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SUSTAINABILITY: THINKING BEYOND ORBIT

Abstract

Sustainability. It is arguably the most said word and most spoken about concept in the 21st century. However, whether it be referenced with respect to 'on Earth' activities, or 'in Space' activities, the word itself means a wide array of meanings, all of which emphasize humanity's plight. Whilst these domains may be thought of as being isolated in nature, these are inexplicably linked. And there lies the ultimate predicament.

The importance of Sustainability, specifically associated sustainable practices, may have only gained prominence through the establishment of the then United Nations Millennium Development Goals in 2000 and the now United Nations Sustainability Development Goals in 2015, but the outcomes, or the lack of outcomes due to the degradation of the global conditions, have existed for a while. What is important here is that as sustainable practices gain traction 'on Earth', it isn't 'in Space'.

Space Debris, and its mitigation, minimization, and avoidance, highlight the current focus for Space Sustainability. Sustainability in this sense can be catered for under various models, ranging from relatively easy to difficult, across the dimensions of inexpensive to expensive, overlayed with a dimension of practical to impractical (for the time being). The ability to plot these models across a maturity scale enables space-faring participants to then adapt to a method to assist with global sustainability ambitions.

Model one is the most optimal, the ability to extend a spacecraft's operating life by refueling or replacing the power module. This sees spacecraft avoiding becomes defunct and non-operational. Model two reflects the current method of resolving the current issue, that is providing spacecraft with the ability to be 'picked up' by another spacecraft for the purposes of 'trash collection'.

Model three is a little complex at this stage but leverages cis-lunar manufacturing or simply the re-cycling of spacecraft for the purposes of lunar activity. This would see spacecraft retiring to the lunar surface to be re-used. Model four reflects another model of Space debris mitigation through de-orbit activities through the Earth's atmosphere, with Model five reflecting relocation of defunct or non-operational spacecraft to the Graveyard orbit.

What these models highlight is a level of optionality and the avoidance of a 'one size fits all' approach to Space Sustainability, specifically Space Debris mitigation, minimization, and avoidance. This paper therefore looks to analyse the high-level feasibility of introducing such a maturity model for this predicament.