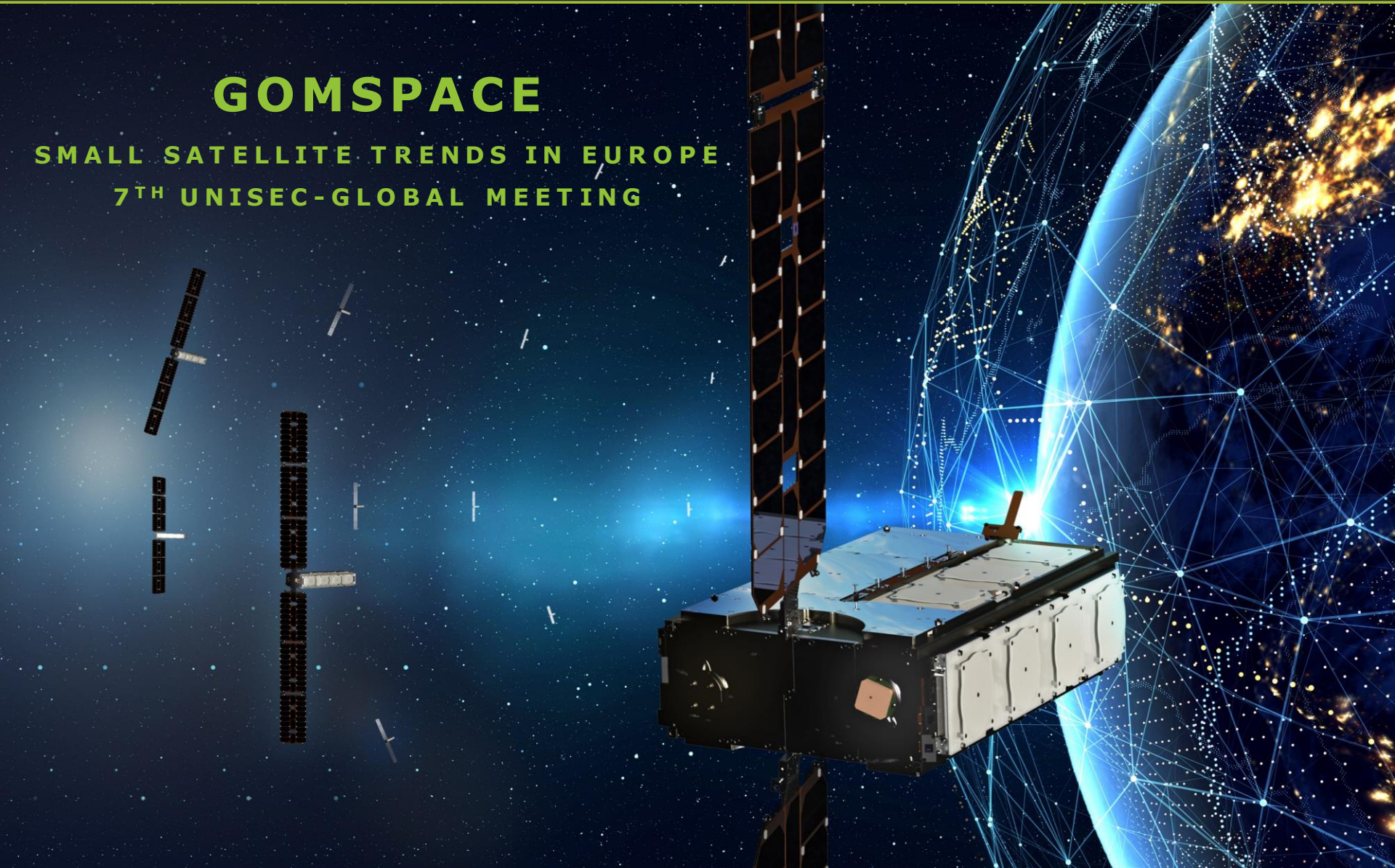


GOMSPACE

SMALL SATELLITE TRENDS IN EUROPE
7TH UNISEC-GLOBAL MEETING



| GOMSPACE AT A GLANCE |

History and Status

- Founded in 2007. Commercial from the start
- Based on research at Aalborg University
- HQ in Aalborg and operations in Sweden, USA, and Luxembourg
- Approximately 160 employees
- Listed on Nasdaq First North Premier in Stockholm since 16 June 2016 ("GOMX").

