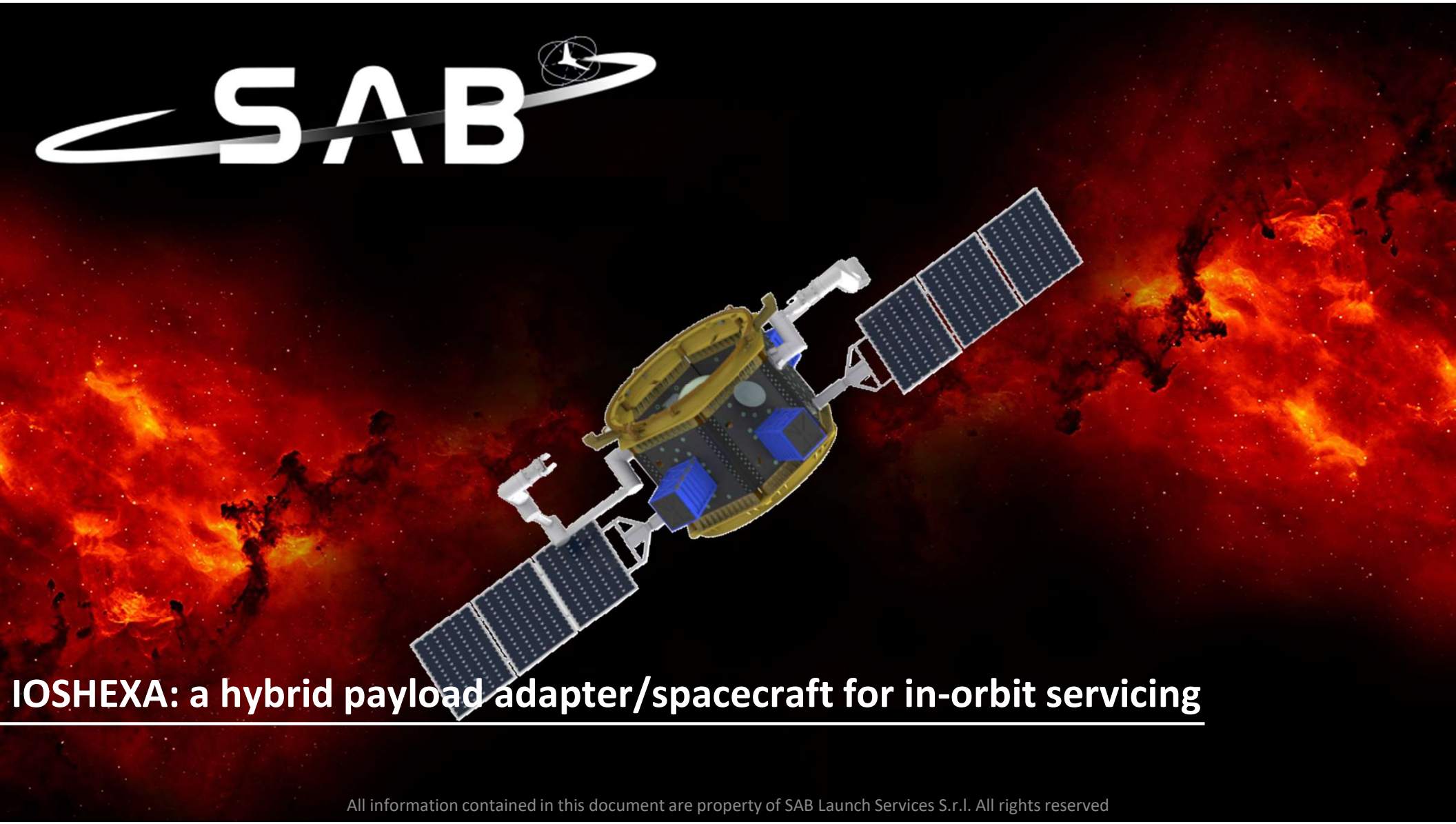


IOSHEXA: a hybrid payload adapter/spacecraft for in-orbit servicing

SAB Group

- **SAB** is the holding of a group of SME's working in the Space Business
- The group is private and independent
- The holding is based in Milan
- **SAB Aerospace** is present in Italy (Benevento), in The Czech Republic (Brno), in Poland (Zielona Góra) and since 2020 also in Romania (Bucharest). The companies core business is focused on the development of Mechanical Sub-systems for Satellites and launchers
- SAB is offering launch services on European Launchers through the business unit **SAB Launch Services**

Space Systems

S.A.B. Aerospace s.r.l.

