H2020 Space Robotic SRC- OG4
I3DS: Integrated 3D Sensor Suit for On-Orbit Servicing

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« Smart Sensors for Smart Missions »

Context

I3DS (Integrated 3D Sensors) is one the key building block (Operational Grant 4) developed in the frame of the Strategic Research Cluster (SRC) on Space Robotics technologies Horizon 2020 Space call 2016 to enhance the EU industry competitiveness in space robotics

I3DS project gathers 10 partners all around Europe

Outline

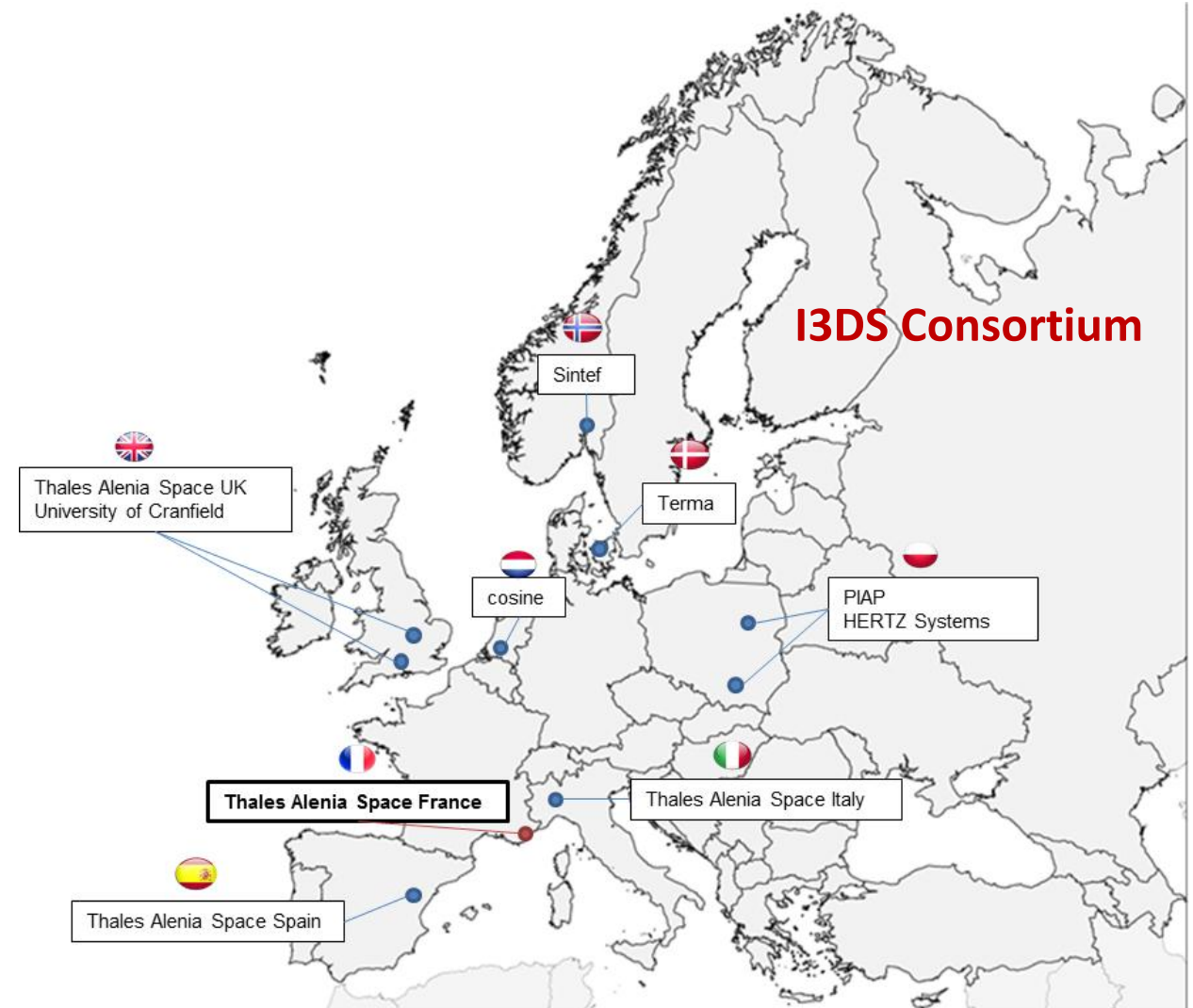□ **General Presentation of I3DS**
- **Context**
- **I3DS Definition**

□ **Work Logic**
- **Use case definition**

□ **Design of I3DS**

□ **Interfaces**

□ **Conclusion & Q&A**

I3DS Consortium

Sintef

Thales Alenia Space UK
University of Cranfield

Terma

cosine

PIAP
HERTZ Systems

Thales Alenia Space France

Thales Alenia Space Italy

Thales Alenia Space Spain

Objectives

- ☐ **Design a generic sensors suite to answer the needs of near-future space exploration missions**

- ☐ **Integrate into a harmonised and modular suite of sensors with a common interface**

- ☐ **Develop a suite of perception sensors for both orbital and planetary applications**

I3DS is a inspector sensors suite with integrated pre-processing and data concentration functions.

