Differential Drag for Collision Avoidance
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Introduction
Small satellite operators need a coherent response to the question of space debris, and many designers can’t afford the volume, weight, and/or cost of a propulsion system. Small satellites provide the most likely platform to make use of differential drag due to their characteristically high surface-area-to-mass ratio, as well as volume constraints that can preclude the use of an on-board propulsion system. Planet Labs has proven that differential drag can be used for tasks such as constellation phasing, and the research presented here demonstrates its use for collision avoidance as well.

Differential Drag

- High drag = Lower orbit
- Low drag = Higher orbit

Avoidance Maneuvers

- Single Satellite Maneuvering (SSM)
- Normal Operations
- SC 2 Maneuvers
- SC 2 Resyncs
- Resume Operations

Maneuvering Methods

These two methods can be used to maintain relative phasing between spacecraft in a constellation.

Operational Interruption

A method of collision avoidance that requires the satellite to be constantly maneuvering is not viable. The table below shows the expected loss of operations time various constellation designs would experience using different methods of collision avoidance if all conjunctions under 500 meters were avoided.

Conjunction Frequency

Using data from Perseus-M (620 km orbit), there are:
- 1.89 conjunctions of 300 meters or less per year
- 3.78 conjunctions of 500 meters or less per year
- 7.87 conjunctions of 1000 meters or less per year

Risks:
- Mission-killing impacts
- Functional degradation from small impacts
- Increased regulation on satellite launches (More costs)
- Worst case: Regulatory refusal to launch objects that can’t maneuver

Using different methods of collision avoidance, small satellites can take advantage of differential drag for collision avoidance.

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