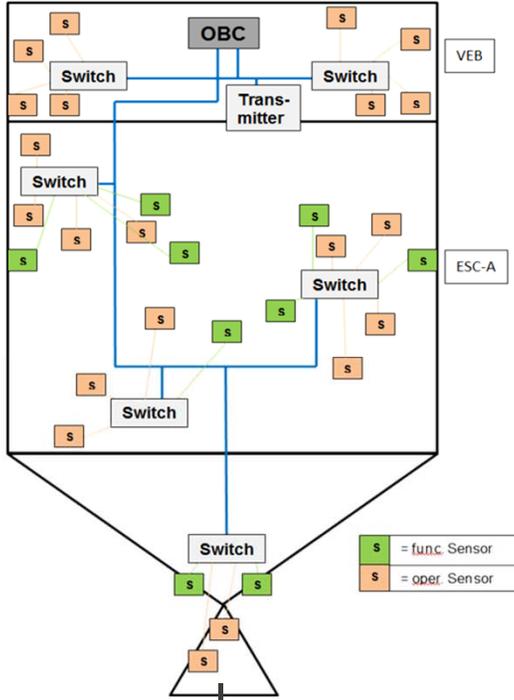


Principle of **centralized** measurement acquisition



**Today
(Ariane 5)**

Principle of **decentralized** measurement acquisition



State of the Art



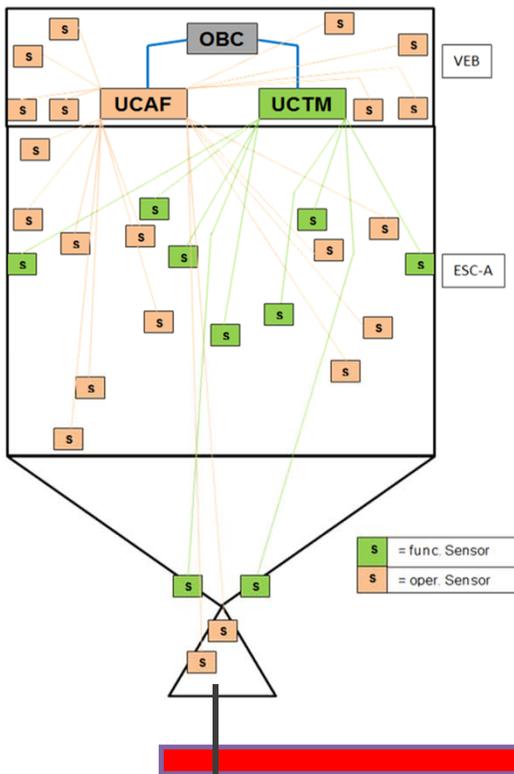
s = func. Sensor
s = oper. Sensor

s = func. Sensor
s = oper. Sensor

2 / 7 Sensor Network Concepts for Launcher Avionics

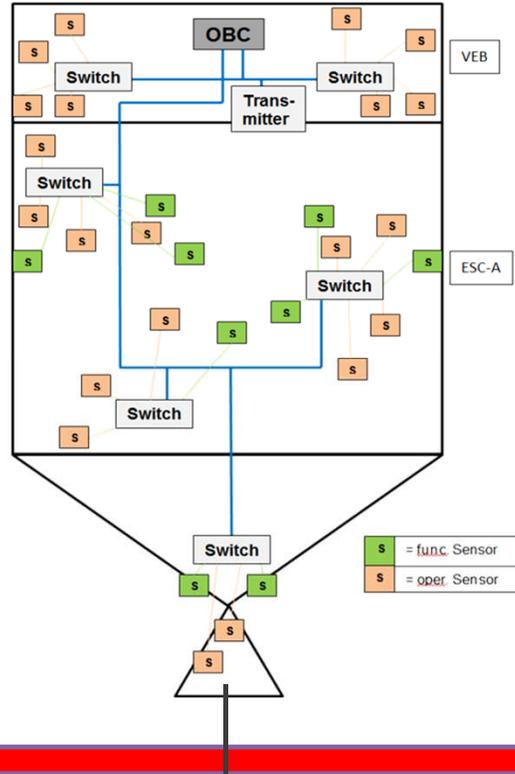


Principle of **centralized** measurement acquisition



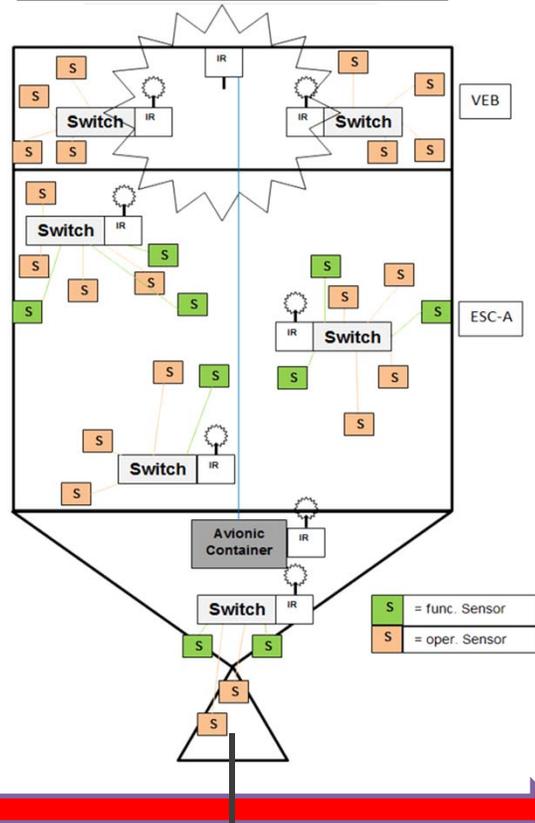
Today
(Ariane 5)