I3DS Objectives

❑**Modular approach:**
- **Inter-changeable items**
- **Scalable design**
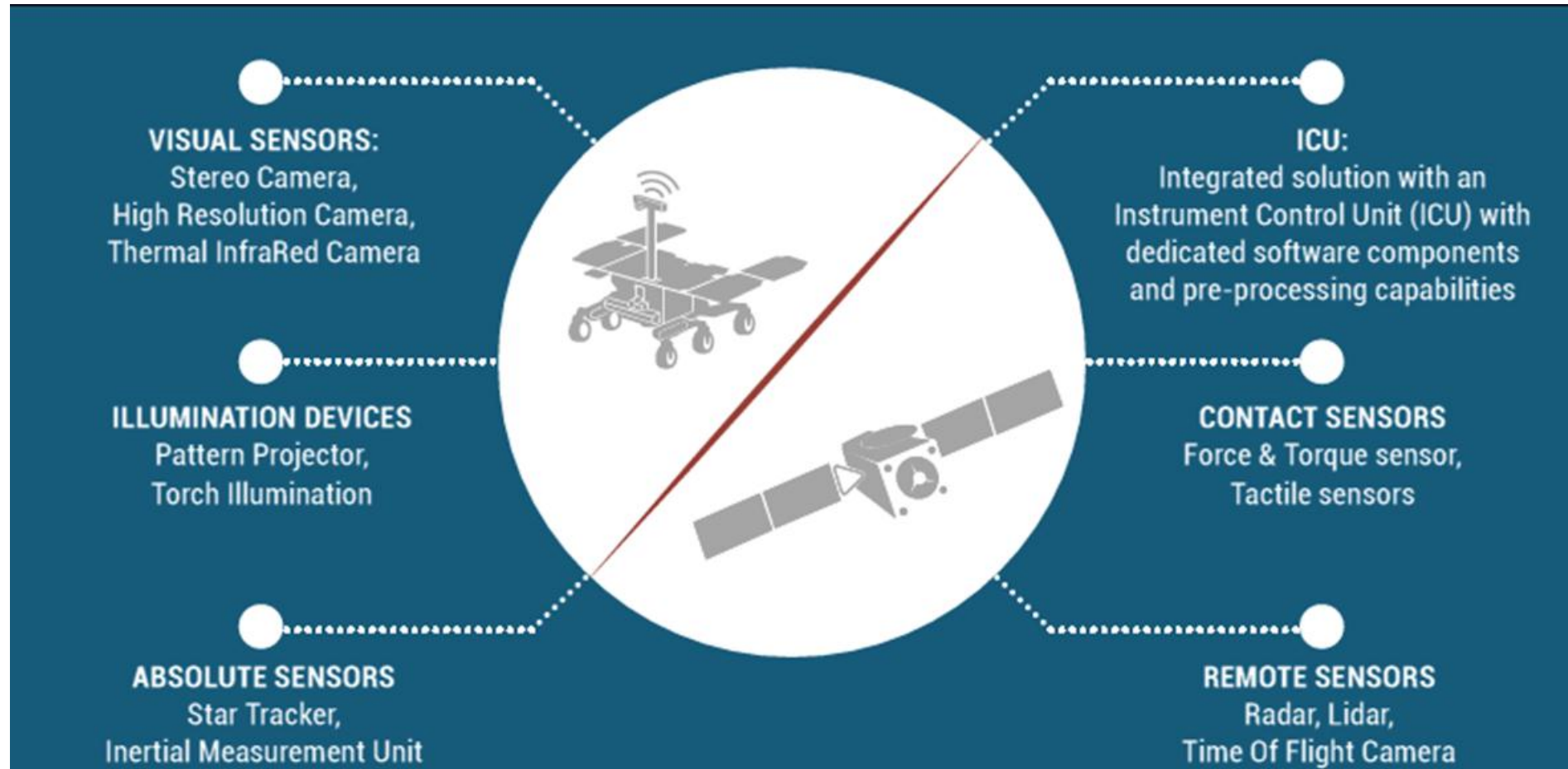- **Standard I/F vs satellite/rover platform**
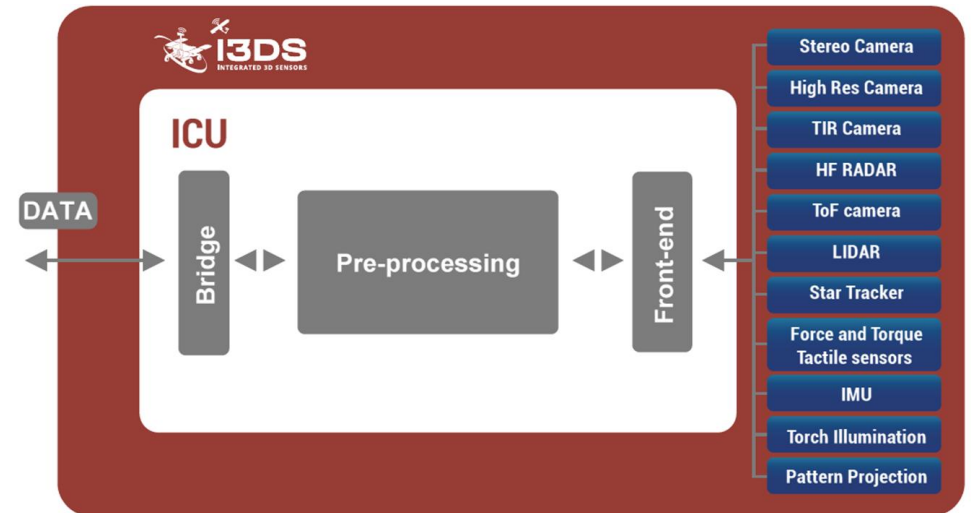
❑**Realise a suite of perception sensors for both orbital and planetary applications that will allow localisation and map-making for robotic inspection of orbital assets and for planetary surface exploration**
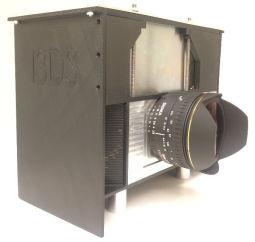
❑**Subsets to be defined according to the application:**
- **Planetary mission: rover**
- **Non-cooperative target capture: debris removal**
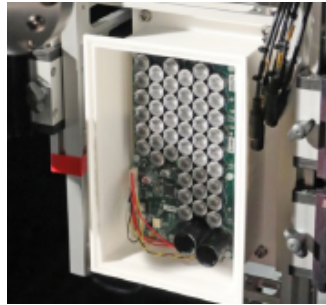- **Cooperative rendezvous: servicing, spacetug**
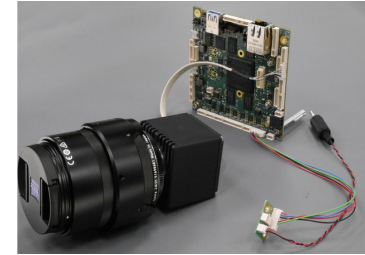
I3DS: Integrated 3D Sensors
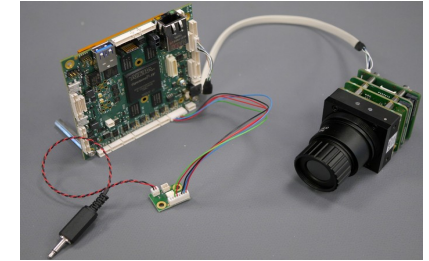

