

Sustainability and Commercialisation of the Space Logistics market

Space debris and increasing commercial activity in LEO

In 2009 the inactive COSMOS communications satellite collided with an active commercial communications satellite operated by US-based Iridium. The incident marked the first ever collision between two satellites in orbit and produced almost 2000 pieces of debris, measuring at least ten centimeters in diameter and many thousands more smaller **pieces**¹. Since this event space fairing nations such as the US and Europe have started putting measures in place to minimise the risks of another collision. Even though these events are a rarity the chances of this happening in the future will be greater as the number of objects in **Earth's orbit is increasing**².

As of today there are around 6800 functioning satellites sharing their orbits with approx. another 8800 tons of **space debris**³. Around 32000 of debris objects are being regularly tracked by space surveillance networks, however there is still another estimated 128 million fragments that are smaller than 5 cm and cannot be directly monitored by **Earth-based Space Situational Awareness (SSA) assets**⁴. Even though small, these objects can cause substantial

damage as was proven with the Sentinel 1A where a particle of a couple of millimeters caused a 40 cm diameter on the solar array **structure**⁵.

Part of the increasing objects around earth is due to trends such as **miniaturisation of electronics and the access to space becoming more affordable** which subsequently are enabling new players to enter and launch new commercial constellations of small satellites. It is anticipated that in the **next decade approximately 13910 satellites below 500 kg will be launched** which is a significant increase when comparing to the previous decade (2011-2020) where 2960 small satellites were launched. These new low-cost constellations aim to deliver services related to global connectivity, Internet of Things or high frequency change detection. Satcom mega-constellations are however taking the largest chunk of this expected increase with an estimated 84%, led by a few commercial operators such as Starlink, Amazon's Kuiper and OneWeb also playing a part, Figure 1.

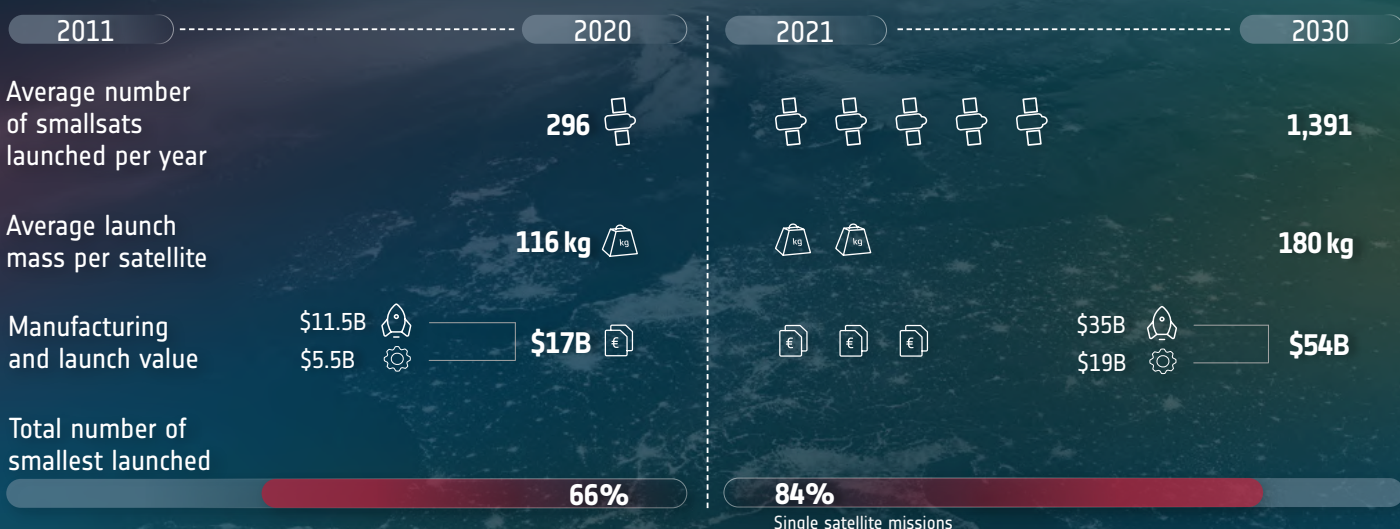


Figure 1: Small Satellite Market by 2030, Euroconsult

1. 2009 Iridium-Cosmos Collision Fact Sheet
2. ESA's Space Environment Report 2022
3. NSR's In-Orbit Services Report Projects \$14.3 Billion in Revenues...
4. Space debris by the numbers
5. Copernicus Sentinel-1A satellite hit by space particle

Space Logistics services expected to mature in the next decade

With the growing activity in LEO there is an emerging need to ensure that activities are handled safely and responsibly. Public actors play a key role in developing standards and policies which until now have been developed at national level by some leading space nations such as the US and Europe. However, an overall legally binding framework at global level is yet to be developed. At the same time developments in the domain of space logistics such as Active Debris Removal (ADR), Life Extension (LE), On-Orbit Assembly and Manufacturing (OOAM), Last Mile Logistics (LML) or Space Situational Awareness Services (SSA) are all expected to mature in the next decade and to be valued at USD 4.4bn in cumulative revenues by 2031, Figure 2.