S.A.B. Aerospace s.r.o.

S.A.B. Aerospace sp.z.o.o.

S.A.B. Aerospace s.r.l.

SAB Launch Services s.r.l.

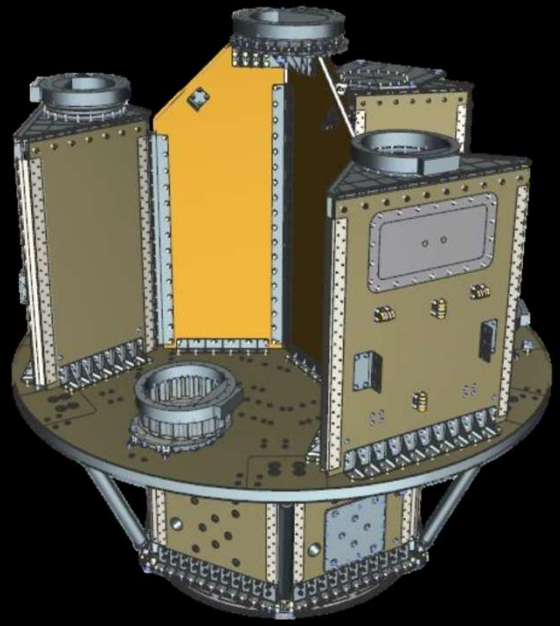
Applications & Launch Services

SAB HOLDING

From SSMS to IOSHEXA

IOSHEXA concept comes from a module of the SSMS Dispenser.

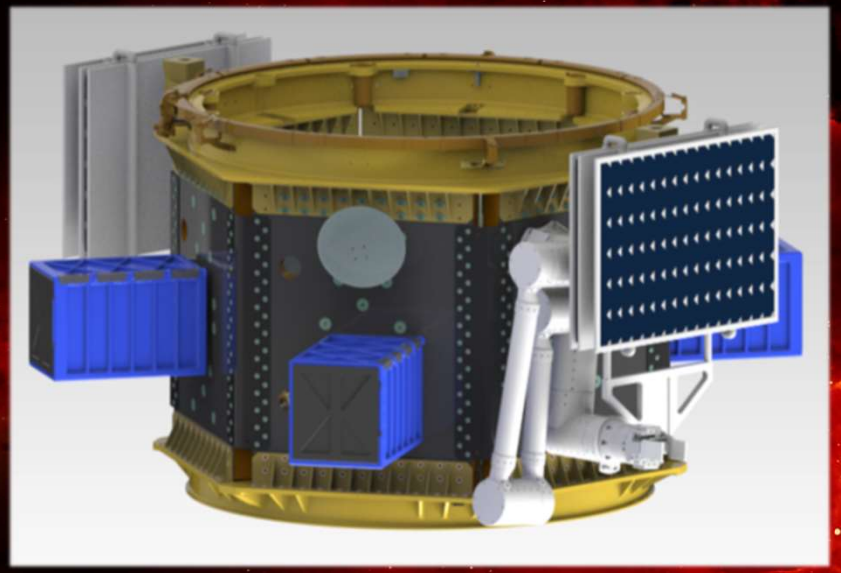
The SSMS Dispenser is the hardware developed by SAB, with the purpose to optimize multiple small satellite missions on VEGA and VEGA-C. The SSMS Dispenser is a modular structure which can be flexibly configured in order to be adapted to the specific satellite aggregate.



Concept Behind IOSHEXA

IOSHEXA is designed to be a payload adapter for rideshare and piggyback missions, with the capability of, posterior to the main passengers deployment, detach from the last stage to perform a wide range of operations.

Thanks to this double functionality, the launch capacity for IOSHEXA and related mission operations are already included in the baseline services already being provided by the Launcher Provider.

