PERIOD

PERASPERA In-Orbit Demonstration

Outcomes of the PERIOD project on In-Space Manufacturing, Assembly and Refuelling Technologies

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ESA Clean Space Industry Days 2022

October 13, 2022

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 101004151

Consortium

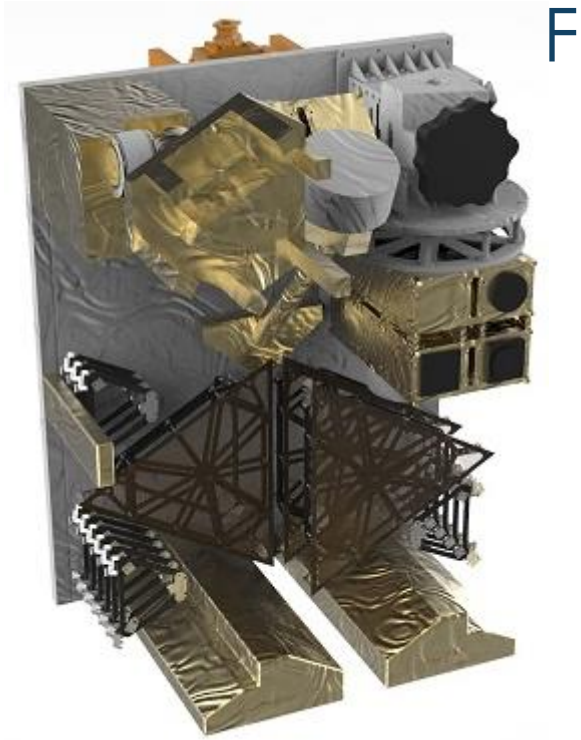
European Union's Horizon 2020
Research and Innovation programme

Content

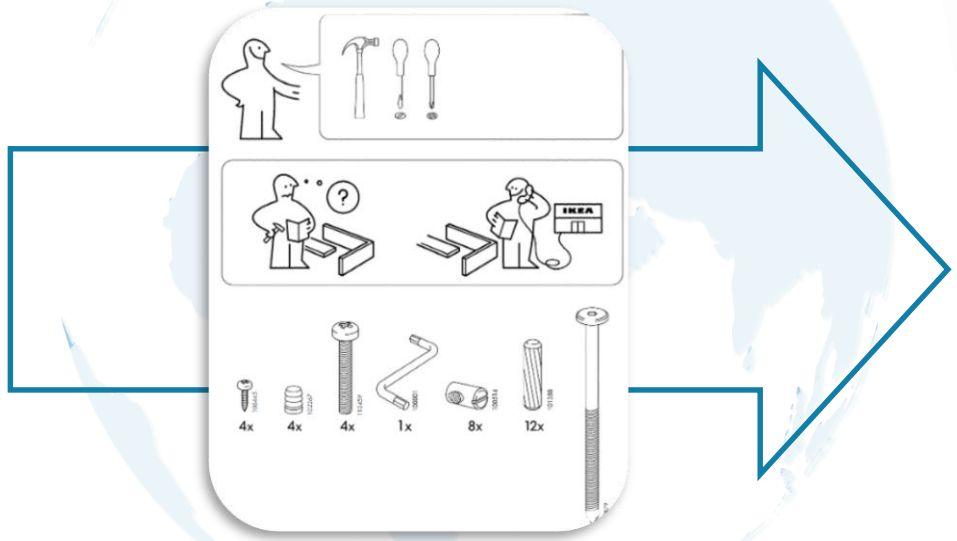
1. Can you imagine building a satellite in orbit?
2. Promising market perspective for In-Space Manufacturing and Assembly.
3. The Orbital Factory.
4. The development and testing of the ISMA capabilities.
5. PERIOD value for business and citizens.

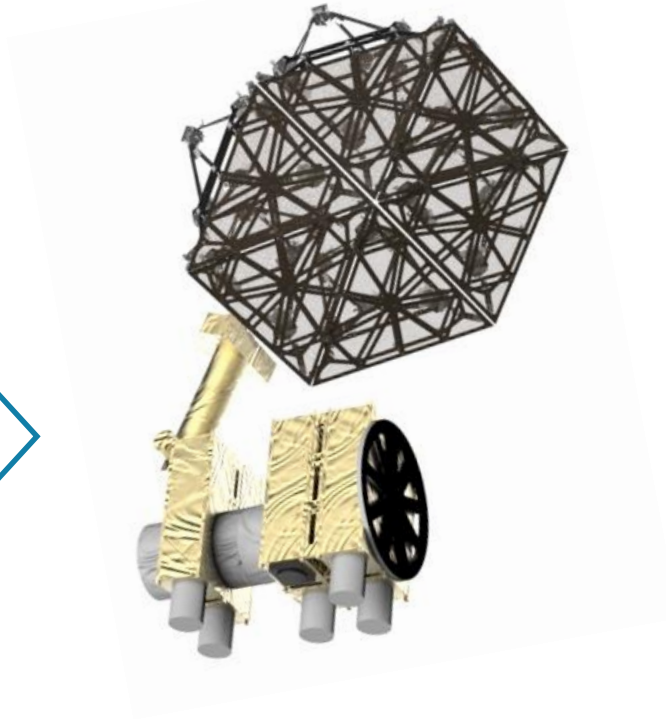
PERIOD main objective

Build a satellite from a kit in an orbital factory.