VISUAL SENSORS:
Stereo Camera,
High Resolution Camera,
Thermal InfraRed Camera

ILLUMINATION DEVICES
Pattern Projector,
Torch Illumination

ABSOLUTE SENSORS
Star Tracker,
Inertial Measurement Unit

ICU:
Integrated solution with an
Instrument Control Unit (ICU) with
dedicated software components
and pre-processing capabilities

CONTACT SENSORS
Force & Torque sensor,
Tactile sensors

REMOTE SENSORS
Radar, Lidar,
Time Of Flight Camera

Sensors

Pattern Projector

Wide Angle Illumination
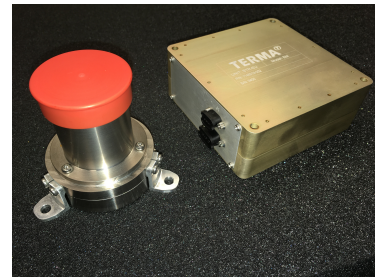

Stereo Camera

High Resolution Camera

Thermal InfraRed Camera
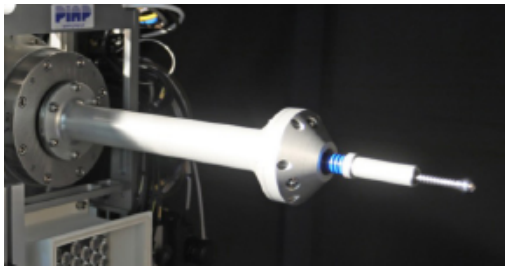
Force/Torque Tactile sensors

Star Tracker

**Lidar**
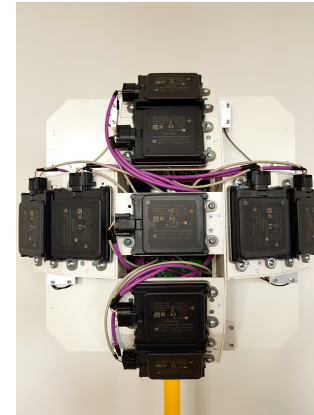
High Frequency Radar

Time Of Flight Camera

Inertial Measurement Unit

I3DS Instrument Control Unit

□ **Provides the primary interface between the I3DS sensor suite and the on-board computer responsible for data fusion and mission control**