Principle of **decentralized** measurement acquisition



State of the Art

Principle of **wireless** measurement acquisition



Tomorrow





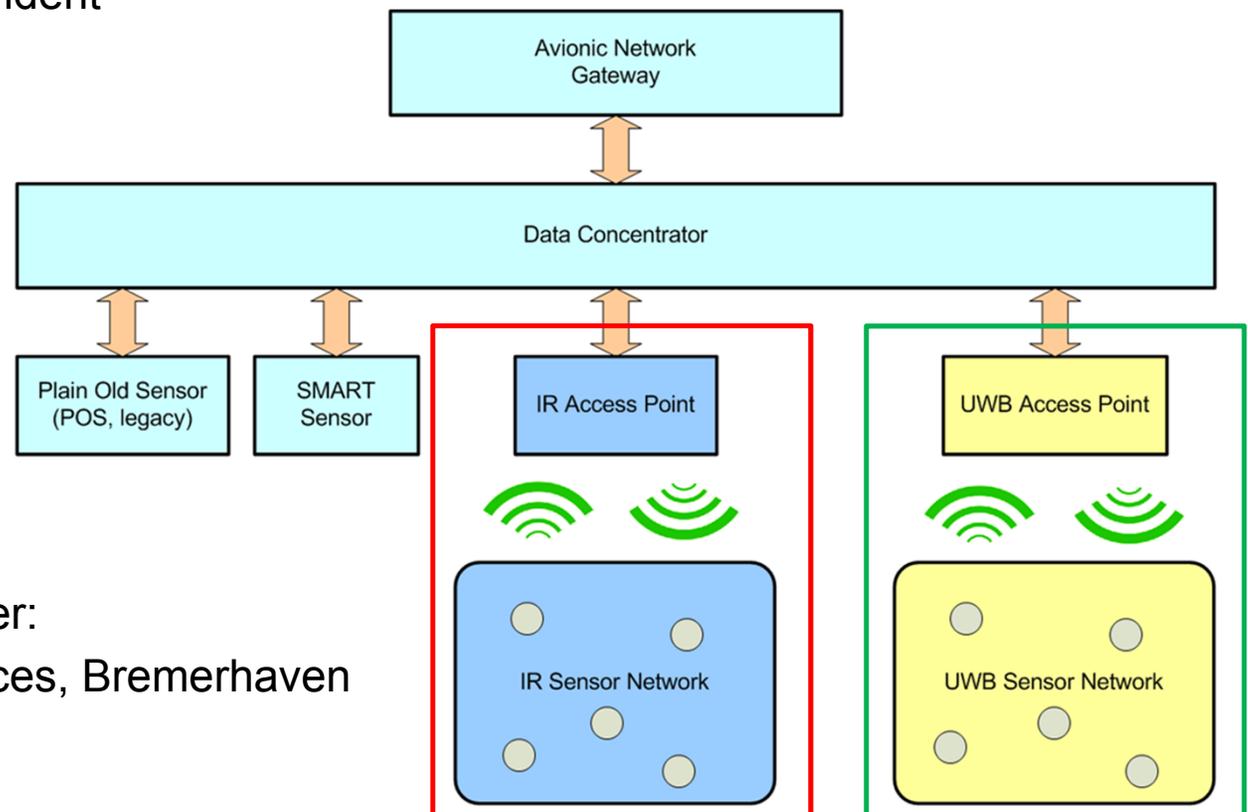