From a satellite kit…



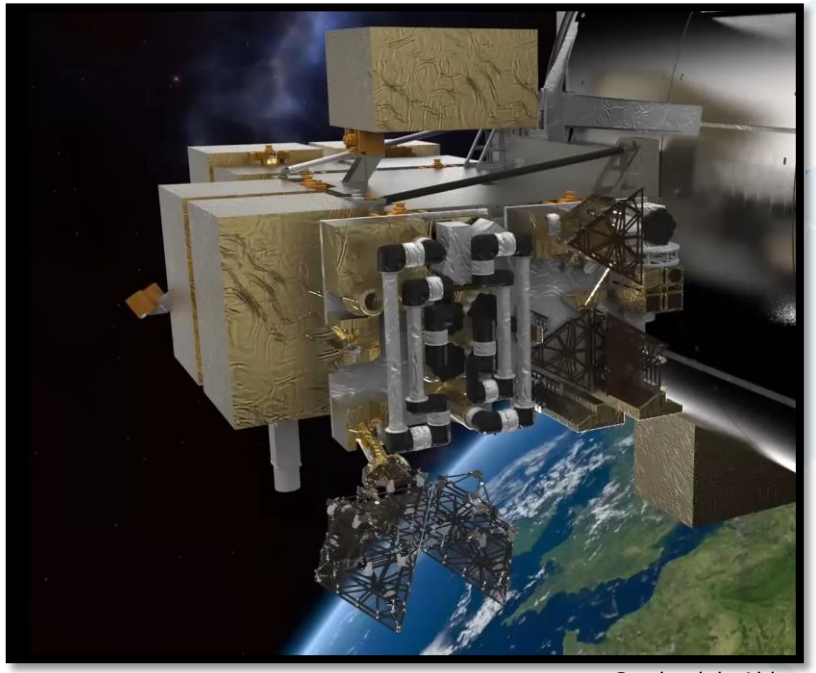


…to a functioning assembled satellite.

An orbital factory to produce in space

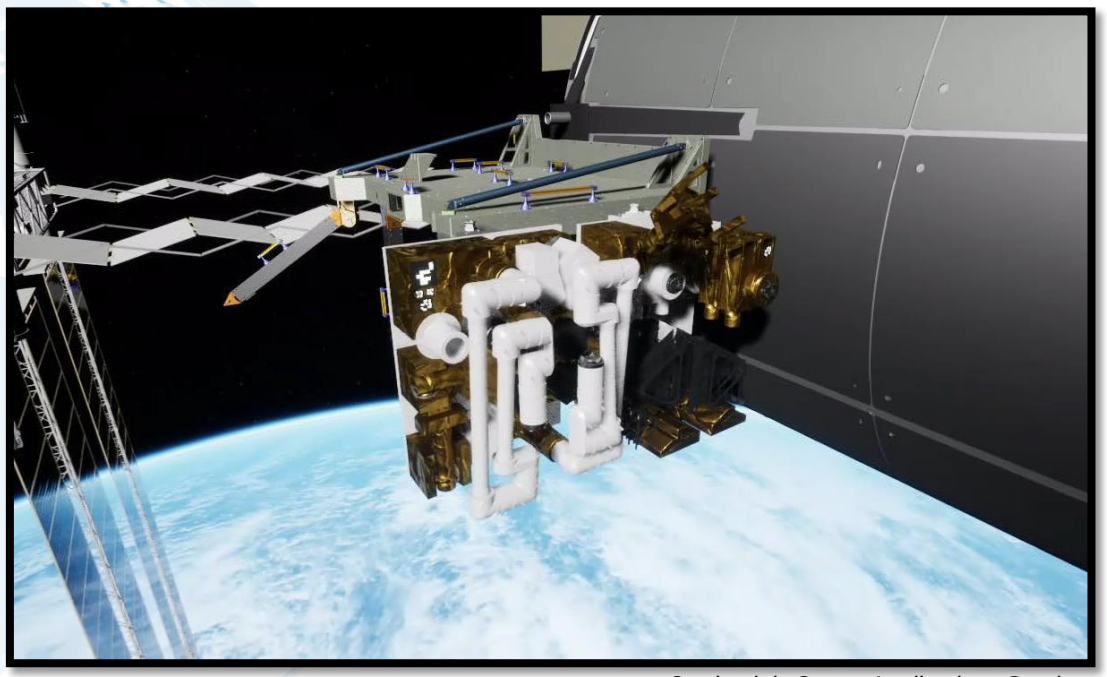
Demonstrate the robotic-based ISMA capabilities.

Satellite Antenna Manufacturing



Credentials Airbus

Satellite Body Assembly



Credentials Space Applications Services

PERIOD objectives:

1. Demonstrate the feasibility to assemble satellites with larger antenna in space and to perform refueling.
2. Master the space robotics technology and support standardization.
3. Demonstrate value for customer.
4. Provide transparent communication towards customers w.r.t. in-space assembly needs, capabilities and risks & mitigations.