□ **Hosts I3DS software components of the system :**

- **pre-processing of imaging streams**
- **the sensor interfaces for controlling and accessing the sensors**
- **the system interface for receiving commands and sending data to the OBC**
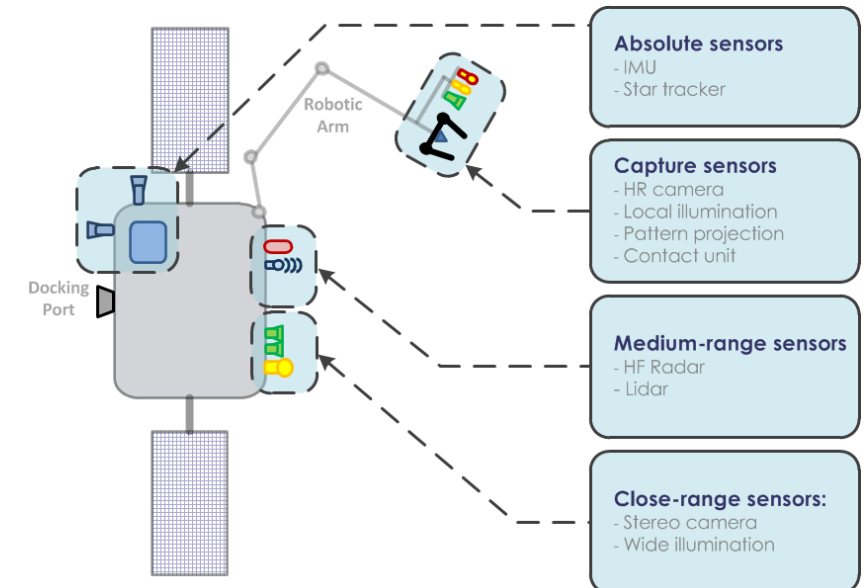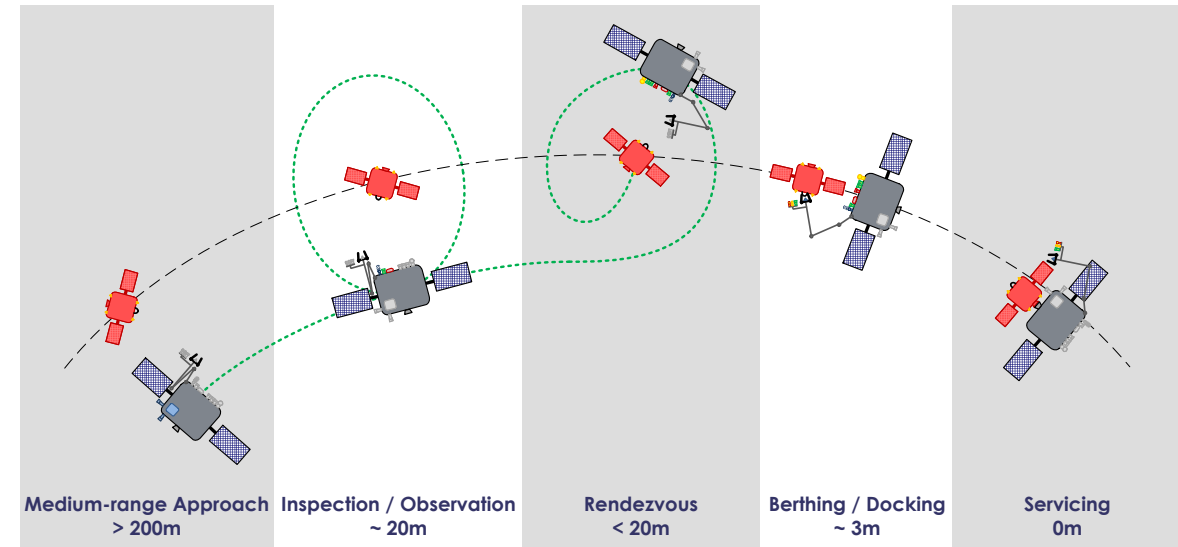- **and the real-time operating system.**
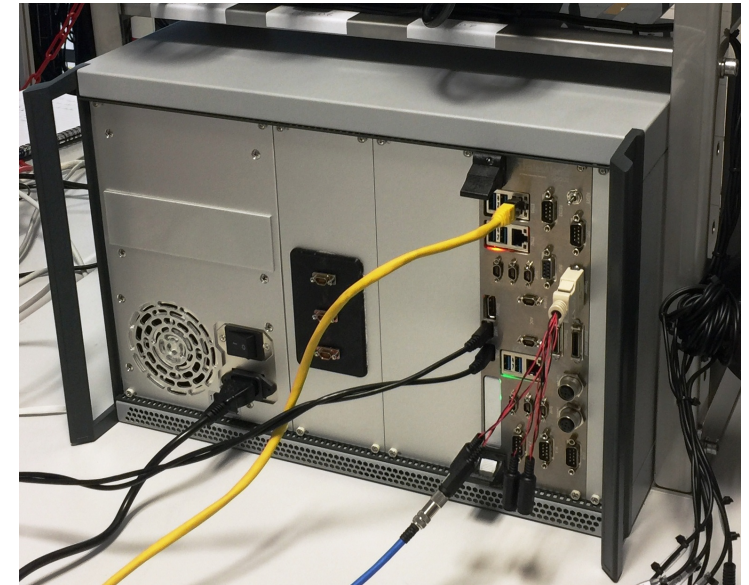
Use-case definition

