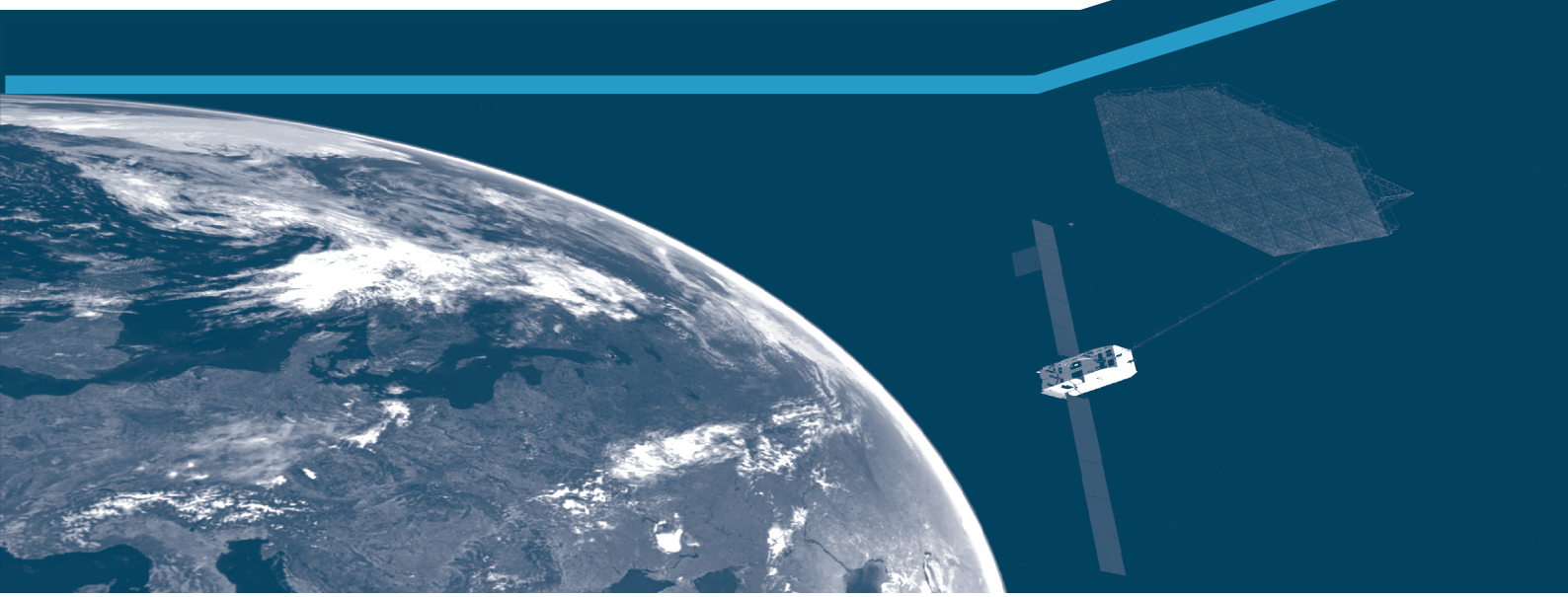
PERIOD

PERASPERA In-Orbit Demonstration

Newsletter 01



Stéphane Estable

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Project Leader & System Architect
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Dear Reader,

I am glad to share with you the Issue #1 of the PERIOD Newsletter.

The PERIOD (PERASPERA In-Orbit Demonstration) project, commenced on the 1st of January 2021, aims at preparing the paradigm shift for changing the way space systems are designed, built and operated, moving from mission-specific solutions to modular spacecraft optimized for the space environment. The very ambitious demonstration scenario of PERIOD includes the manufacturing of a satellite in the "Orbital Factory".

Reaching our first important milestone, we released the Mission Statement that depicts the roadmap for implementing our concept. We are confident that by demonstrating On Orbit Service (OOS) and In Space Manufacturing & Assembly (ISMA) capabilities, the PERIOD mission will initiate the transformation of the lifecycle of space systems toward higher value, higher system capacities, higher resilience and lower capital expense, and toward independent European capabilities allowing Europe building the future orbital infrastructure and being competitive on the ISMA market.

The present newsletter issue is structured in four (4) sections that depict the activity streams of PERIOD project. You may be informed about the current status and achievements of our initiative.

Enjoy the reading & stay connected with PERIOD via our communication channels!