New way to build and operate space systems

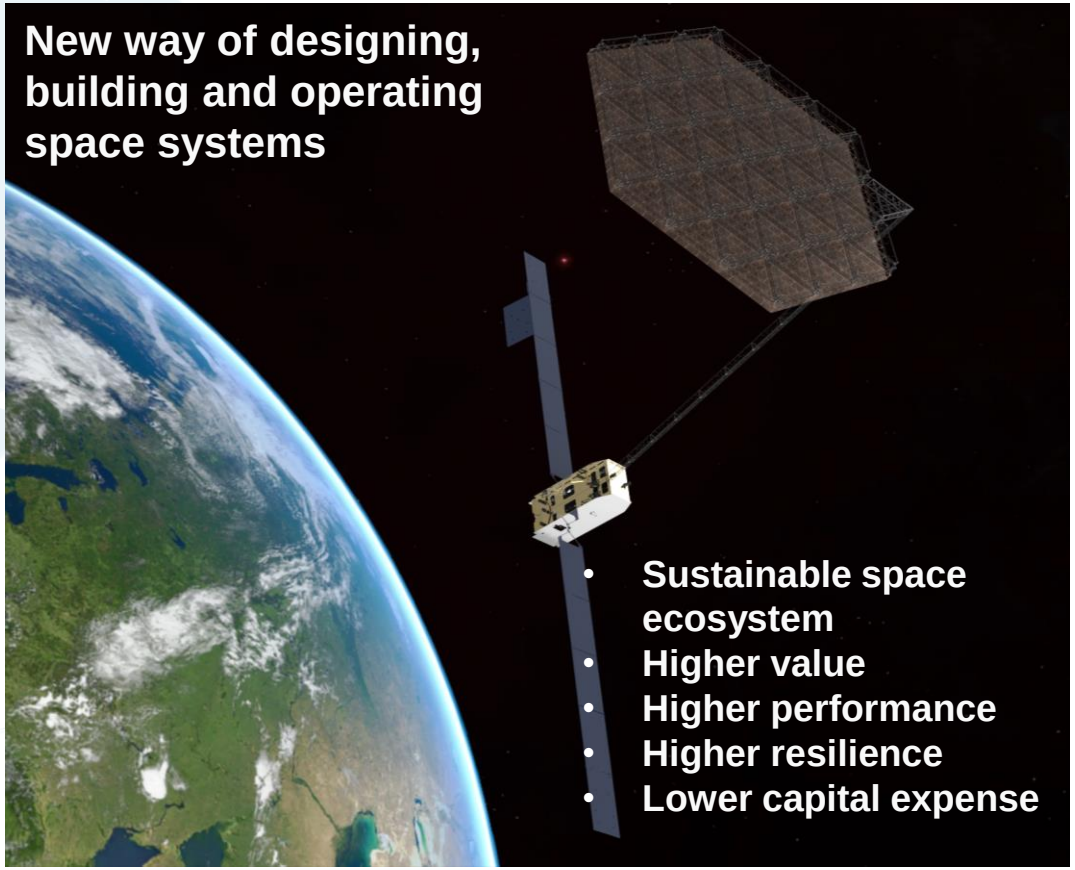
Foster a paradigm shift change away from "static space" and towards "flexible, dynamic and sustainable space".

Problem

Current state

ISMA Capability

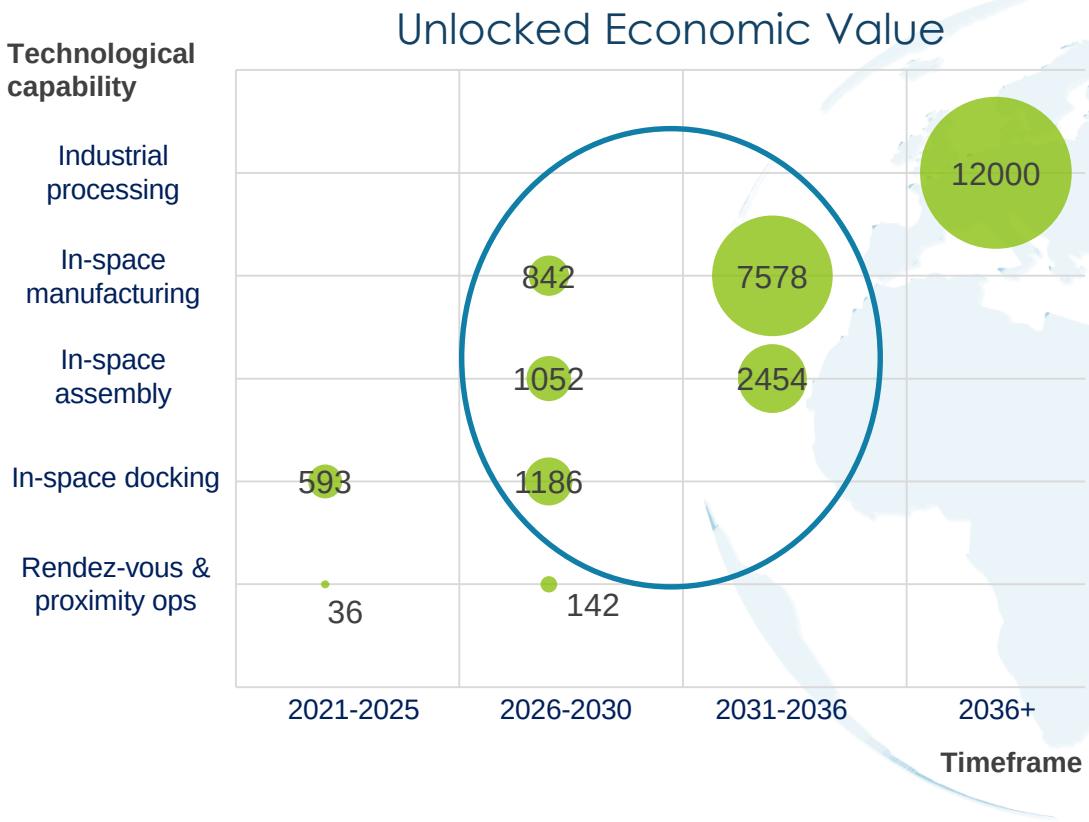
Solution



Next state

Future space ecosystem

ISMA will unlock a very high economic value.