□ **Details Available in D1.2**
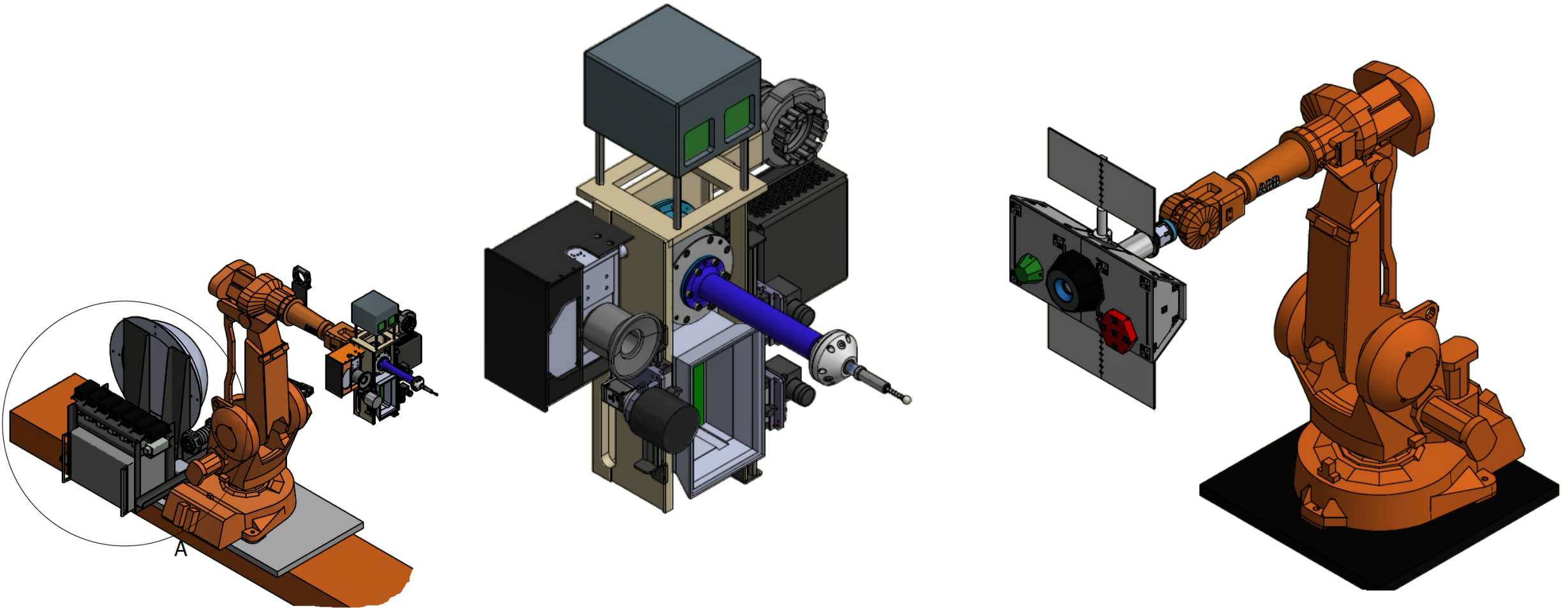
□ **Orbital use-case**
□ **Sensors chosen using their ranges**
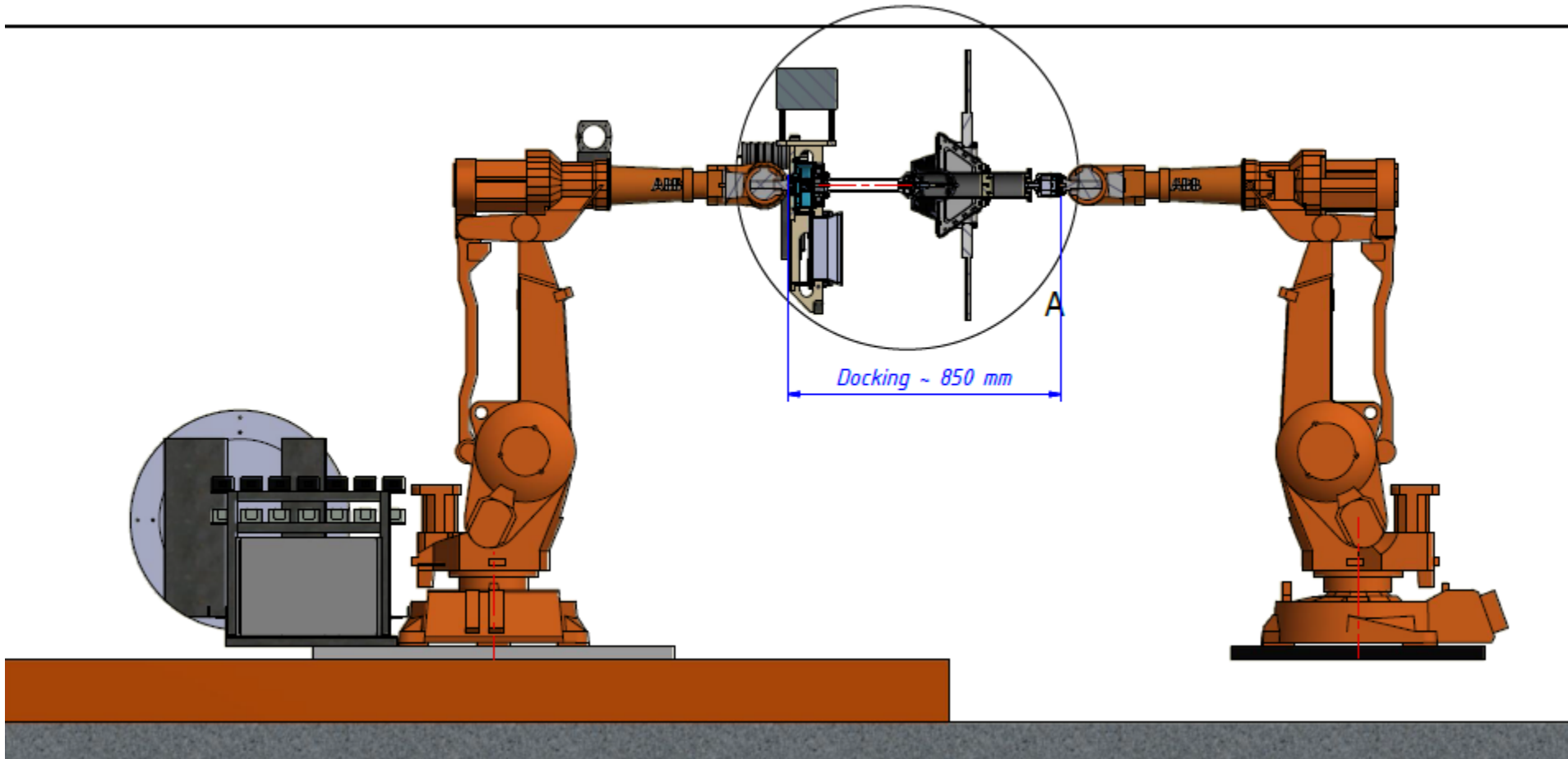□ **Missions Phases**