Achievements

- Pioneered aircraft tracking from space
- Delivered the first nanosatellite to the European Space Agency
- Developed the strongest product portfolio in the industry

Market Traction

- Customers in 55 countries
- Participated in more than 50 satellite missions
- ESA investing €4Mio in product improvements for deep space



Competitive Advantage

- Proven nanosat capability, flawless "flight heritage"
- World class radio technology capability



COMPANY STRATEGY

MISSION

"We help teams across the globe achieve their goals in space"

VISION

"To make nanosatellites the preferred choice for customers who have demands for professional mission critical radio based surveillance and communications solutions"



SUBSYSTEMS



- 80% IN HOUSE
- 20% TRUSTED PARTNERS
- ADAPTED TO MISSIONS

RADIO PAYLOADS



- SOFTWARE DEFINED RADIO
- ANTENNAS 0-40 GHZ
- AIS & ADS-B TRACKING
- COMMUNICATION

PLATFORMS



- SIZE: 1-64U
- FLEXIBLE CONFIGURATIONS
- INTER-SATELLITE LINKING
- ACTIVE STATION KEEPING

CONSTELLATION SERVICES



- SATELLITE OPERATIONS
- NETWORK MANAGEMENT
- DATA DISTRIBUTION

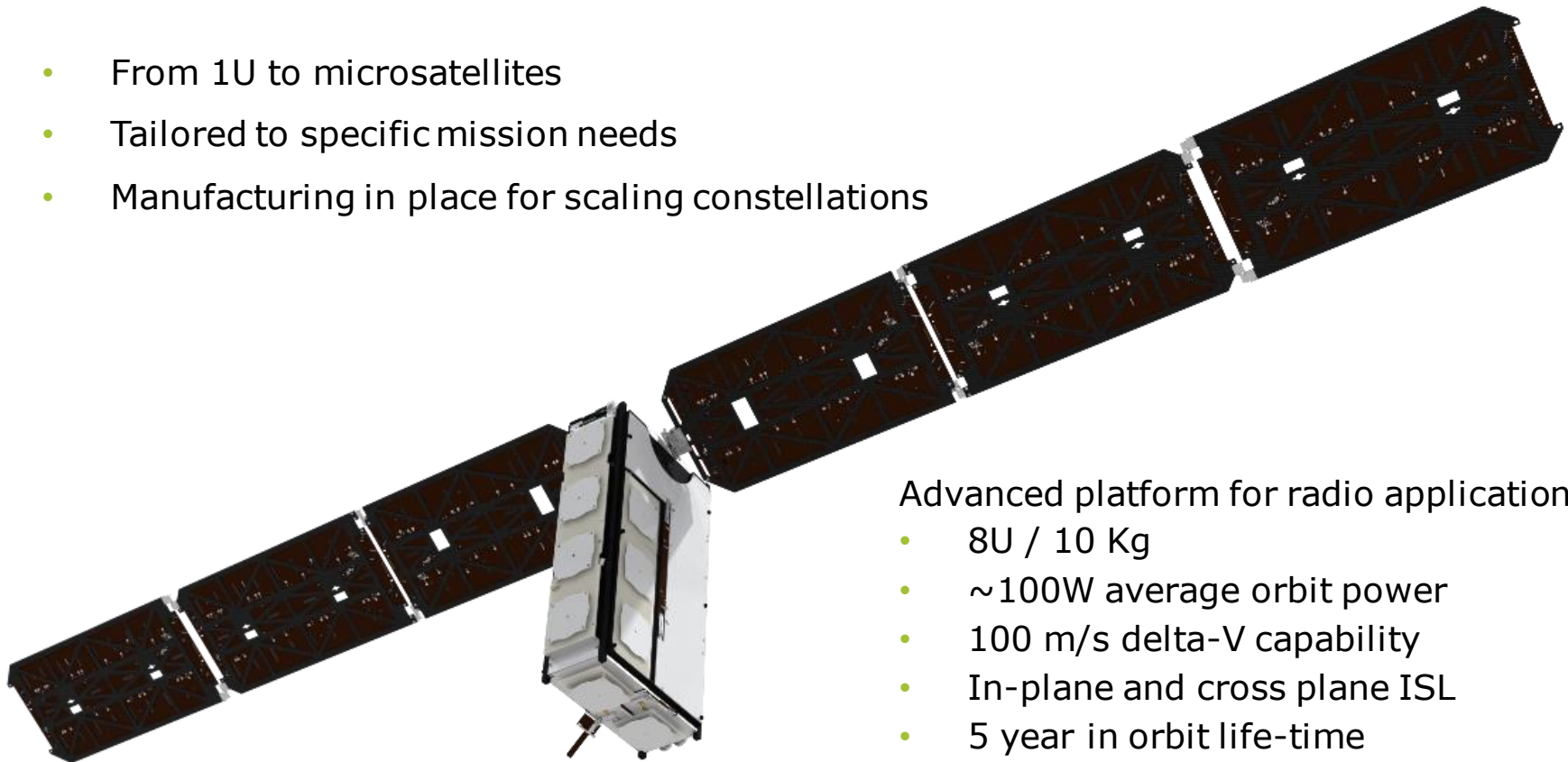
SUPPORT ELEMENTS



- LAUNCH PROCUREMENT
- REGULATORY AFFAIRS
- INSURANCE

PLATFORMS – MINIATURISED YET CAPABLE

- From 1U to microsatellites
- Tailored to specific mission needs
- Manufacturing in place for scaling constellations