Results from the ISMA market analysis and trends performed in PERIOD phase A.

Max. economic value of €26bn would be unlocked via identified technologies and applications, considering revenues generated in the first 10 years after 1st operational mission of each application.

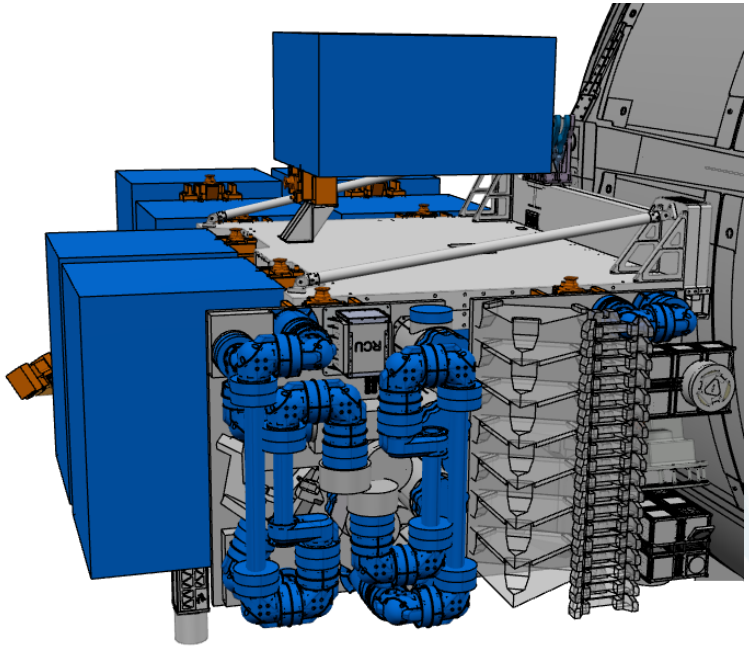
€14bn would be the value when excluding missions with 1st operation beyond 2035.

Operational tech. capabilities	Timeframe 1st operational mission	Unlocked value (€m) - 10y after 1st operation
Rendez-vous & proximity ops	<2020	178
In-space docking	2020-2025	1779
In-Space Assembly	2025-2030	3505
In-space Manufacturing	2025-2030	8420
Industrial material separation and processing	2036-2045	12000

PERIOD experiment accommodation

IOD focused on elements providing highest value
for innovation and preparation of future ecosystem.

