Blake Notes

Blake

Sites:

1.

1 Extracted Data

1.1

The distribution of space debris was extracted using Web Plot Digitizer [**?**] from NASA's collected data (See Figure 1 [**?**]).

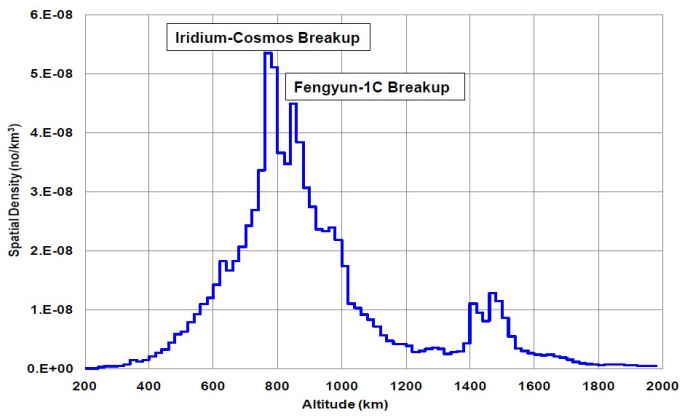

Figure 1: The LEO debris distribution is primarily clustered in altitude corresponding to the Iridium-Cosmos Breakup and Fengyun-1C Breakup

2 Lasers

2.1 ORION

[**?**]

- Ground based removal is feasible and testable

- Cost
  - A: remove (30,000 debris objects) in 2 yrs full operation up to 800km altituded (20 hr/day) -¿ $93M-$108M
  - B: remove (115,000 debris objects) in 3 yrs full operation up to 1500km altituded (20 hr/day) -¿ $140M-$176M

2.2 SpacedBasedLaserSweep

[?]

- "the debris density at the most critical altitude can be reduced by 23The laser will engage many objects at least two times, and perform roughly 140,000 engagements in 10 years. This means that the average time between two firings will be between 30 min and 40 min."
- "The simulated baseline mission has a duration of 10 years, a laser operating range of 20 km, a laser pulse energy of 372 J and a beam tracking velocity limit of 151=s."

2.3 PhippsSpaceLaserNudge

[?]

The mass and cost evaluations have been done by Photonic Associates, LLC

- lasers used for LEO perturbing and GEO nudging
- LEO NUDGE mass 5000kg, range = 1600km, $220M, tagets 1 mass 1000kg
- LEO small mass 6000kg, range = 250km, $207M, tagets $10\hat{5}$ mass 0.05kg

2.4 NumericalGroundBasedLasers

[?]

- cost $20/g to send objects to space -implies 2 times cost to send to space

2.5 clearing with lasers

-http://spie.org/newsroom/technical-articles-archive/4076-clearing-space-debris-with-lasers

"Energy costs 3/MJ on the ground, but any system designed to fly up and grapple or attach something to debris costs $10,000/kg to place in orbit."

2.6 PhippsSpaceLaserNow

[?]

- Ground small – target mass 0.75kg, 12k$/debris, 16k$/kg removed, 20,000 debris/yr, 200s/target
- Ground large – target mass 750kg, 4.7M$/debris, 6.3k$/kg removed, 750 debris/yr, 3.7yr/target
- Polar ground large – target mass 1400 kg, 5.3M$/debris, 3.8k$/kg removed, 300 debris/yr, 66 days/target
- Space small – target mass ¡0.038kg, 310$/debris, 8$/kg removed, 100k/4.6 30 debris/hr 20+=75km
- Space Large – target mass 1000kg, 280k$/debris, 280$/kg removed, 2k debris/4yr 600+-300km

2.7 Summary

The cost and reduction functions for any laser based LEO debris reduction method is dependent upon many attributes of the laser. An initial cost and reduction analysis would be to compare energy usage of the laser, energy needed to remove a single debris target, and the time taken to complete this task. While this would work provide a rough estimate, much more sophisticated cost and reduction analysis has already been computed at Photonic Associates LLC, taking into account numerous factors, such as mirror sizes, target size/mass, laser range, laser down time, laser tracking time, among others. The results are compiled below in Table 1.

Removal Rate (debris/yr)	Cost Rate ($/yr)	Target Range (km)	Target Mass (kg)	Operation (perc)	G/S	Sou
15,000	93M - 108M	800	small	83	G	[?
38,333	140M - 176M	1500	small	83	G	[?
20,000	240M	1000	0.75	80	G	[?
202	953M	800	750	80	G	[?
75	397M	800	1400	20	G	[?
260,000	80M	760	0.083	50	S	[?
500	140M	600	1000	100	S	[?

Table 1: Compares different laser models

3 Current Evaluation

3.1 CurrentCostRisk

[?] TODO

3.2 Space Debris Assessing Risk and Responsibility

TODO

References