Advanced platform for radio applications:

- 8U / 10 Kg
- ~100W average orbit power
- 100 m/s delta-V capability
- In-plane and cross plane ISL
- 5 year in orbit life-time

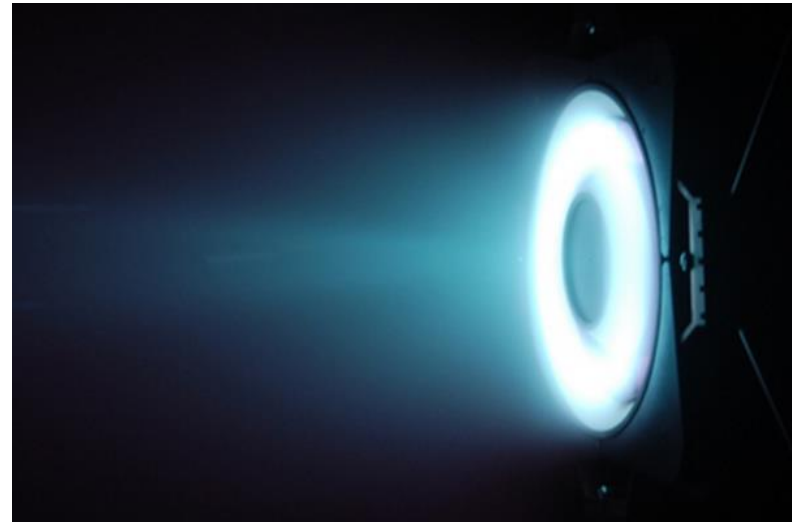
50% of the payload power of "OneWeb", but with 7% of the mass – massive launch segment savings!

GOMX FLIGHT DEMONSTRATION PROGRAMS

MISSION	OBJECTIVES	STATUS / RESULTS
	<ul style="list-style-type: none"> • 2U platform • 1st gen. ADS-B receiver 	<ul style="list-style-type: none"> • Launched in 2013 • Successful payload • Platform still in operation
	<ul style="list-style-type: none"> • 2U platform, new avionics • Aero brake payload • Quantum mechanics payload 	<ul style="list-style-type: none"> • Launch failure in 2014 • Recovered functional after launch explosion
	<ul style="list-style-type: none"> • 3U platform • 2nd gen. ADS-B receiver • Software Defined Radio • 3MBit/s X-band downlink • Robust ADCS capability 	<ul style="list-style-type: none"> • Launched in 2015 • All mission objectives successfully met • Payload functions extended through in-orbit upgrade • Entered in 2016 (12 month+from ISS)
	<ul style="list-style-type: none"> • 2 x 6U platform • AIS, ADS-B tracking • Visual & hyperspectral camera • Cross linking • Enhanced ADCS capabilities • Propulsion for station keeping 	<ul style="list-style-type: none"> • Launched in February 2018 • Successfully in-orbit commissioned

