Dr Stéphane Estable, PERIOD project Coordinator and System Architect, Airbus Defence & Space

Satellite Evolution Global

Q&A

Testing live prototype technologies in space

The PERASPERA In-Orbit Demonstration (PERIOD) project is a combined effort coordinated by the Horizon2020 Project and funded by the European Commission which tests live prototype technologies in space to illustrate the potential for in-orbit applications. We spoke to Dr Stéphane Estable, PERIOD project Coordinator and System Architect for Airbus Defence & Space, about the project's aims, action plan, and how its success could change the industry.

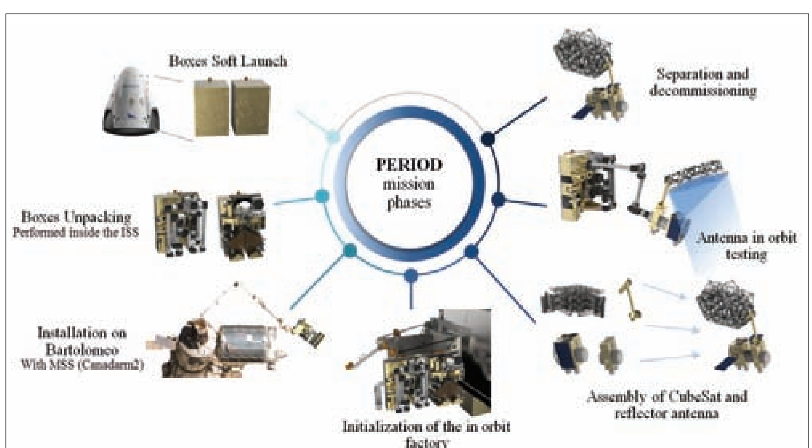
Laurence Russell, Assistant Editor, Satellite Evolution Group

Question: Which emergent technologies do you predict will lead to the biggest space industries and markets in the near future?

Stéphane Estable: Robotics and autonomy represent the active part in an infrastructure, servicing, and maintenance scenario, and deliver the enabling technologies necessary for object handling, manipulation, assembly, etc. In this context, the technologies related to "Orbital Infrastructure" and "Orbital Factory" services are predicted to occupy a significant share of the space market since the goal is to ensure sustainable on-orbit applications and also the proper operation of tens of thousands of satellites and hundreds of lunar missions in the next decade.

On-orbit sustainability aims at the introduction of economical space structures and applications comparable to terrestrial solutions. Use assets as long as possible, modify and upgrade them according to changing needs and requirements, avoid wasting resources, etc. Specific technology building blocks that are currently under development and maturation include (but are not limited to):

- Robotic arms, tools, and workbenches;
- Robotic Control Units & Operating Systems;
- Precision manipulators;



PERIOD mission phases. Image courtesy AIRBUS


Gilat
skyedge IV
ground-space harmony
Multi-orbit, multi-service platform.
Working in harmony with software defined satellites.
Chosen by the leading satellite operators.
leading the elastix era
Gilat Satellite Networks | www.gilat.com

Mechanical & functional setup of HOTDOCK Standard Interface. Photo courtesy AIRBUS ●●●

- Standard Interfaces (mechanical, electrical, and thermal);
- Docking devices;
- Autonomy and Data Fusion frameworks for space robotics;
- Robot vision;
- Industrial processes; and
- Robotic simulation.

Question: What are the standout applications of ISMA (In-Space Manufacturing & Assembly) technologies?

Stéphane Estable: With ISMA, larger antennas could be built with better performance and at lower costs. Larger antennas are needed for both Earth Observation and telecommunications missions. For example, the radar sensitivity is directly linked to the size of the antenna, or the missions using radar benefit from larger diameter reflectors to avoid the need for larger power distribution.

Large aperture array-fed reflector-based systems need to cope with high throughput, and the targets are increasing to hundreds of Gb/s or Tb/s requiring reflector dimensions in the order of 12m, 30m, and above 50m. The concept of LDRs (Large Deployable Reflectors) is one technology being developed to support those needs which are also in the EU technology development portfolio.