Configuration #1 for Satellite Assembly

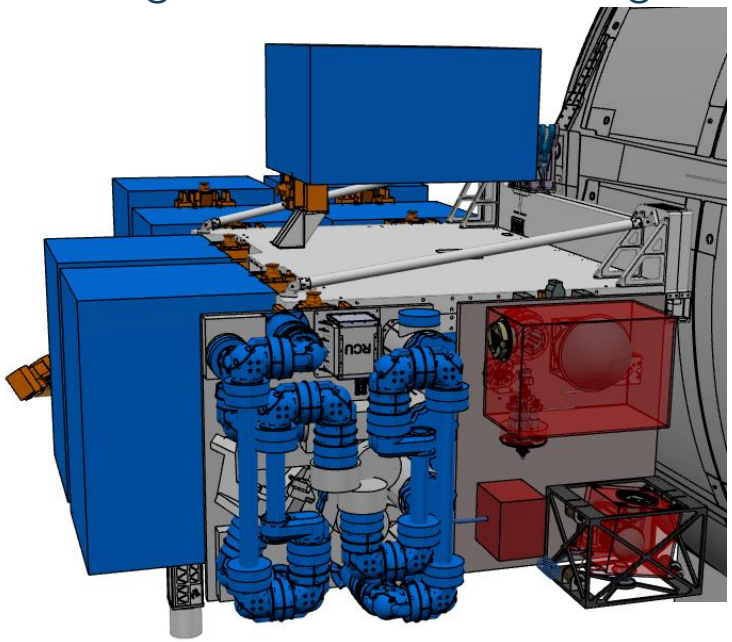


IOD relying on existing
ISS infrastructure

Experiment upgrade
for refueling

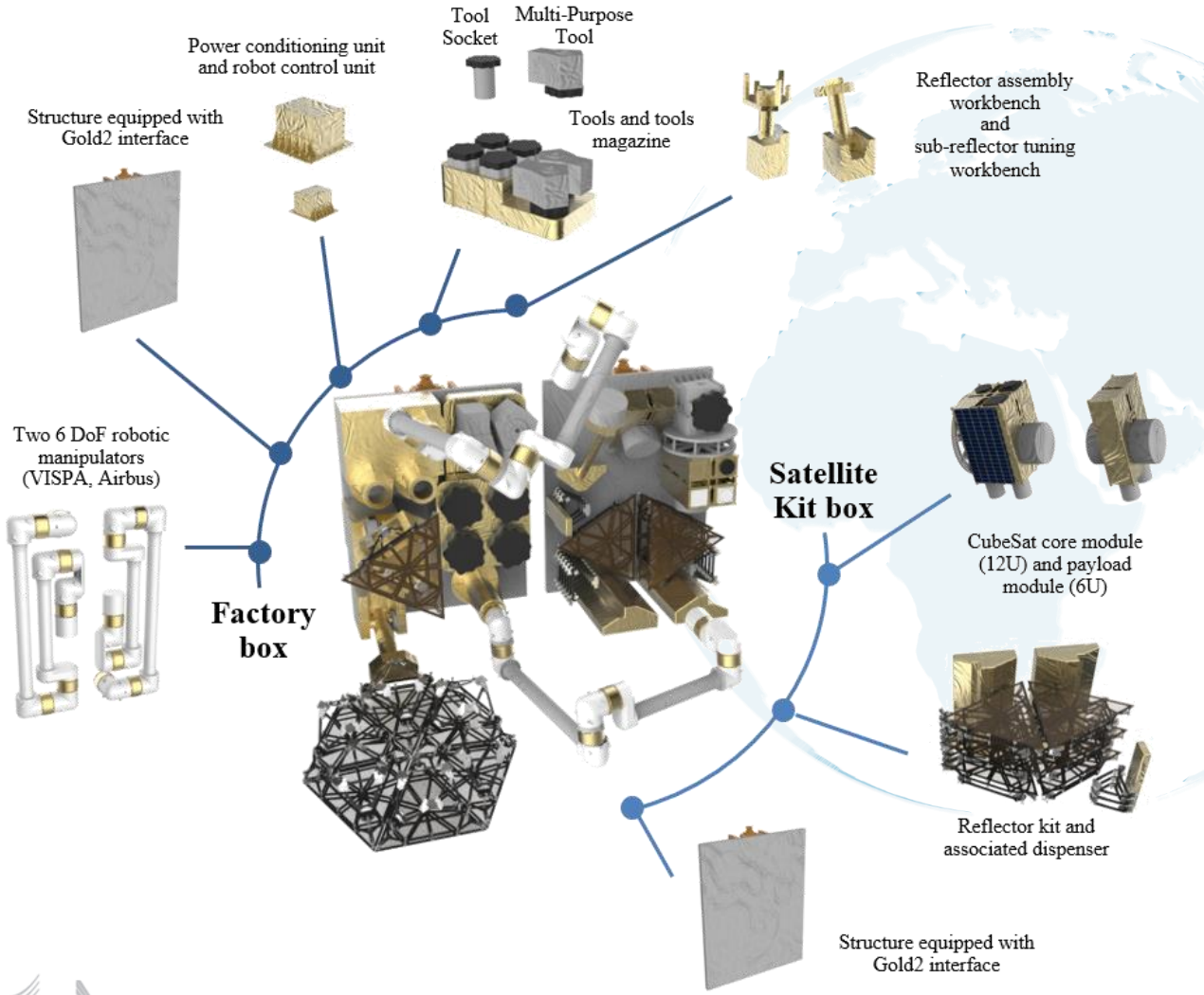
Factory Control Station

Configuration #2 for Refueling



ISMA Factory design concept

PERIOD system defined in a product-centric approach.



Factory Box

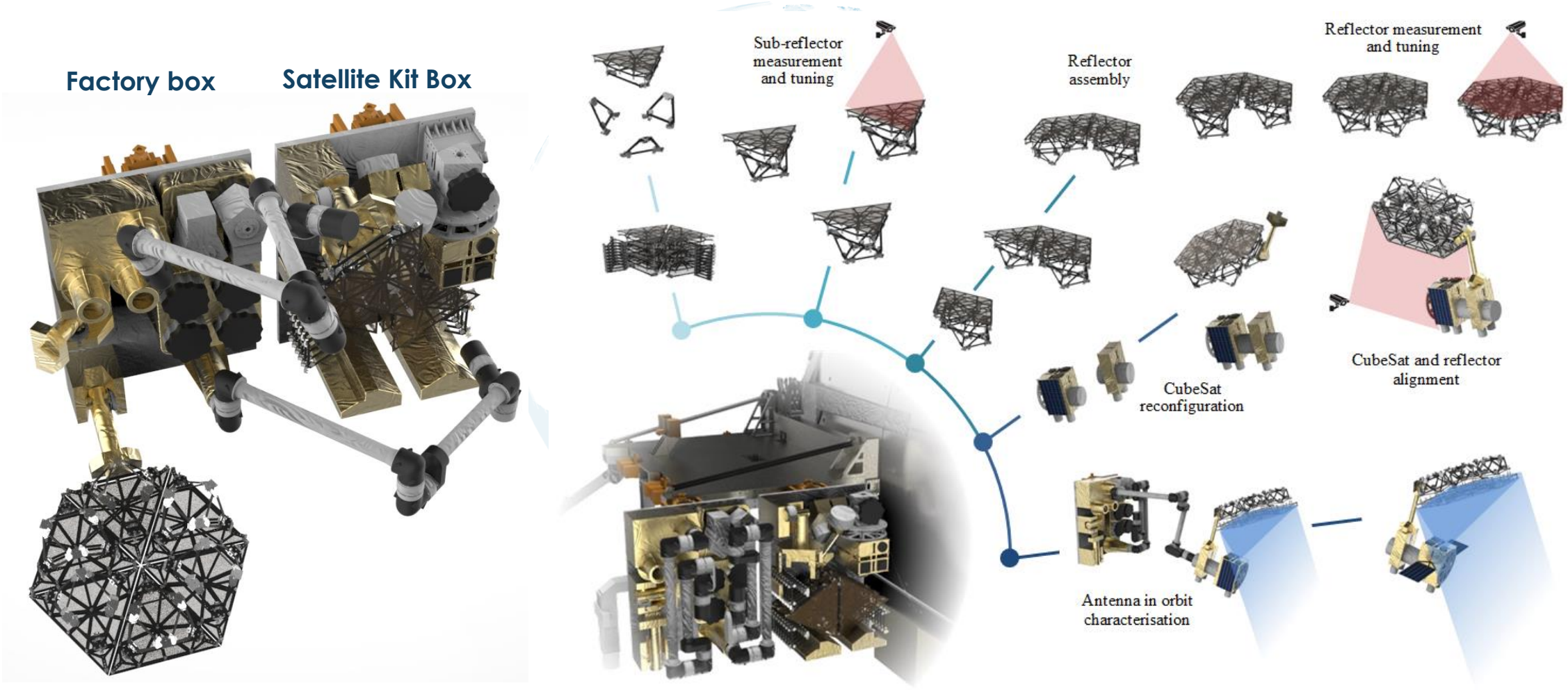
- Manipulation System
- Set of tools
- Tool magazine
- Workbench elements
- Power Conditioning Unit providing power IF
- Robot Control Unit providing data IF and running the Control Software