TRENDS IN EUROPE

- ESA focus on CubeSats and small satellites
 - Technology projects
 - Deep space missions
 - Asteroid exploration
- Propulsion
 - Electrical Propulsion (EP)
 - Hybrid Propulsion
- Constellations moving forward
- Space debris
- Space Law



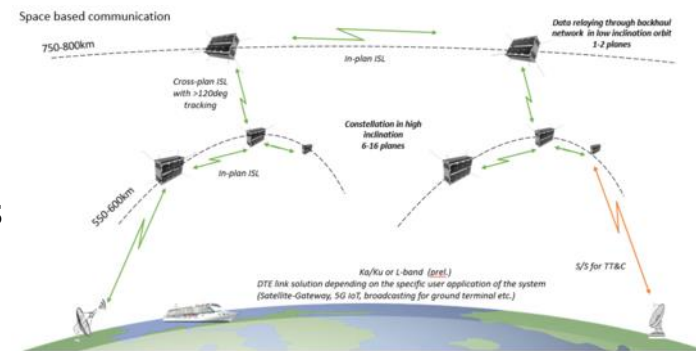
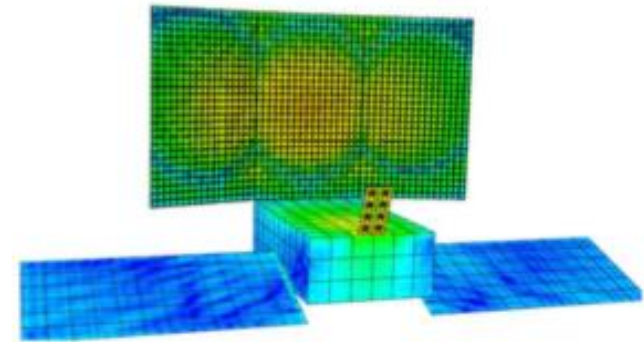
MISSIONS – EXPLORING NEW DESTINATIONS

- Full turn-key capability:
 - Space segment design and delivery
 - Ground segment design and delivery
 - Supporting launch procurement and regulatory affairs
- Currently leading many innovative ESA missions:
 - RACE, 2x 6U, Rendezvous and Docking experiment, 2021
 - GOMX-5, 2x 12U platform for wideband, 2021
 - Juventas, 6U deep space mission, 2022
 - M-ARGO, 12U stand alone asteroid explorer, 2023
- Helping many commercial companies with advanced missions:
 - Unseen labs in France, advanced 6U, launched in 2019
 - KLEOS in Luxembourg, 4-satellite cluster launch in November 2019
 - Aerial & Maritime , 8x 3Us for AIS & ADS-B tracking around the Equator to launch in 2020



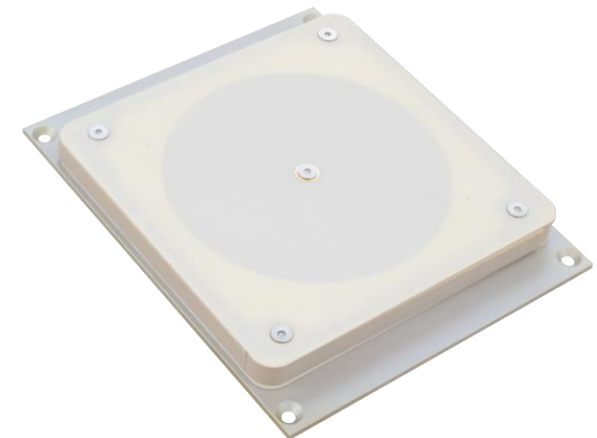
R&D PIPELINE – CONTINUED DISRUPTION

- We invest in disruptive technologies for the future:
- Advanced antennas:
 - Reflectarray technology for CubeSats
 - Allowing advanced multi-beam solutions for SATCOM applications (Ku/Ka-band)
- Hybrid Propulsion
- Constellation Management
 - Autonomously managing complex constellations
 - Integrating the space segment with the “business segment”
- In parallel we continue to improve our existing products with improved performance and lifetime improvements