However, there will still be limitations on the maximum size of deployable reflectors that can be launched. LDRs larger than 50m, for example, are prohibitively expensive.

Also, as of today, satellites are not designed for servicing, and the industry has yet to align on standards for attachment points, refuelling ports, and other servicing-oriented features which are needed to advance the market.

Serviceable satellites will be supported by the development of the Standard Interconnects within PERIOD and a long-term servicing market could develop from 2030 onwards. More immediate mid-term applications of ISMA will be in the assembly of structures in orbit. The future space ecosystem can then capitalise on these applications which will enable the construction and maintenance of the future space infrastructure.

With the new validated ISMA capabilities, the industry can take over with the proposition of new commercial services and applications in the domains of:

1. Manufacturing, servicing, and assembly of hardware in orbit;
2. Building products in space for the return to Earth; and
3. ISRU (In-Situ Resource Utilization).

A clear focus on the technologies necessary for this will significantly increase the potential growth of the future space economy.

Question: What will it take to establish a competitive edge in this kind of market?

Stéphane Estable: The generation of independent European capacities for building the future orbital infrastructure and being competitive in the ISMA market is the ultimate target. To accomplish this, high investments would be necessary to further develop and mature the related key ISMA technologies and perform IODs (In-Orbit Demonstrations).

But this is not the only aspect for establishing a competitive edge in this market. We also need a sustainable, goal-oriented, operational, and regulative framework that gives enough flexibility to let business arise and grow in this field. Beyond that, we need to work on improving the potential customer's awareness of ISMA capabilities and the associated benefits, as well as informing them transparently about the potential risks and mitigations.

Question: Could you introduce us to the PERASPERA In-Orbit Demonstration (PERIOD) project?

Stéphane Estable: PERIOD is a Horizon2020 project, part of the 3rd call of the SRC (Strategic Research Cluster) on Space Robotics Technologies. PERIOD aims to prepare 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 envisioned ambitious demonstrator will include the manufacturing of a functioning satellite in an 'Orbital Factory'. The demonstration concept is consisted of:

1. The manufacturing of an antenna reflector;
2. The assembly of a complete satellite from building blocks equipped with SI including verification;
3. The reconfiguration of the satellite payload for system upgrade;

4. The inspection of the assembled satellite; and
5. A refuelling test with attachment.

In this first project phase (A/B1, up to December 2022) the preliminary design of the demonstration and the orbital Factory is being generated, with the objective to continue with a demonstrator in orbit.

Question: The project partners with "all suitable European key players" including Airbus and SENER. How will the demonstration benefit them and others in the industry?

Stéphane Estable: As already mentioned, the project brings together the competencies of all European key players suited to the implementation of an In-Orbit Demonstration (IOD) mission. The team is coordinated by Airbus Defence and Space GmbH and involves nine partners with different areas of expertise (Airbus Defence and Space SAS, Airbus Defence and Space Ltd, DFKI, EASN-TIS, GMV, GMV-SKY, ISISPACE, SENER Aeroespacial, and Space Applications Services).

The team has defined an ambitious demonstration that has never been realized so far. With this demonstration, we aim to convince the potential stakeholders that the European industry is ready to undertake more complex missions to meet their demands. And that these missions are feasible with lower capital expense, higher value, higher system capacity, and higher resilience.