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101004151

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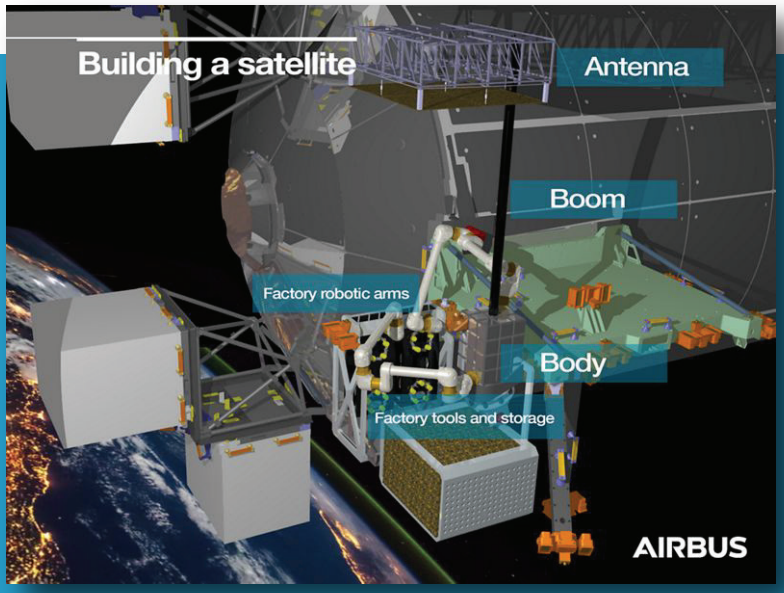
1 Mission Definition

The PERIOD demonstration objectives have been elicited from the high-level customer needs. Substantiated by programmatic constraints, technical feasibility and market opportunities, they have been translated into detailed mission requirements. A mission architecture has been developed that maps those requirements to mission phases and physical entities.

The mission phases have been aligned in a high-level mission sequence that served as an input for the initial operations planning. Likewise the physical decomposition has been used as an input to the definition of the system concept.

PERIOD demonstrator © Airbus



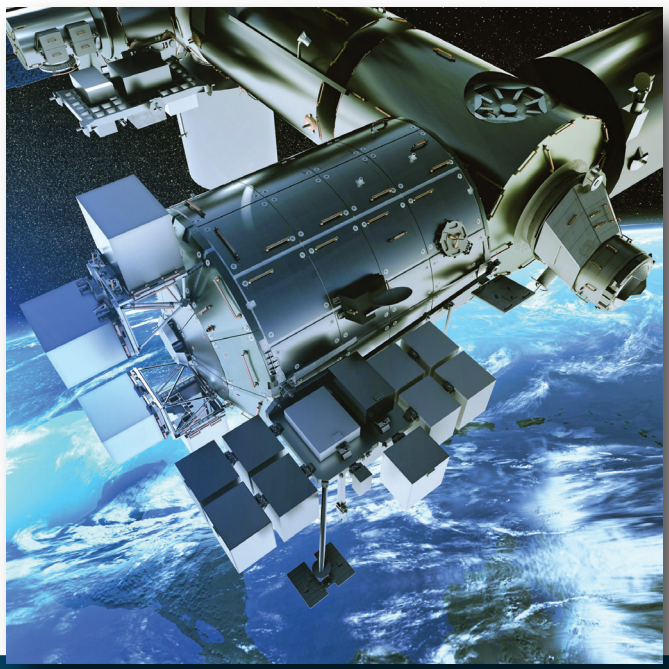
In parallel, also the mission for the payload satellite with its scientific mission has been plotted. The results of the combined Mission Definition process have been formalized in the Mission Description Document and submitted for review during the Mission Definition Review (MDR).

In the next iteration of the Mission Description the findings from the MDR will be implemented. Based on this update the system requirements will be adapted and flown down to the next level of decomposition.
Throughout the development of the PERIOD demonstration the MDD will be kept up-to-date and continue to serve as a reference for the technical design.