R&D PIPELINE – RADIO TECHNOLOGIES

- Very broad radio program based on the SDR platform
 - Heritage since GOMX-3
 - Extremely flexible (70MHz – 6GHz)
 - Hardening program – 5 Years in space
 - Version 3 due 2020 Q2 (more storage and interfaces)
- Current solution:
 - S-Band (ISL and HSL)
 - AIS receiver
 - ADS-B receiver
- Future solutions:
 - XT8250, X-band (2020 Q2)
 - Ka-band (GOMX-5)
- Many custom solutions for Signal Intelligence and IoT

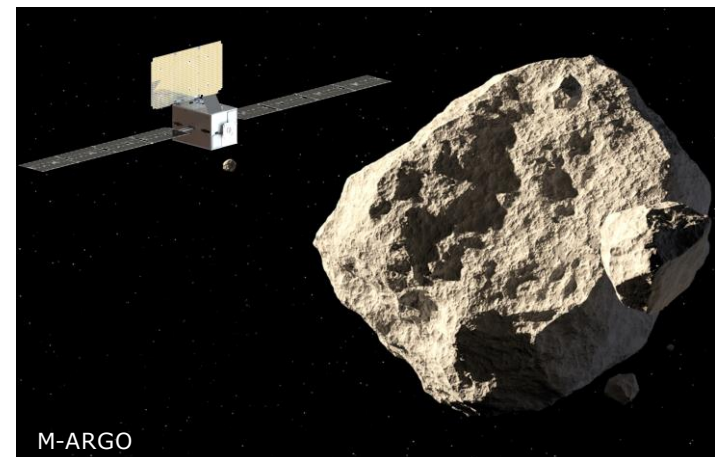


| "HYBRID PROPULSION" |

"Hybrid" means a combination of cold gas and electric propulsion:

- The cold gas part will provide: High thrust in all directions (up to 12 thrusters) at low power, but low delta-V.
- The EP part will provide: High delta-V, but at low thrust and high power
- Hybrid propulsion combines the best of two worlds and is needed to take on advanced mission such as M-ARGO, a 12U stand alone asteroid explorer

Capability	EP	Cold Gas	Hybrid
Delta V	High	Low	High
Thrust	Low	High	High
Isp	High	Low	High
Power used	High	Low	Flexible
P/F agility	Low	High	High
6DoF	No	Yes	Yes



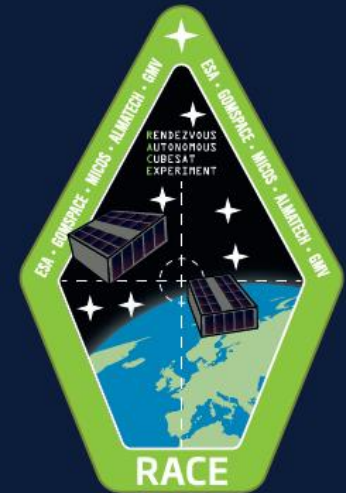
GOMX-5 MISSION



- **Joint ESA and GomSpace Mission – 2x 12U CubeSats**
- **Constellation technology validation**
 - Demonstrate large orbital transfer maneuvers in LEO
 - High speed intersatellite linking
 - Hybrid propulsion
 - GNSS Precise Point Positioning
 - Many different payloads