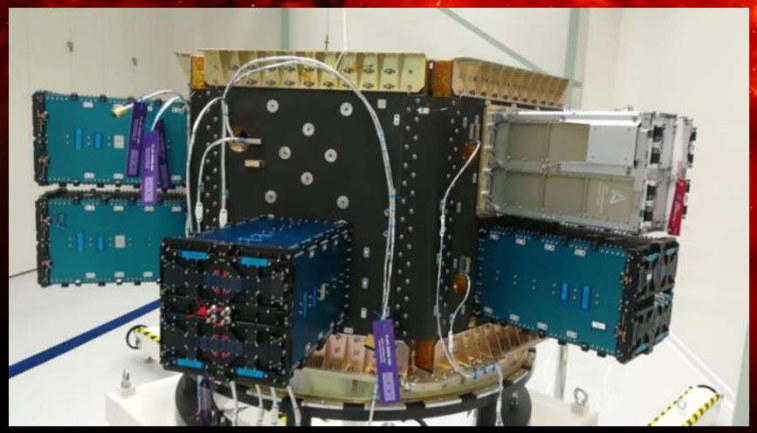


From SSMS to IOSHEXA

The main reasons behind the choice of the HEXA module can be summarized with:

• It is the most frequently used module of the dispenser: it is present in most of the configurations.

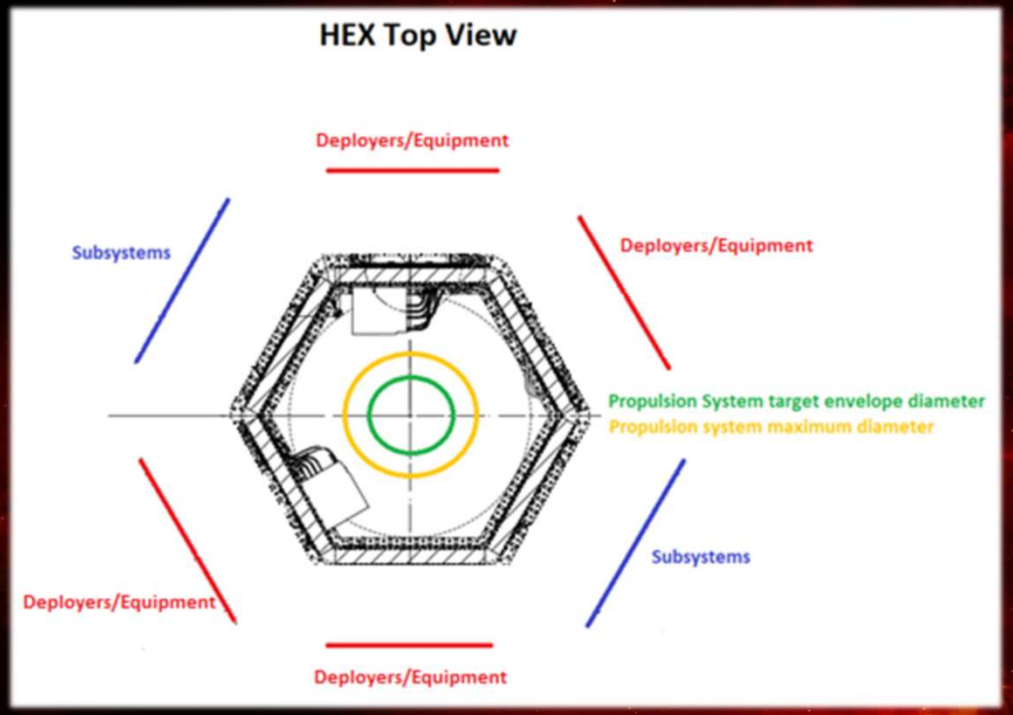
• Its shape is well suited to convert into a spacecraft and it permits modular configurations according to the passengers to deploy and the in-orbit servicing operations to perform in each different mission.



IOSHEXA Modular Concept

IOSHEXA structure has the shape of a hexagonal prism. To support the idea of performing different mission operations in a case-to-case format, every of the of the six external faces can be designated to host a selection of spacecraft subsystems, smallsat deployers or in-orbit servicing equipment.

This leads to a sort of modular design that can fulfil an extensive variety of mission.