- **Step 1: Inertial Navigation / Drifting orbit**
- **Step2: Far-range acquisition of the target**
- **Step3: Inspection of the target**
- **Step4: Final Approach + Tracking**
- **Step5: Capture**
- **Step5-bis: Emergency manoeuver**

Orbital Suite

Orbital Suite

Docking ~ 850 mm

I3DS Software

❑ **The software components of the system are** pre-processing of imaging streams, **the sensor interfaces for** controlling and accessing the sensors, **the system interface for** receiving commands and sending data to the OBC, **and the** real-time **operating system.**

❑ **Sensor interface classes independent of sensor hardware**
  ▪ **Classes for camera, ToF, LIDAR, radar, IMU, star tracker and analogue**
  ▪ **Each class defines measurements and commands**
  ▪ **ASN.1 definitions developed and compiled using TASTE tools**

❑ **Multiple ICU's and standalone smart sensors**
  ▪ **Not bound to having all sensors connected to single ICU**
  ▪ **Smart sensors can also be pluggable with OG5**

❑ **Modes associated to command I3DS taking into account the throughput of the sensors**

❑ **Parameterised modes depending on the sensors class**
  ▪ **Set the framerate, the image format, the area of interest, the exposure time, activate/deactivate the illumination devices, trigger single image acquisition**

I3DS pre-processing capabilities

❑**For all the cameras: Stereo Camera, HR Camera and TIR Camera**

- ▪ **Vignetting Correction**
- ▪ **Optical Distortion Correction**
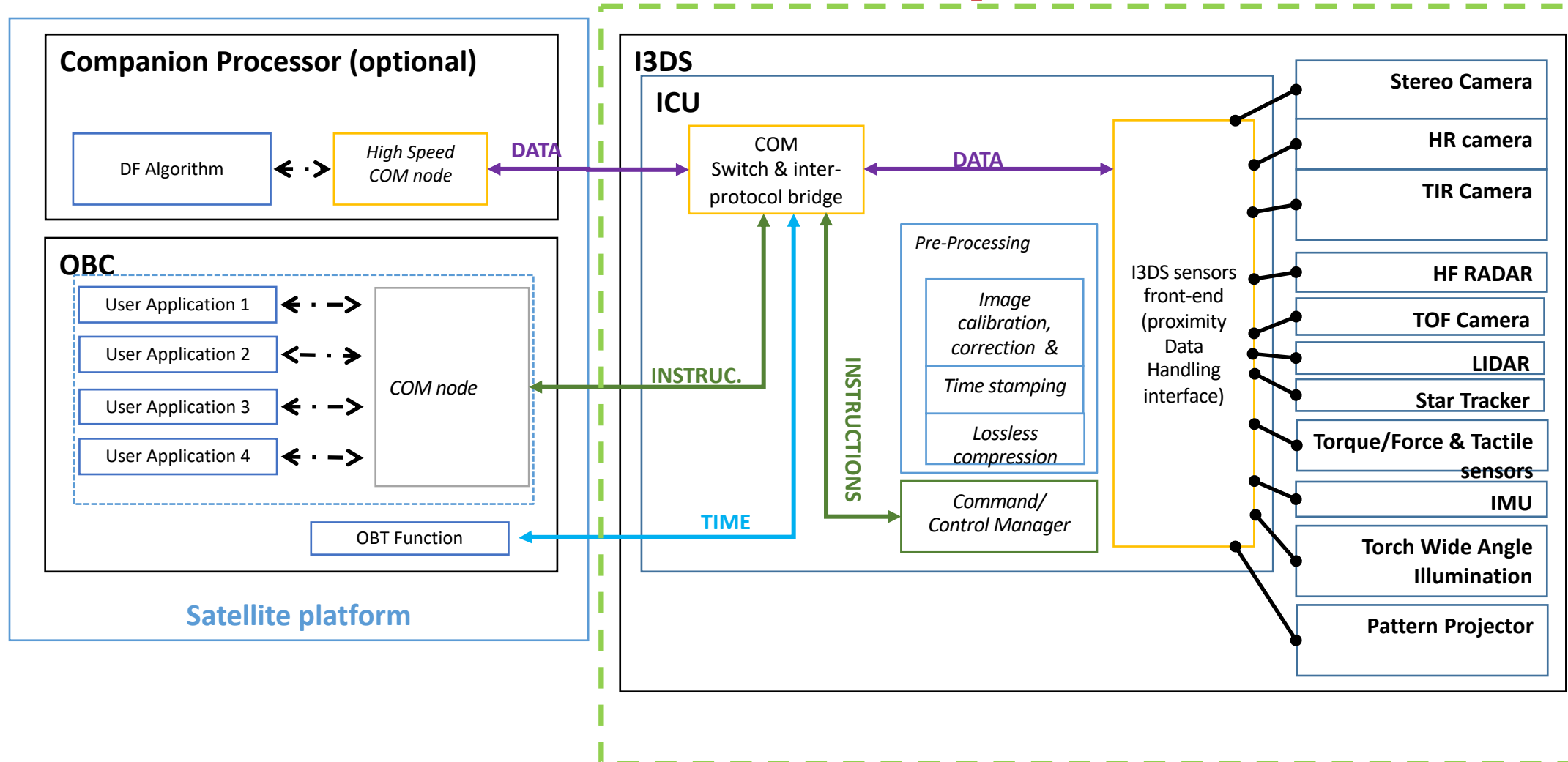- ▪ **Histogram Equalisation**