RACE MISSION



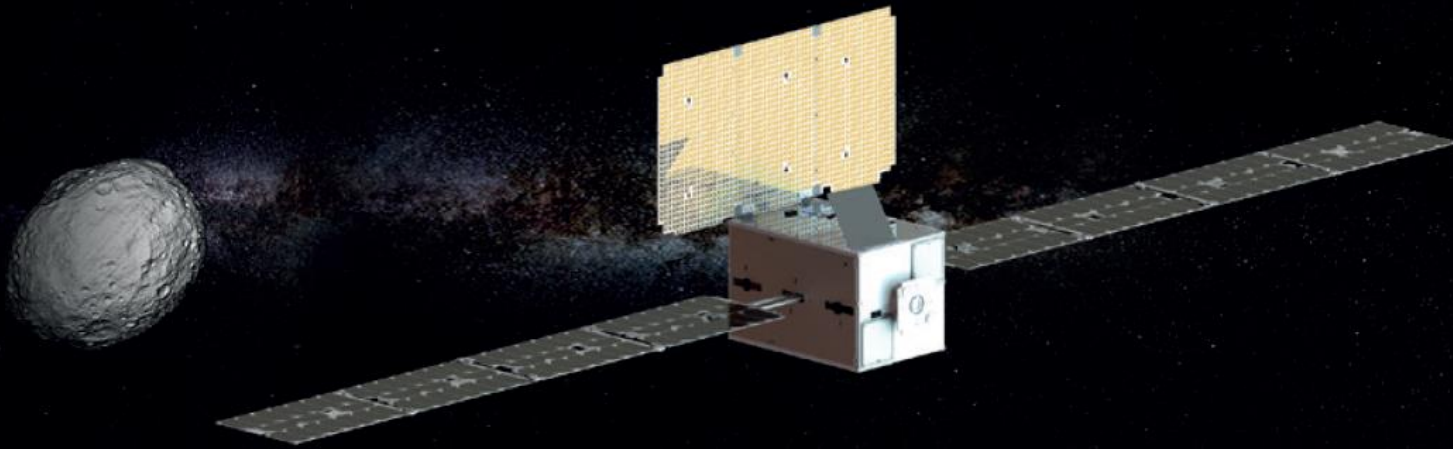
- **ESA Rendezvous Autonomous CubeSats Experiment – 2x 6U CubeSats**
- **GomSpace Project Prime: GMV (PL/RU), Almatech and Micos (CH)**
 - The two satellites are launched together in Low Earth Orbit.
 - After the initial commissioning phase, the spacecraft will perform the rendezvous and docking (RVD)
 - Perform close fly around (CFA) experiments



HERA/JUVENTAS MISSION

- **6U nanosatellite for ESA's Hera mission (Juventas)**
- **Passenger on the ESA Hera spacecraft**
 - Juventas will be deployed at rendezvous with Didymos binary asteroid
 - Will operate from a stable terminator orbit around the Didymain asteroid
 - At the end of its mission lifetime (1-3 months), Juventas will land on the surface Didymoon. High rate sensors will monitor the impact bouncing and landing events for information on asteroid surface properties