3 Project Setup

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

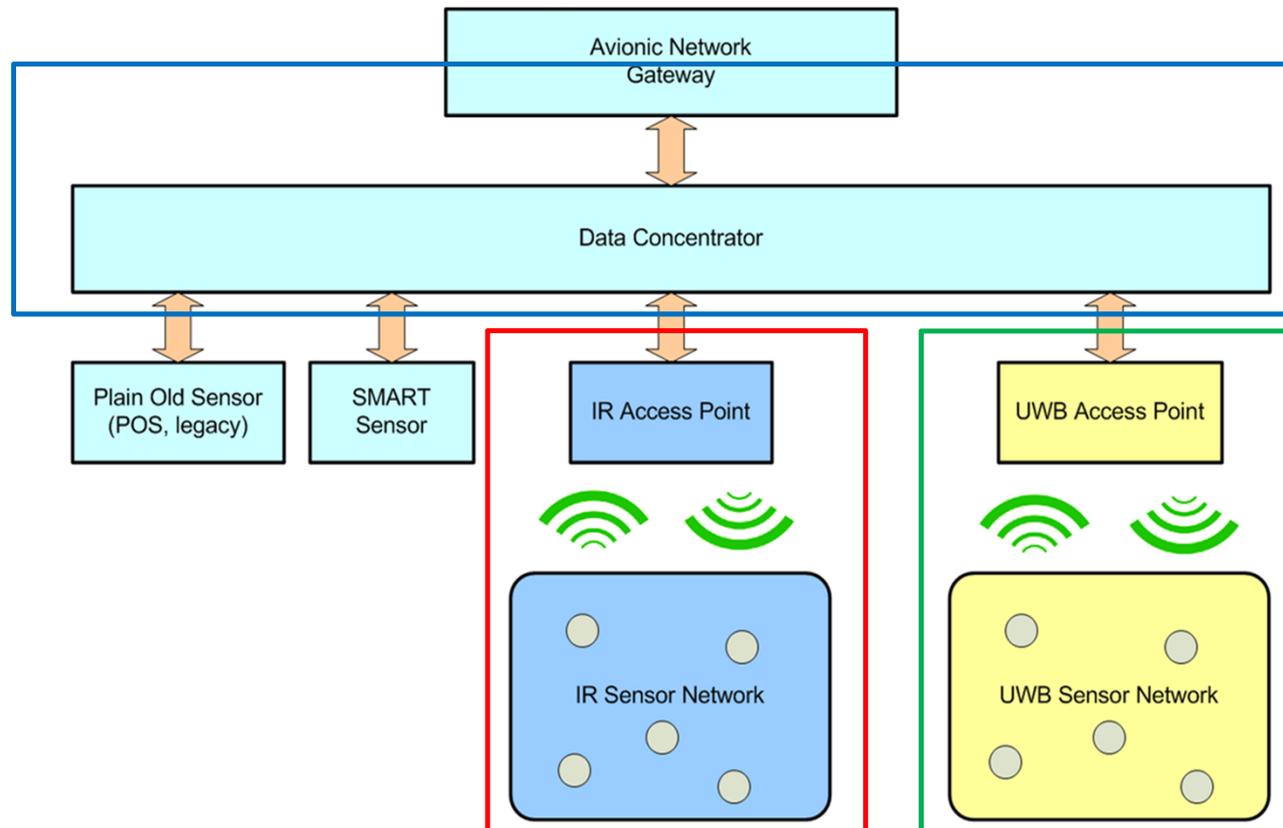


4 Technologies

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”)