The efforts taken by governments for more sustainable use of LEO is seen as the main driver for ADR services with another potential demand coming from the commercial side due to the growth of mega constellations. The market for ADR is projected to generate around USD 980 million in revenue by the end of this decade. However, there are some barriers that may challenge these projections due to market maturity and space law not properly addressing space debris. Especially the lack of regulation may lead to reluctance of commercial players investing their resources

as they have no obligation to do so. Nevertheless, it also provides an opportunity for early entrants to influence national and international standards according to their political and **industrial interests**⁶.

From the all the segments, SSA is seen as the largest market at 1.4 billion USD in the next 10 years and will answer to immediate needs from commercial and government satellite operators. Major strides are already being made in the collection of data for identification of key threats in different orbits and commercial players are offering unique value proposition by building ground and/or space based **service offerings**⁷.

Finally, Last Mile Logistics is also projected to represent 4% of the SL market with most demand coming from commercial constellations in LEO, while 24% dedicated to Life Extension, a market that is already maturing, will penetrate mainly the traditional satellite operator in GEO. The market for OOAM is still very much nascent and is primarily focused on increasing TRL but expected to gain from technologies and skills developed in other Space Logistics segments.

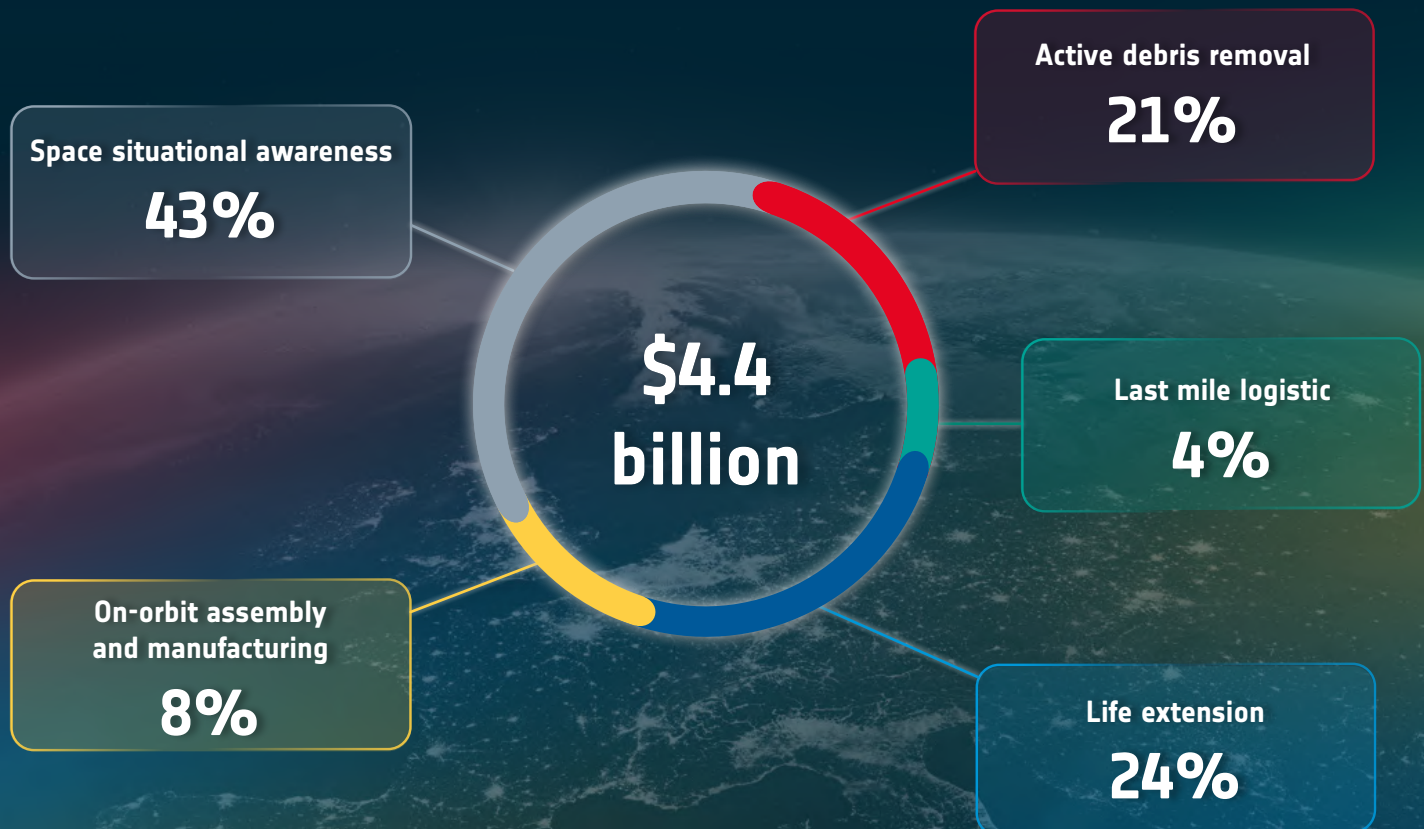


Figure 2: Space Logistics market by 2031, Euroconsult

6. Euroconsult, Space Logistics Markets, 2022

7. NSR, In-Orbit Services, 2022

SL in Europe: Newcomers, legacy players and partnerships

In Europe a mix of newcomers and legacy players are developing and demonstrating new key concepts and services for the Space Logistics market. Thales Alenia Space announced back in September 2022 it will lead a programme funded by the European Commission which aims to deploy services with regards to life extension and enhancement of assets and ultimately reduce space debris, while Airbus has led several experiments on **debris removal concepts**^{8/9}.

Swiss based Clear Space which is supported under ESA's Clean Space initiative is also developing debris removal services and is extending their portfolio as they recently announced a collaboration with satellite operator Intelsat for the development of **life extension services**¹⁰.

As for last mile logistics, Exotrail will combine its in-orbit mobility service by partnering with Isar Aerospace and deliver multiple satellites between 2024 and 2029 in lower earth and geostationary transfer orbits. Further agreements have also been reached with SpaceX and Arianespace; securing their spacedrop manifest for years to come. Exotrail's first space logistics mission, spacedrop - 001 is set to depart with SpaceX Falcon 9 on October 2023 with the second mission flying in June 2024. D-orbit has also reached an agreement with Astrocast by signing a multiple launch and deployment contract and will support in delivering 20 nanosatellites over a period of 3 years with its orbital transfer **vehicle figure 3**^{11/12}.