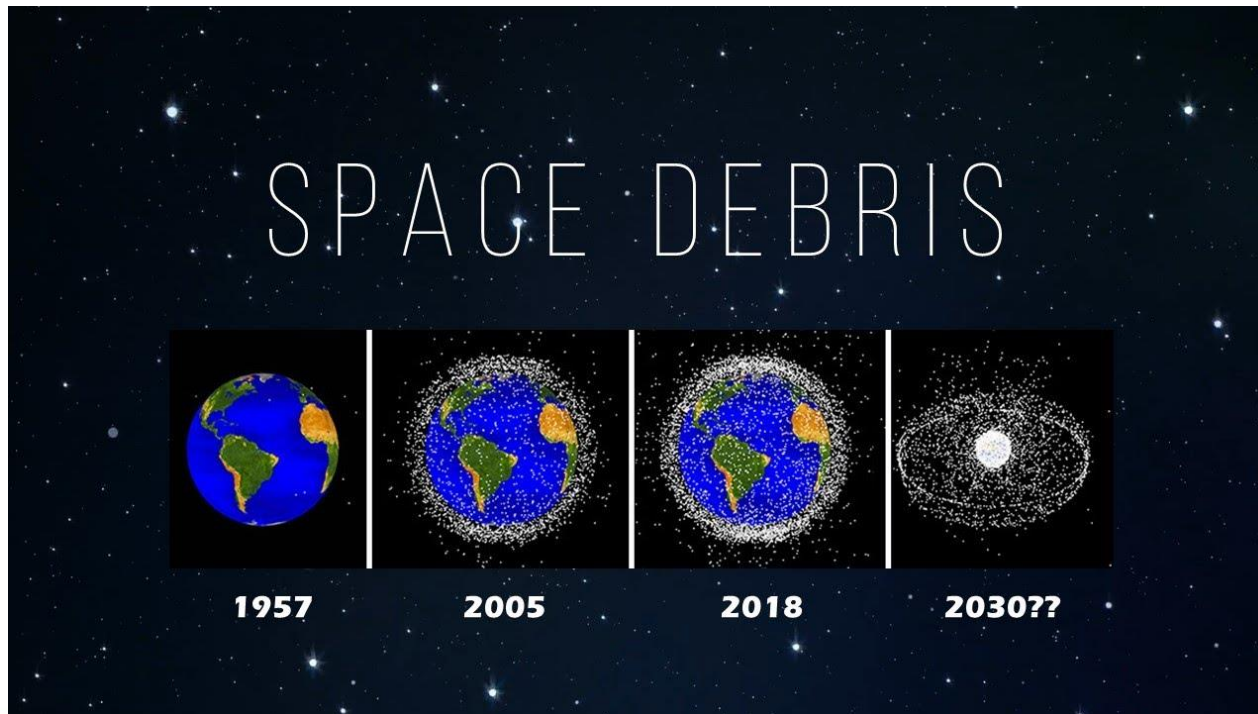
M-ARGO MISSION



- **ESA Miniaturized Asteroid Remote Geophysical Observer (M-ARGO) - 12U**
 - M-ARGO will demonstrate the ability of a small CubeSat to navigate to an asteroid and perform remote sensing observations by itself
 - Direct-to-Earth X-band communication
 - High-performance deep-space electric propulsion
 - Imaging spectrometer payload for in-situ resource observation
 - Autonomous optical navigation experiment during cruise

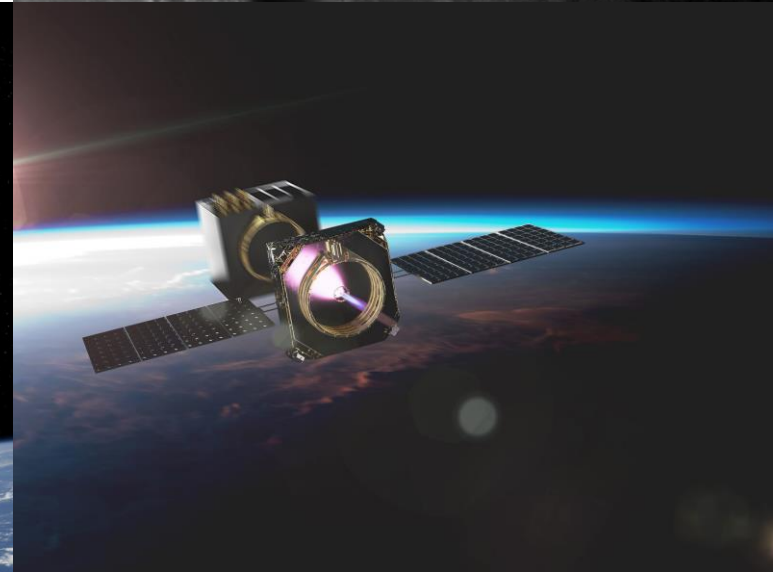
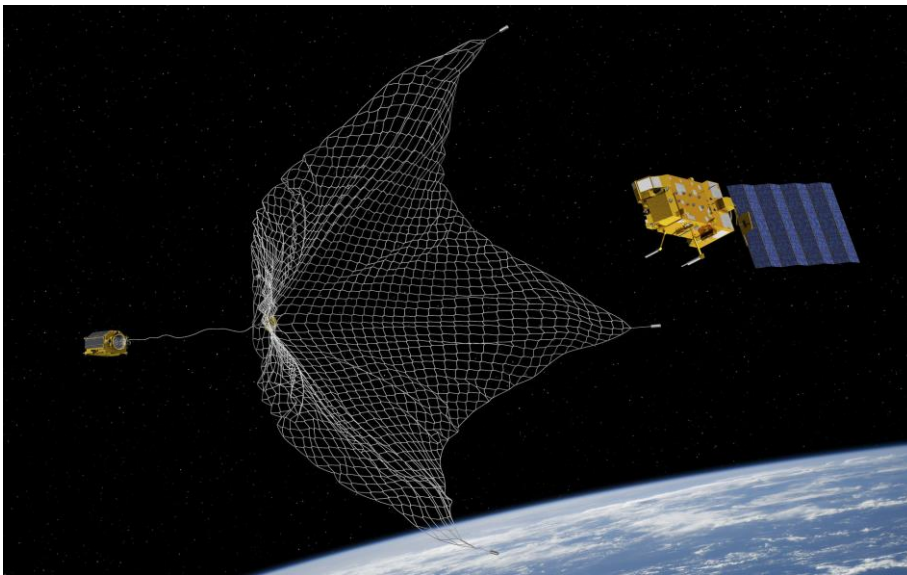
SPACE DEBRIS