❑**For the Stereo Camera**

- ▪ **Stereo Rectification**

❑**For the HR camera + Pattern Projector**

- ▪ **Structured light Pattern Description**
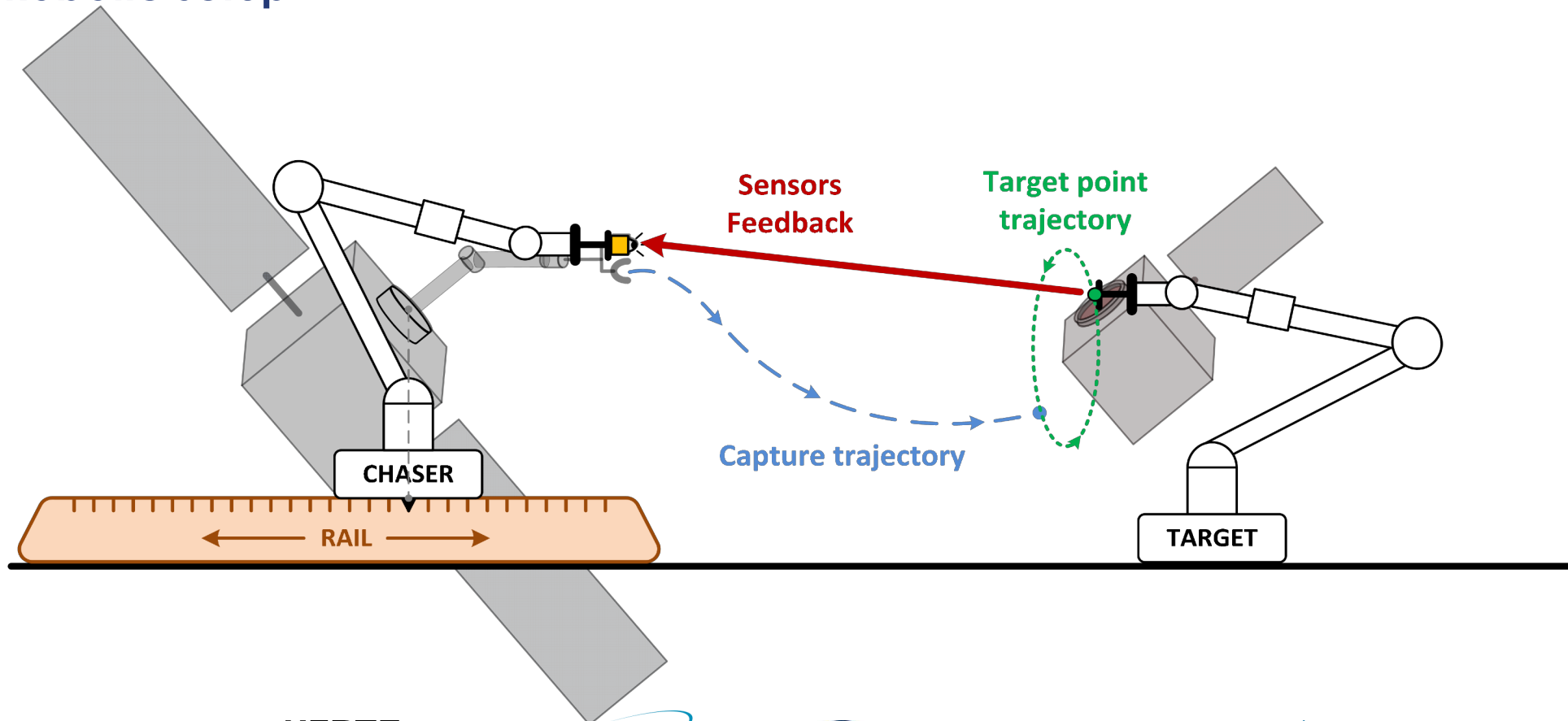- ▪ **Depth map/point cloud production from structured light**