Satellite Kit Box

- CubeSat core module and payload module equipped with Standard Interconnects
- Reflector parts
- Storage (dispenser)

ISMA Factory operations concept

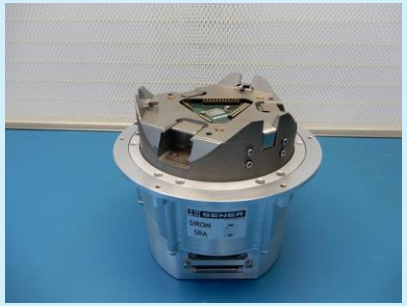
Semi-autonomous integration of reflector and satellite.

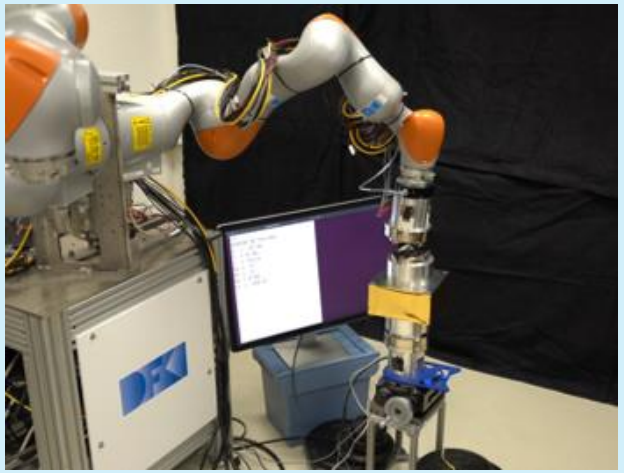


Standard Interconnect Benchmarking

SI Physical characterization, Functional & Performance tests.

SIROM

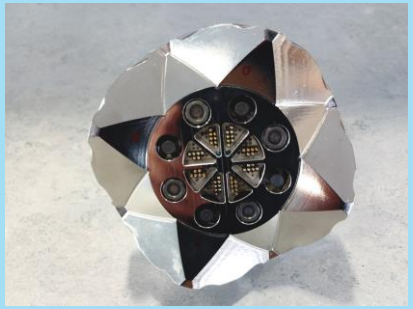


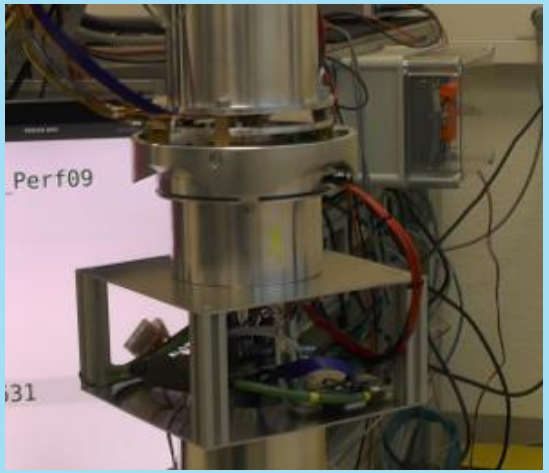


SIROM in functional test

(credit: SENER Aeroespacial)