- Jan Wörner, ESA Director General (November in Sevilla)
 - “There are about 4.500 satellites in orbit. Only about 1.500 of them are active!”
- Many new launchers planned in the coming years
 - This will create even more space debris



SPACE DEBRIS

- Space debris removal methods:
 - Harpooning
 - Catching in net
 - Propulsion – tugging / refueling
- Deorbiting at mission end, will likely be a future requirement!



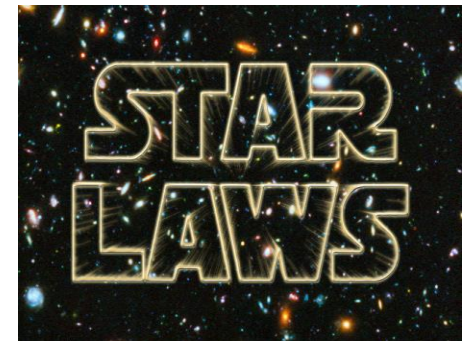
| SPACE LAW |

- **Space law** is the body of law governing space-related activities, encompassing both international and domestic agreements, rules, and principles.
- The UN Committee on the Peaceful Uses of Outer Space (UNCOPUOS) established in 1958, is the forum for the development of international space law.
- The Committee has concluded five international treaties and five sets of principles on space-related activities:



| THE FIVE SPACE TREATIES |

- **The "Outer Space Treaty" (1967)**
 - Treaty on the Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies.
- **The "Rescue Agreement" (1968)**
 - Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space
- **The "Liability Convention" (1972)**
 - Convention on International Liability for Damage Caused by Space Objects
- **The "Registration Convention" (1976)**
 - Convention on Registration of Objects Launched into Outer Space
- **The "Moon Agreement" (1979)**
 - Agreement Governing the Activities of States on the Moon and Other Celestial Bodies



|STATES' INTERNATIONAL RESPONSIBILITY FOR NATIONAL ACTIVITIES IN SPACE|

- **Outer Space Treaty, Article VI**

Parties to the Treaty shall bear **international responsibility** for national activities in outer space, whether such activities are carried on by governmental agencies or by non-governmental entities (**private actors**), and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty.

The activities of non-governmental entities (**private actors**) in outer space shall require **authorization (license)** and continuing supervision by the appropriate State Party to the Treaty.

- Who to blame?
- Who should enforce the rules?
- How to fine?
- What are responsible actions?



CUSTOMER TRACTION

- Helping our customers in more than 55 countries
- Serving academic, commercial and government customers

"We are certain that the GOMX-4B mission will significantly advance the state-of-the-art of nanosatellite capabilities in view of future operational missions following on from the highly successful GOMX-3 mission"
 - Dr. Roger Walker, head of cubesats ESA

"Their flight proven products are for us a major source of confidence, allowing us to focus our expertise on payloads, missions and services,"
 - Jonathan Galic, CEO of UnseenLabs





"WE HELP TEAMS ACROSS THE
GLOBE ACHIEVE THEIR GOALS IN SPACE"

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