IOSHEXA Operations

IOSHEXA will be able to provide the most suitable solution for the following operations:

- Release/Replacement of nanosats and microsats
- Active Debris Removal
- Orbital support services (refueling, assembly, recycling and refurbishment)
- Additive Layer Manufacturing (ALM)
- Cooperative Attitude and Orbit Control System (AOCS) takeover

IOSHEXA Fields of Activity

IOSHEXA main fields of activity can be resumed in:

- Orbit Insertion
- Active Debris Removal
- In Orbit Servicing

It is important to note that, thanks of the modularity of its configuration, every mission can cover more than one of these fields.

Example of Possible Missions

Mission definition	Internal capacity utilization	External faces capacity utilization		
-Deployment of a set of cubesats, for a total of 48U	Subsystems	2 x Subsystems (Solar Array)	4 x 12U Cubesat Deployers	
-Deployment of a set of cubesats, for a total of 36U -ADR	Subsystems	2 x Subsystems (Solar Array)	3 x 12U Cubesat Deployers	1 x In-Orbit servicing equipment
-Deployment of a set of cubesats, for a total of 12U -Refurbishment + maitenance of a satellite -ADR	Subsystems	2 x Subsystems (Solar Array)	1 x 12U Cubesat Deployer	3 x In-Orbit Servicing equipment

IOSHEXA Business Case

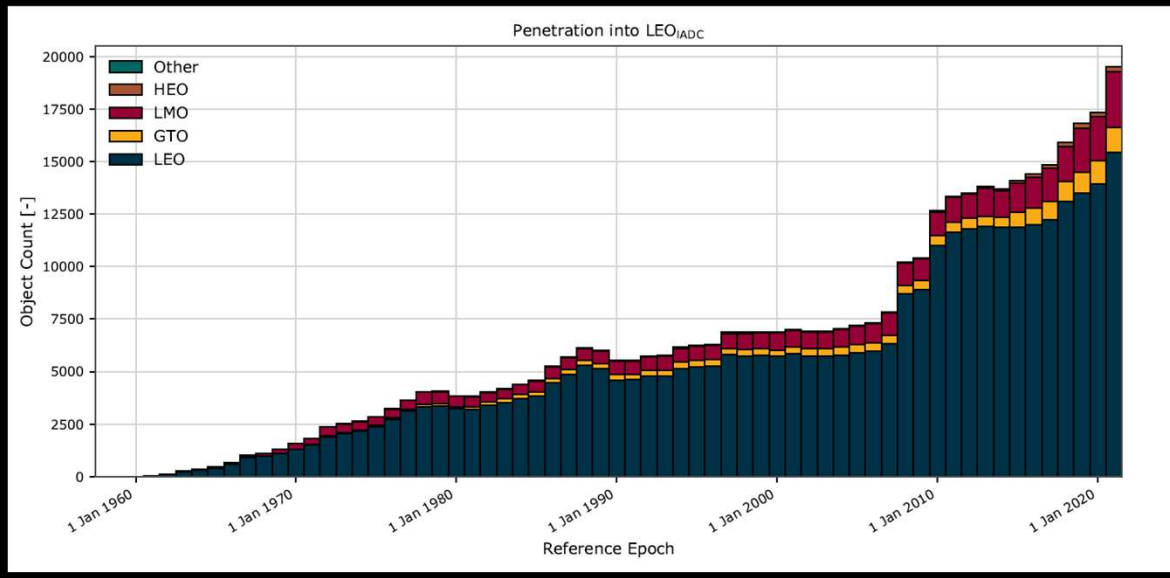
The project born with only the purpose of orbit insertion of small satellites, an already solid market that is currently still growing.

At a later stage, thanks again to the modularity granted from its shape, the focus moved also on In-Orbit servicing and active debris removal, two markets that have not yet taken shape, but that are foreseen to bloom in the current decade.

Debris Population

The population of objects in LEO region is increasing since the beginning of the space age and nowadays this increase becomes progressively steeper due to the new constellations being launched and planned.

These constellations other than having high probability to pollute space environment with new debris, represent an important risk factor for collisions with space debris.



Ref: ESA Space Debris Office, *ESA'S ANNUAL SPACE ENVIRONMENT REPORT*, 27 May 2021.

Active Debris Removal

This threatening scenario is likely to continue to draw more and more attention on space debris mitigation, making ADR one central activity in the future of spaceflight.