I3DS interfaces in a real system
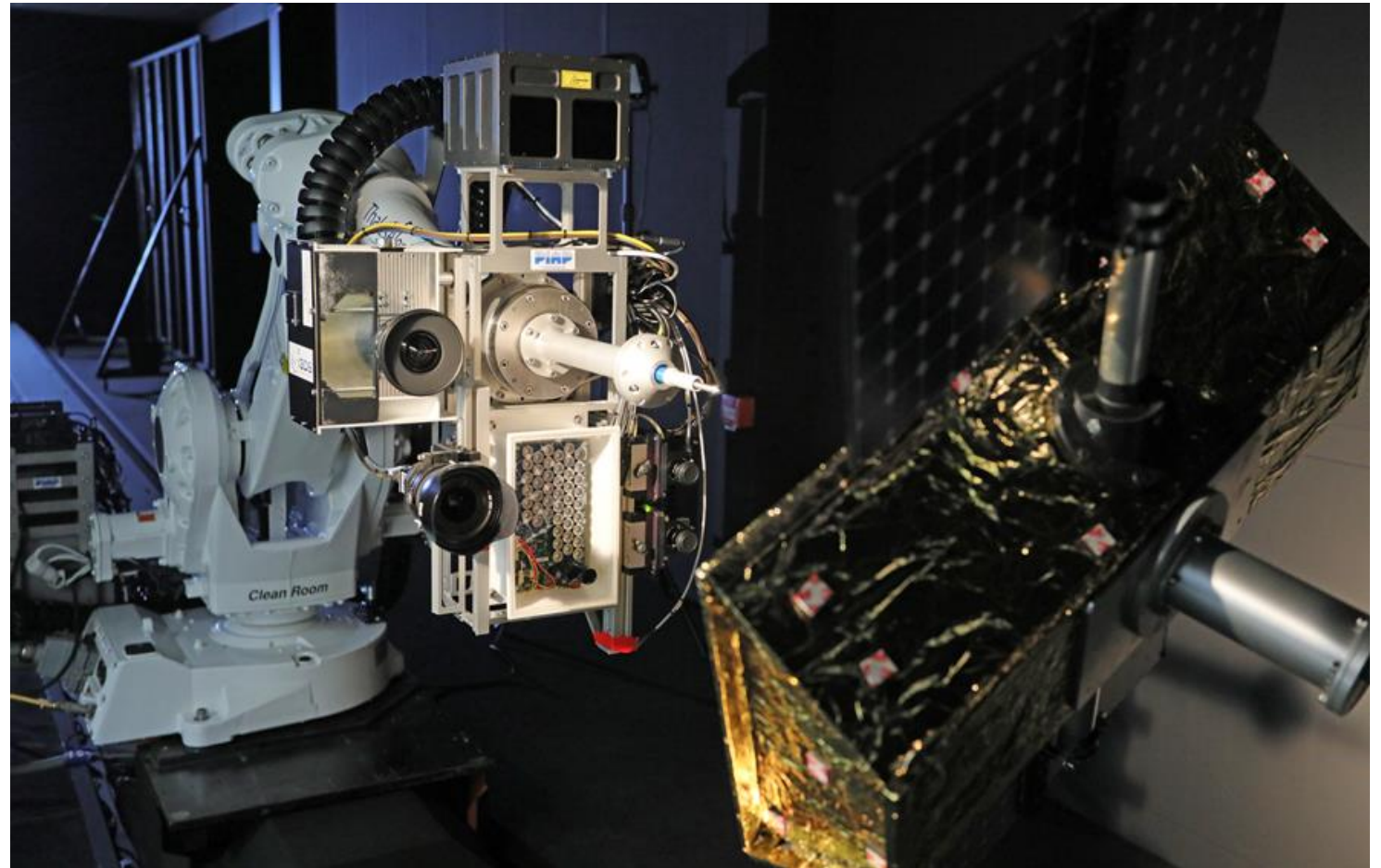
I3DS Experimental Validation (Orbital)

❑ **Experimental validation**

▪ **Robotic setup**
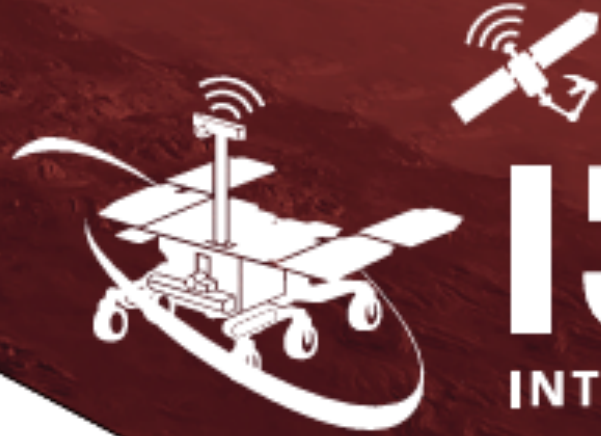
I3DS Experimental Validation (Orbital)

Robotic tests on Thales Alenia Space in France, Cannes ROBY (Robotic OrBital Facility)

Conclusion

1. I3DS is a system on its own with its own hardware and software with embedded processing for on-board sensing capabilities

2. Enables Robotic payload coupling with state-of-the-art platforms

3. Provides autonomous capabilities for rendezvous and exploration

4. Enables to enhance robotic capabilities and imagine more and more complex and ambitious missions

Thank you for your attention !