

Sustainability in Space: Re-using space objects in orbit

There is a risk of polluting the ozone layer with aluminium oxide due to the increased number of objects being deorbited and burnt up.

How can we re-purpose satellites and create factories in orbit to recycle the materials? In recent years, the cost to manufacture and launch satellites has reduced dramatically, as has the time to build the hardware. As a result, we have seen the rapid development of mega-constellations in Low Earth Orbit (LEO). The increasing number of satellites and launches presents two potential issues with regards to space sustainability and pollution of the Earth's ozone layer:

1. De-orbit – Earth's LEO orbit is becoming increasingly congested and there are strong guidelines for operators to de-orbit their satellites at each satellite's end-of-life to prevent further congestion. However, when a satellite is de-orbited, the platform burns up in Earth's upper atmosphere releasing chemicals and potentially inducing changes in the chemistry of the atmosphere.
2. Rocket fuel – solid-fueled rockets cause significant damage to the Earth's atmosphere as Aluminium Oxide (Al_2O_3) and Hydrogen Chloride are released as a result of the reaction.

The ozone layer exists in Earth's upper atmosphere (stratosphere) and protects the Earth from ultra-violet radiation that would otherwise cause damage to life forms on the surface. The ozone layer is gradually formed, destroyed and reformed in a continuous cycle. The amount of certain elements and compounds in the atmosphere affects this cycle and can lead to the ozone layer being destroyed faster than it reforms. There is concern that with the dramatically increased number of objects being de-orbited, and with the growth of mega-constellations, the Aluminium Oxide released into the Earth's atmosphere may cause significant disruption to the ozone cycle. In addition to this, both the Al_2O_3 and Hydrogen Chloride released into the atmosphere during rocket launches could further contribute to the depletion of the ozone layer.

In many cases, the factor limiting a satellite's lifetime is the amount of fuel it can carry and degradation of key components (e.g. batteries and solar arrays). Many other components in the platform are still functional for years after the satellite stops operating and have the potential for re-use. As mentioned previously, Low Earth Orbit is already populated with many old satellites and other debris such as rocket bodies that could be utilised as a resource for new missions. Recycling these units and materials would be one way to reduce ozone pollution and maximise the use of resources already in orbit.

Can the debris already existing in orbit be used to create factories in space for new applications – solving both the congestion of LEO and pollution of the ozone layer?