IOSHEXA could operate to actively remove space debris to combat this increasing threat. Accommodating space debris removal systems on IOSHEXA allows it to take measures now and in the future to conserve a space debris environment with tolerable risk levels, particularly in Low Earth Orbit (LEO) altitude regions.

IOSHEXA Demonstration Mission

First IOD Mission for IOSHEXA is foreseen in the 2025, where the following activities shall be performed:

- Release of Cubesats
- Active Debris Removal of a Microsat located on a SSO ~800 km

IOSHEXA demonstrative mission

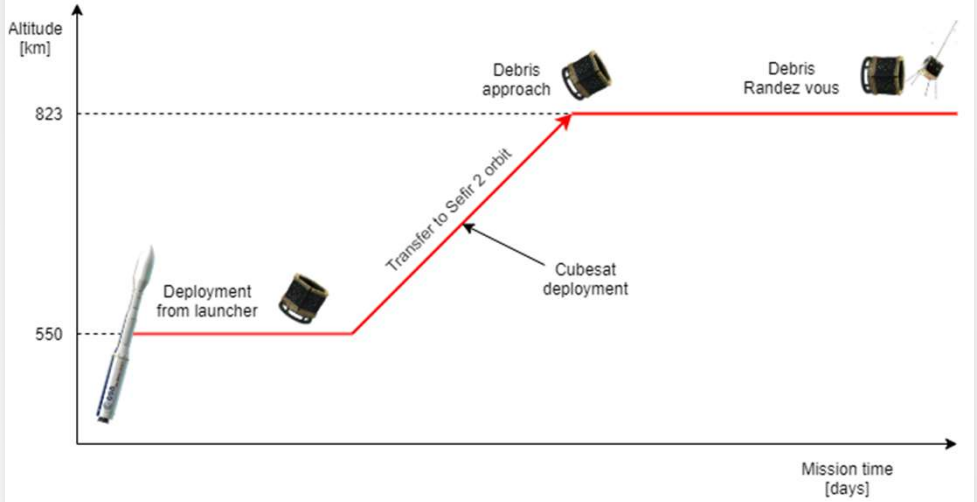
The reasons behind the choice of such mission are mainly:

- It is representative for typical orbital maneuvers foreseen for IOSHEXA's missions.
- It includes both kinds of IOSHEXA's main operations (cubesat deployment, IOS).
- Debris mitigation is foreseen to be a crucial aspect in the near future of spaceflight and ADR could become a crucial activity in this frame.
- A capture of an uncooperative target would be a perfect proof of concept for the robotic system in development for IOSHEXA.