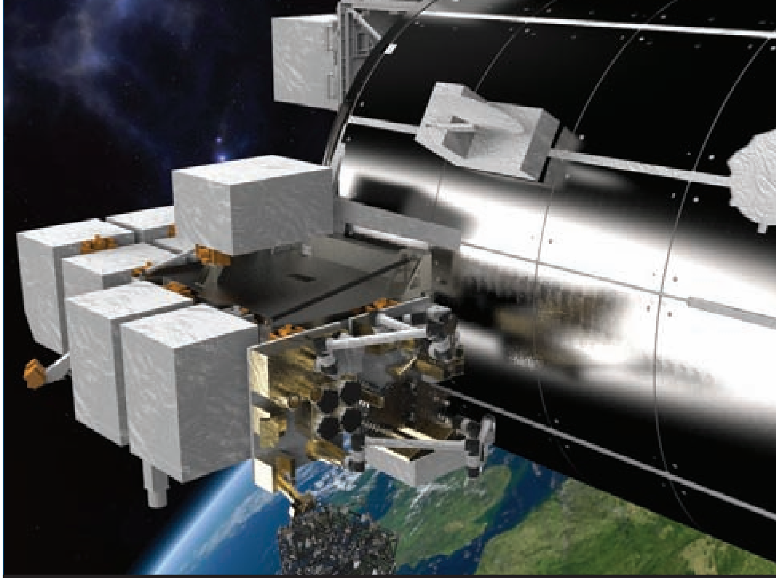
It is expected that the new market opportunities generated will strengthen the competitiveness and growth of European companies. In the medium and long term, this will be translated to an economic return for the involved industrial partners.

Question: For the benefit of potential stakeholders, what's the bottom line about these technologies?

Stéphane Estable: There is no doubt that all different actors of the space sector can benefit from ISMA in several ways. If the EU were to start ISMA developments now, Europe will avoid becoming reliant on the US and China for future space infrastructure and ensure that European industry is globally competitive as an ISMA-service provider, ensuring both economic advantage and sovereignty.

For space agencies, ISMA technologies and applications can allow scientific missions to be more ambitious and reach performances that would not be otherwise possible via traditional on-ground manufacturing, at an affordable price. Additionally, they can be key elements towards space sustainability and reducing the congestion in orbits with space traffic and debris issues.

Commercial satellite operators always seek opportunities to decrease the CAPEX (Capital Expenditures) and OPEX (Operating Expenses) of their business. This could be partly achieved via OOS (On Orbit Servicing) such as life extension, refuel, rescue, relocation, and decommissioning. Additionally, Telecom payloads can benefit from shorter life cycles than the traditional 15 years of operation of a GEO Telecom satellite. Besides servicing, new mission architectures based on very large antenna



Accommodation of the orbital factory on Bartolomeo. Photo courtesy AIRBUS

reflectors assembled or manufactured in-orbit, as well as large persistent platforms in GEO accommodating several payloads, could enable new business models.

For satellite integrators and manufacturers, the application of ISMA at the different steps of the satellite lifecycle would allow the transition from Earth-based manufacturing to space-based manufacturing, thus producing spacecraft which are optimized for the space environment, making the best use of manufacturing and launch resources. At the same time, reliability and redundancy requirements would be relaxed via the possibility of direct in-orbit verification and validation of hardware produced in orbit.

For space insurance companies, ISMA applications would allow for both a better understanding of the events in orbit, thanks to space-based inspection/monitoring missions, and would also reduce unexpected loss of missions, via rescue or repair services, so they could save claim costs and be able to more accurately calculate insurance premiums.

Question: With time and appropriate investment, what do you anticipate the ISMA industry will be capable of delivering a decade from now?

Stéphane Estable: As already mentioned, the ISMA industry can bring revolution to the space market achieving a sustainable space ecosystem and bringing new services.

We are confident that a decade from now, considering a stepwise evolution, many different capabilities will be introduced. Large-antenna commercial satellites autonomously assembled in space will provide citizens with a wide range of services, and scientific satellites will allow us to see further into deep space than ever before. Payloads will be autonomously exchanged on standard reconfigurable satellites.

Most satellites will be repaired, serviced, or de-orbited in space, meaning that we will be able to better face the space debris issue. Advanced space robotics will be used for local and autonomously manufacturing and assembly on the space stations in LEO, lunar orbit, and Mars orbit and indeed on the lunar and mars surfaces.

Even more remarkably, the same robotic technologies and autonomous industrial processes will be used for producing resources in space and even producing human organs for the people back on Earth.