GMV has won several contracts for building national Space Surveillance and Tracking (SST) systems based on their COTS software which will also contribute to the EU's **Space Safety and Tracking (SST) system**^{13/14}.

Telespazio is also entering the SSA domain by partnering with Northstar to enhance cooperations and deliver solutions for the European market. Under this agreement Telespazio will serve as NorthStar's exclusive distributor and value-added solution provider for governmental customers in **Europe**¹⁵. Northstar Earth and Space is a company planning a constellation of satellites specifically for collecting space situational awareness data and is expected to launch its **first satellites mid-2023**¹⁶.

It is clear to see from these developments that the increasing activity in LEO and its consequences are not going unnoticed. There is a clear demand coming from governments to push for more sustainable and safe use of space and European industry have and are developing capabilities to meet those demands. The European Space Agency under its Space Safety Programme is taking a lead in this by implementing a zero debris policy by 2030 and bringing together service provider and customer for **commercialising in-orbit servicing**¹⁷. Whereas, the Future Launchers Preparatory Programme is supporting the development of in space transportation capabilities to access new destination and missions such as spacecraft servicing, repair and in-orbit construction of large structures.

Five parallel contracts have been signed with key SpaceTech partners for the early activities on Space Logistics Proof-Of-Concept 1 on In-Orbit Rendezvous and Docking. Its In-Orbit Demonstration is foreseen in 2024-2025. In parallel, a Proof-Of-Concept 2 on In-Orbit Refuelling between a space-tug and an orbital propellant depot will be initiated.

The next decade will see these technologies mature and prove which of those have commercially viable business cases.



Figure 3: Space Logistics: **Spacevan**, Exotrail



Figure 4: **ClearSpace-1** captures **Vespa**, ESA



Figure 5: **Towards a Space Transportation Ecosystem**, ESA

8. THALES ALENIA SPACE TO LEAD EROSS IOD, ON-ORBIT...
9. SRC Operational Grants
10. ClearSpace to Work with Intelsat on Commercial GEO Life-Extension...
11. Exotrail and Isar Aerospace sign multiple launch services agreement...
12. D-Orbit to deploy 20 Astrocast satellites over three years
13. GMV Provides Core Software for German Armed Forces' SSA Center
14. GMV supports the development of Portuguese SST system
15. New Space Domain Awareness Services for European Governments...
16. First NorthStar SSA satellites to launch in 2023 by Virgin Orbit
17. The clean space blog