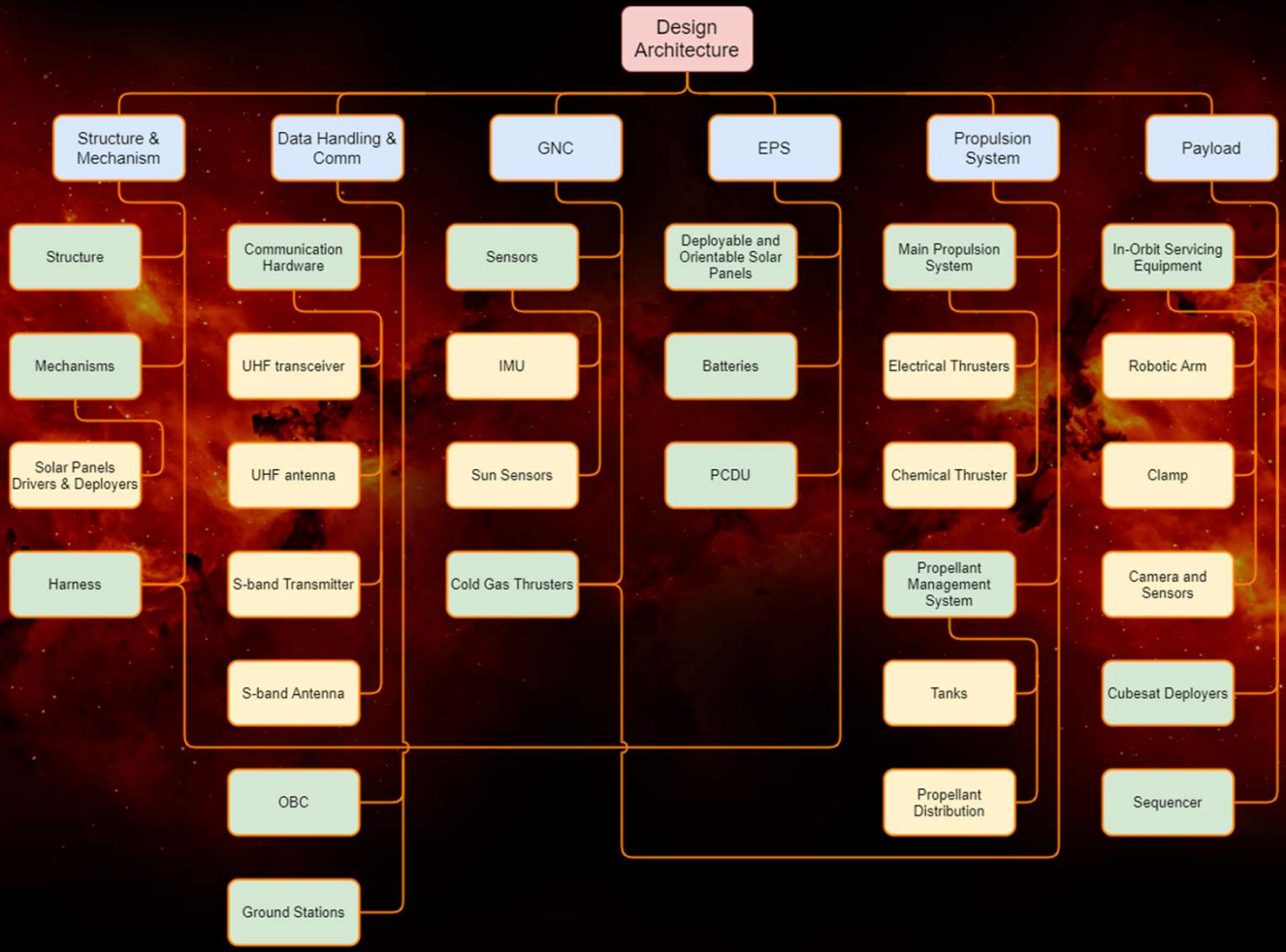
Concept of IOD Mission

The IOD ConOps in a very summarized version is:

- IOSHEXA deployment from VEGA AVUM @550 km SSO
- Orbital transfer towards requested deployment orbit
- Cubesat deployment operations
- Orbital transfer towards target debris orbit
- Randezvous and capture
- Deorbiting maneuvers



Preliminary Design Architecture



Propulsion System

The propulsion subsystem foreseen for IOSHEXA is composed of a double an electrical/chemical double motorization to convey the maximum performance dependant on mission scenario needs.

In particular, orbital maneuvers will be divided between the two systems:

- Plasma thusters: orbit raising, phasing, decommissioning
- Chemical thruster: change of inclination, last kick for atmospheric re-entry

Electrical Power System

Main components of the EPS will be the battery pack, the PCDU and the solar arrays.

The battery pack will be developed by SAB Aerospace thanks to its heritage in batteries for large spacecraft.

The solar panels will be entrusted to a partner company, they will need to be deployable and orientable and will occupy two opposite faces of the hexagon.

Communication System

The communication subsystem for IOSHEXA is divided in two subsystems, a low-gain transceiver and a high-gain transmitter. This because low data rate characterizes most of the mission, while a very high stream of data verifies during the capture operations, due to a monitoring camera that is foreseen to be installed on the robotics.

- The low-gain antenna will be an UHF omnidirectional whip antenna
- The high-gain antenna will be a S-band dish antenna

Robotic System for IOS

For the robotics one promising system is in development at the moment. This is a system that can be used in for every in-orbit service operation that requires capture and berthing.

It is composed of 3 subsystems:

- 1 robotic arm with 5 DoF
- 2 interchangeable end effectors to interface with clients/debris
- 1 grapple to berth with clients/debris

Development plan

IOSHEXA project is currently in its Phase 0. The schedule for the development is:

- Beginning of Phase A by the end of 2021
- Beginning of Phase B by mid 2022
- Beginning of Phase C by the end of 2022
- Beginning of Phase D by the end of 2023
- IOD mission foreseen for 2025