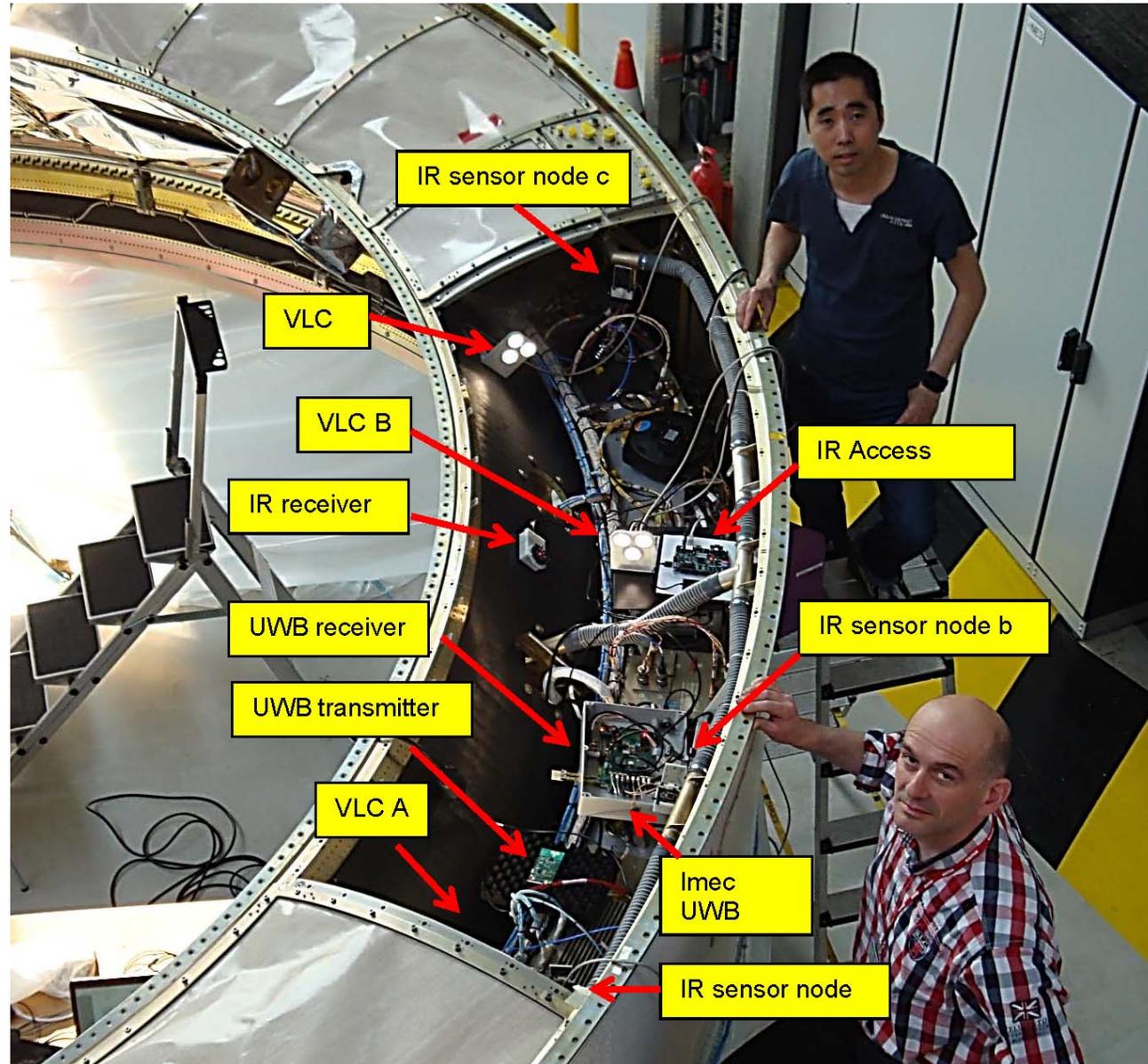




5 First Results

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

6 / 1 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 <u>LEO</u>	ES* : 20,000 kg
260 km	

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

*ES
Storable Propellant
(Hydrazine/N₂O₄)
re-ignitable

**ECA
Cryogenic stage
LOx/LH₂

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

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