2 Concept Definition

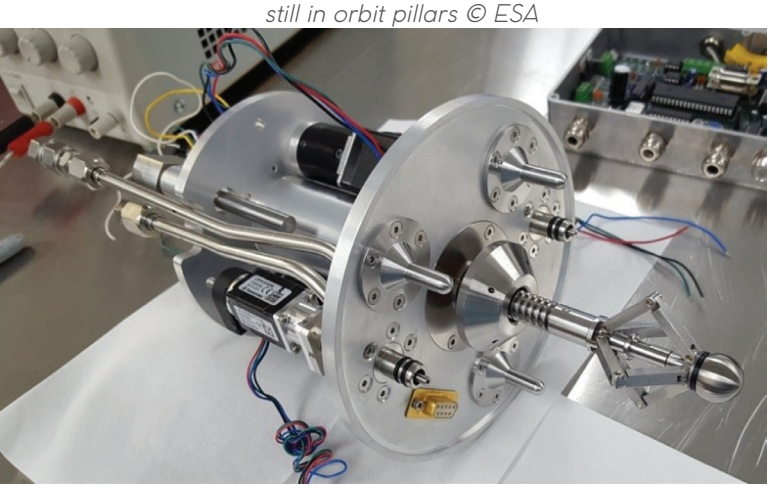
Bartolomeo (https://bit.ly/3dArRDG) provides an excellent environment for initial in-orbit demonstrations (IOD) of the technological capability and feasibility for the In-Space Manufacturing and Assembly (ISMA) use cases, to prove and evaluate related operational concepts as well as to increase maturity of space robotics technology first used in space. Repeatability of the necessary operations enables evaluation and generate evidence in terms of performance, robustness and success probability. The costs and effort for logistics, infrastructure and other aspects not related to the robotic capabilities can be kept low.
The robotic factory IOD will aim at assembling a small satellite with a large antenna reflector manufactured in space, exchanging payloads of the satellites and performing an attachment and refueling experiments utilizing ASSIST (https://bit.ly/3ye4Wpn).

Bartolomeo at ISS © Airbus 2021



Preparing the paradigm shift for changing the way space systems are designed, built and operated

Docking mechanism could lead to refuelling satellites still in orbit pillars © ESA



In the next steps, the required functions to realize the defined operations and their allocation to the logical and physical elements (subsystems) will be described in the MBSE model and a more detailed design of the factory architecture and the accommodation will be developed.

The architecture definition, implementing the integration of the Strategic Research Cluster (SRC) building blocks in a robotic factory, is currently ongoing and major trade-off studies are under preparation. The decisions for the system concept are ranging from the number of manipulators to the use of Standard Interconnects down to the software functionality and sharing of control between ground and in orbit execution.

The redundancy concepts for the different subsystems and equipment's is under specification to meet the overall mission dependability.

The complete architecture definition will be represented in an Model Based System Engineering (MBSE) environment to model the mission definition, the operational definition, the functional definition and the logical definition in one SysML model.

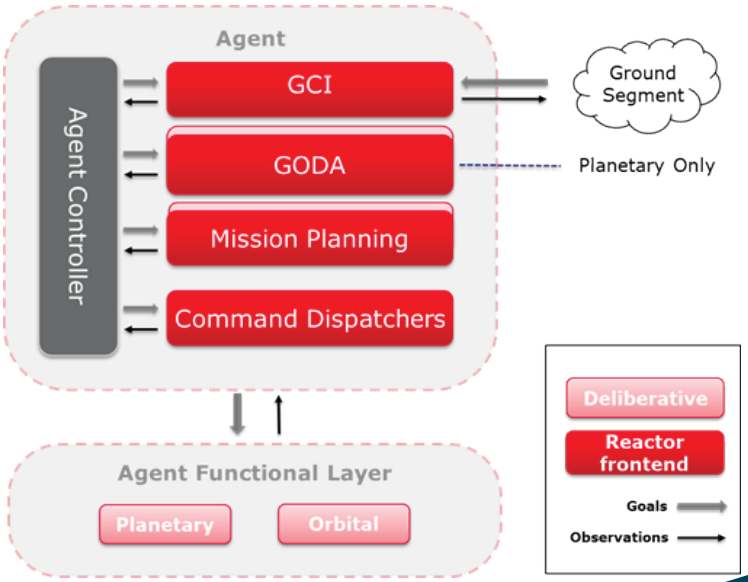
In addition, needed analyses will be carried out with regard to various criteria such as function, structure, electrical, computing power, etc. and the concept is optimized iteratively based on the results and relevant trade-off.

3 Technology Development

The main results of the activity achieved till the Mission Definition Review consist out of:

a. providing a reference document for space software development and evaluation,
b. specifying an overview of the reference implementations of core (software) building blocks (i.e., ESROCOS, ERGO, InFuse, I3DS),
c. illustrating available capabilities in an early demonstration scenario,
d. identifying implementation gaps of the reference implementations with respect to the performance requirements,
e. defining further development activities to close identified implementation gaps and advance the building blocks to TRL 5.