HOTDOCK

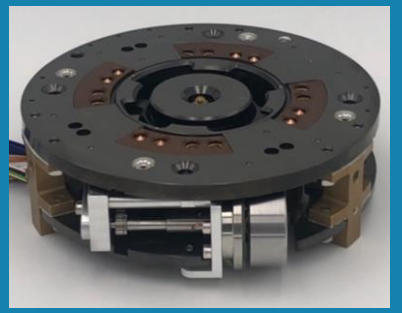


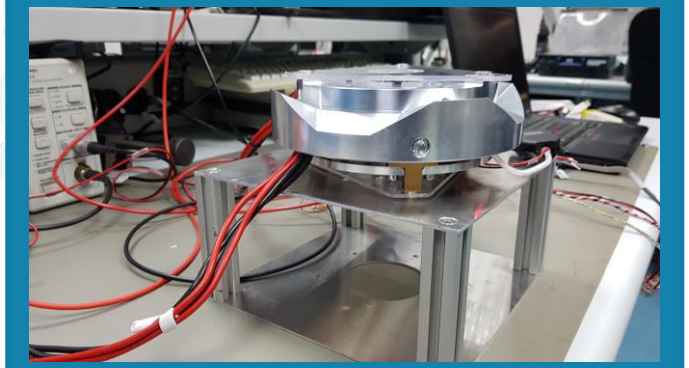


HOTDOCK in functional test

(credit: Space Applications Services)

iSSI®





iSSI® in electrical tests

(credit: iBOSS GmbH)

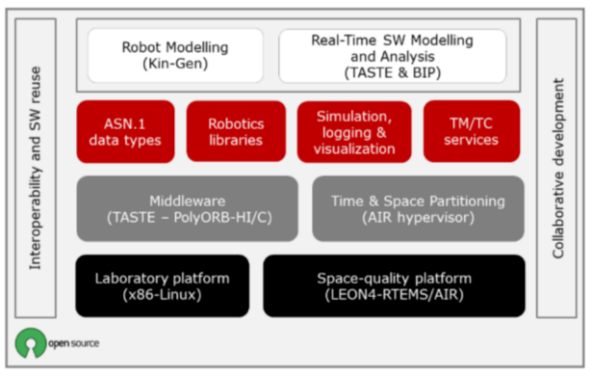
H2020 SRC Building Blocks

PERIOD Technology development

Development to TRL5 of SRC Common Building Blocks for preliminary integration and testing in breadboard.

ESROCOS
European Space Robotics Control and Operating System

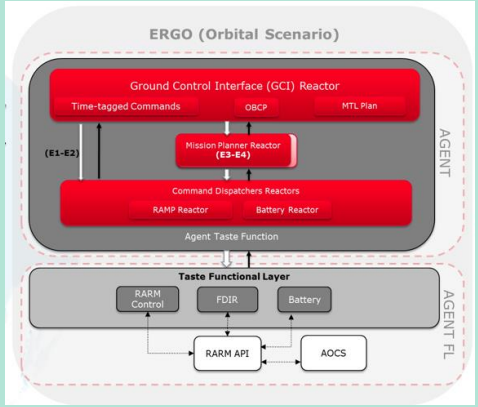
https://www.h2020-esrocos.eu



Open-source framework for space robotics software

ERGO
European Robotic Goal-Oriented Autonomous Controller

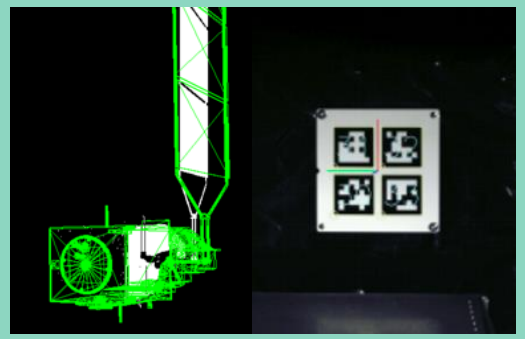
https://www.h2020-ergo.eu



Autonomous Framework for robotic operations

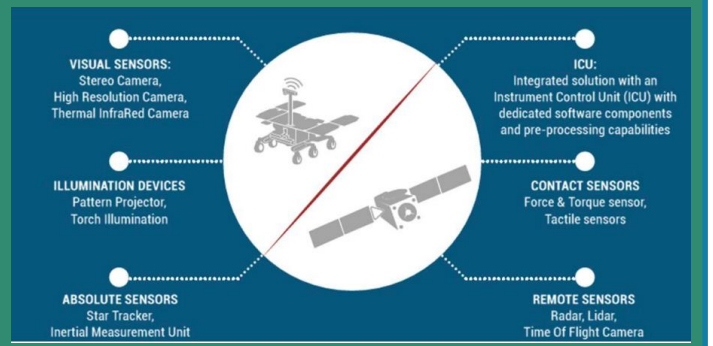
InFuse
Data Fusion For Space Robotics

https://www.h2020-infuse.eu/



Model-based and marker-based pose estimation

I3DS
Integrated 3D Robotics Sensors Suite



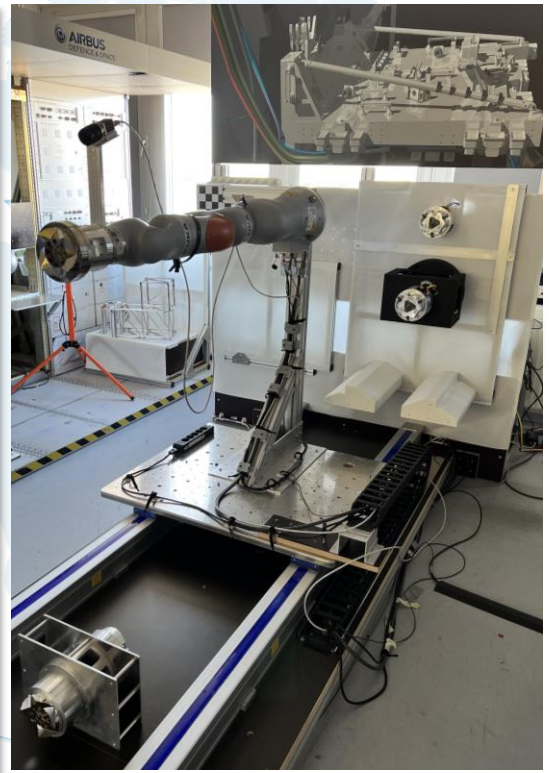
https://cordis.europa.eu/project/id/730118

Sensor management and pre-processing

PERIOD factory evaluation in breadboard

Integration of the SRC Common Building Blocks in an Airbus breadboard for testing and evaluating basic ISMA operations.

