

Circumventing “Lost in Space” and evading Kessler Syndrome

Swapnil Anil Surdi⁽¹⁾, Gayatri Navya Narayanam⁽²⁾

⁽¹⁾ University of Southern California, University Park, Los Angeles, CA 90089, USA, surdi@usc.edu

⁽²⁾ University of Southern California, University Park, Los Angeles, CA 90089, USA, narayang@usc.edu

ABSTRACT

Kessler Syndrome is a well-known consequence of high-density constellations in LEO. The rate of satellites being placed in LEO is increasing drastically, whereas the rate of decay of orbital debris is still the same. The current system that predicts collisions is time consuming and complex. At Earth level, it is difficult to maintain everything by a single system, which makes us move towards decentralized systems. This paper explores a self-organizing decentralized network of Ground Stations and Satellites.

The current system for tracking satellites and debris, takes a lot of computing power, and does not provide an accurate result. One of those systems, SOCRATES, predicted a close approach of 584 m, between Iridium 33 and Cosmos 2251. Those two satellites ended up colliding and creating debris. It is discussed how the new proposed system will aid towards the safety of the space tourism and satellite constellations. The proposed system will incorporate a new network protocol that will use least space in the spectrum, reducing the noise in space. This protocol could be utilized over the ISM bands or a special band could be allocated for this. Possibility of use of Terahertz frequencies for communication between Alpha nodes of the network is discussed. Any satellite or ground station could be an alpha node, if it can compute the predictions fast enough.

A collision could be better sensed locally, instead of being predicted by distant systems. Just like blockchains, any information about new objects will spread from the node that detected it. Possibility of “Consensus” utilization between Alpha nodes in the network, is discussed along with crowd sourcing. The Bitcoin or Ethereum, which are based on blockchain consensus, have a delay of about 30 seconds, which includes sharing and processing of the information by almost the whole network. Unlike this, the satellite network will take a few seconds, as the information is not to be processed by all nodes and it can use broadcasting features over wireless network. Also, all the nodes in the network will not require the whole blockchain in their memory, which will reduce the complexity of the electronics required on the satellites. Potentially, all the new satellites are supposed to carry this small electronic system which can be part of the network if required. Several uses for adding this block, like giving up its location if the orbital debris removal comes into picture, are also discussed. The network will prioritize the information about the current positions of the orbital debris and satellites but will also share the predicted impacts or close pass-by. This data will improve the statistical analysis for the conjunction assessment by making it more accurate and less complex than the current situation.