OG2-ERGO autonomous framework architecture



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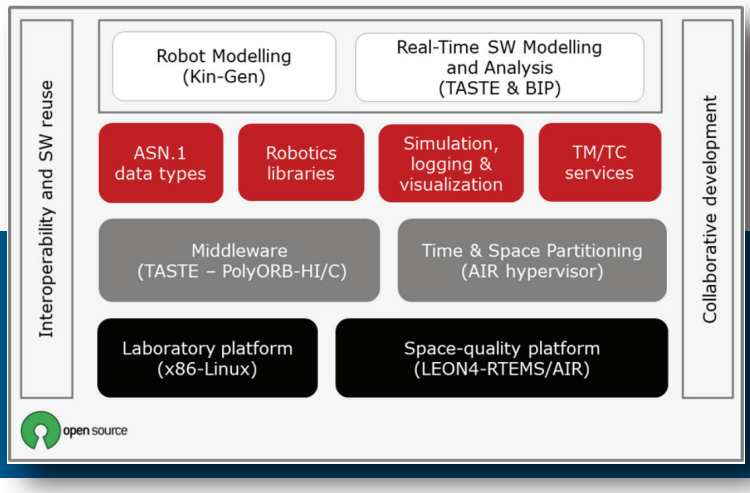
ESROCOS



The identified procedures for space software development and evaluation rely heavily on a set of European Space Standards of the European Cooperation for Space Standardization (ECSS) as well as the software development guidelines defined by the Motor Industry Software Reliability Association (MISRA), i.e., MISRA C and MISRA C++.

Next steps of the activity planned till the Preliminary Requirements Review (PRR) will involve in the first place the refinement of the already identified gaps and technical requirements of the building blocks. The implementation phase will follow to close the identified gaps and advance the software in question till TRL5.

At the same time, the test and validation plan will be prepared that will be used after the PRR to perform the technology readiness assessment (TRA) of the involved software building blocks.

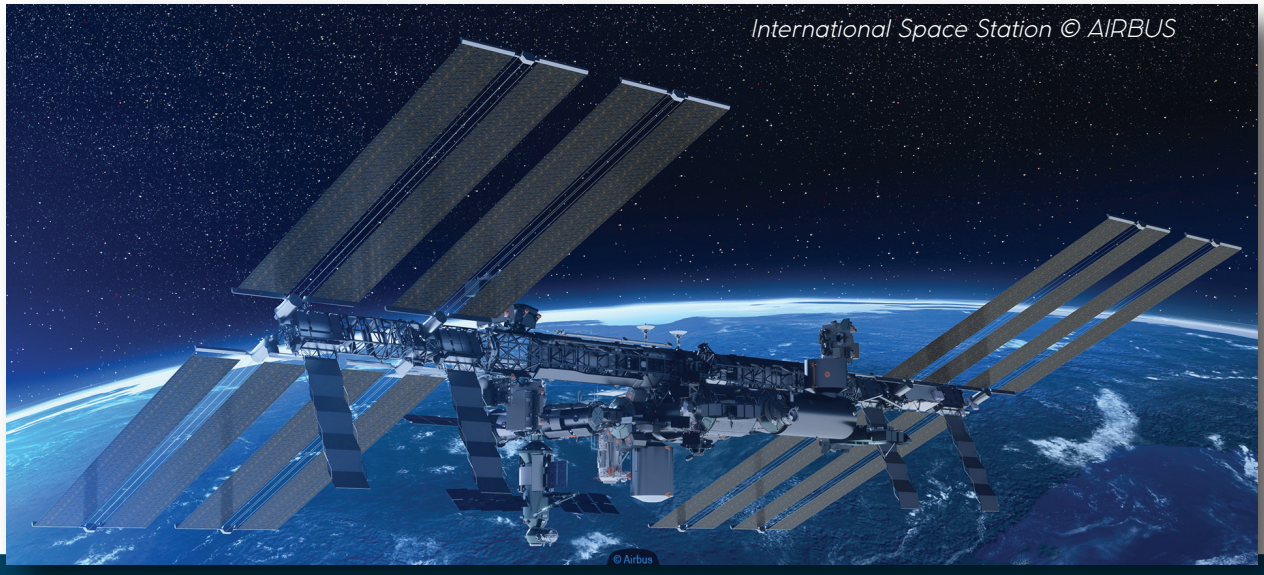
Challenges & Opportunities 4

PERIOD will integrate many difficult tasks from the In-Space Manufacturing and Assembly (ISMA) domain. Each one of them requires the development of dedicated demonstration kits, tools, skills and operational procedures. And all of these constituents need to be safe, dependable and resilient in their work environment. Thus a large challenge is the integration of those elements into a working system.

Due to the remoteness of space being one key aspect in the future utilization of the system, a high level of autonomy will already be implemented in the demonstration mission.

If the ISMA activities will be successfully demonstrated within the scope of the PERIOD demonstration, this will be an enabling factor to a possibly large commercial market.

One of the next challenges to be tackled would be the logical integration of PERIOD on the Bartolomeo Platform attached to the ISS. It should be demonstrated that the PERIOD operations can be performed within the constraints of the platform.



International Space Station © AIRBUS

Preparing the paradigm shift for changing the way space systems are designed, built and operated

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101004151