Credentials Space Applications Services



Credentials Airbus

Integration and testing of:

1. ESROCOS
2. ERGO
3. InFuse
4. I3DS (device control)
5. SIROM
6. HOTDOCK
7. e.Cube OBC
8. Robotic Simulator
9. Robotic Control Station

Including

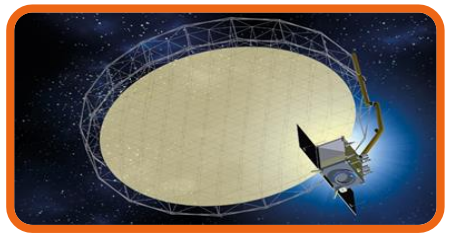
1. Cubesat mockup with SI
2. Kuka arm
3. End effector camera

Test work on-going with demonstration planned in December 2022.

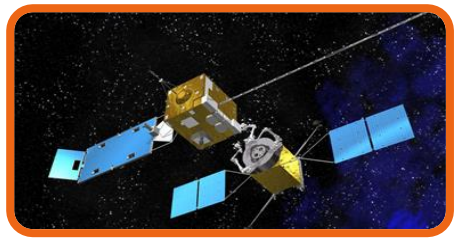
ISMA high value for business and citizens

ISMA can be applied in various space and terrestrial domains.

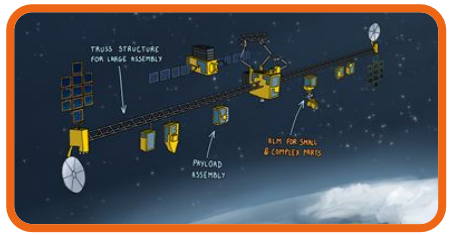
Higher Communication capacities



Higher Satellite resilience



Lower Capex



Performance

Availability
Profitability
Sustainability

Profitability

PERIOD
PERASPERA In-Orbit Demonstration

PERIOD is developing a new generation of multi-purpose and autonomous tool that can be used in multiple domains.

Safety
Availability

Safety
Profitability

Image

Exploration infrastructure

Automation

- EU high innovation potential
- EU high ambitions to attract new engineer generation

Follow PERIOD in the social media!

Regular posts/tweets on social media based on existing progress/material/news.

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https://www.linkedin.com/company/period-project/

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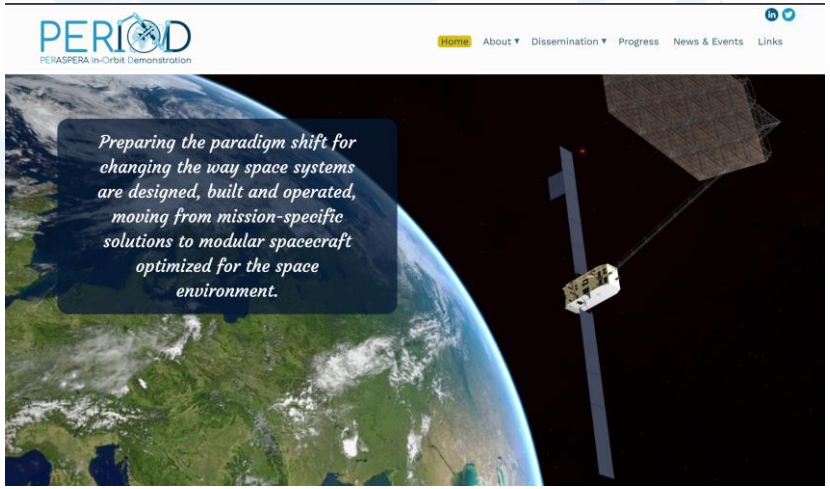
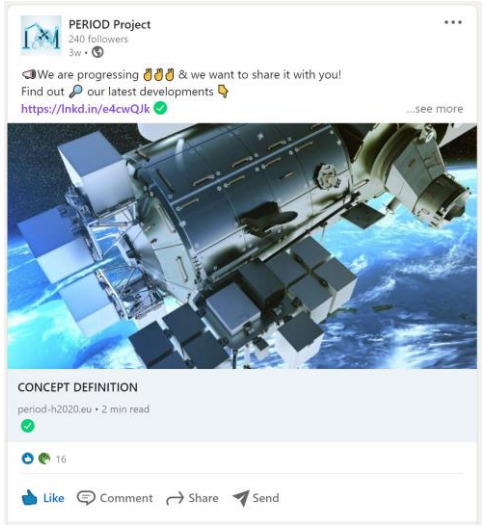
https://twitter.com/PERIOD_H2020

Website
https://period-h2020.eu/





Thank you!

Acknowledgment

The research leading to these results has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 101004151.

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