Orbital Debris and Collision Avoidance in Low Earth Orbit

Clancy Crawford AE 323 – Assignment 3

The growing congestion of Low Earth Orbit due to increasing amounts of orbital debris and upcoming mega-constellation launches poses a serious threat to the safety and sustainability of space operations.

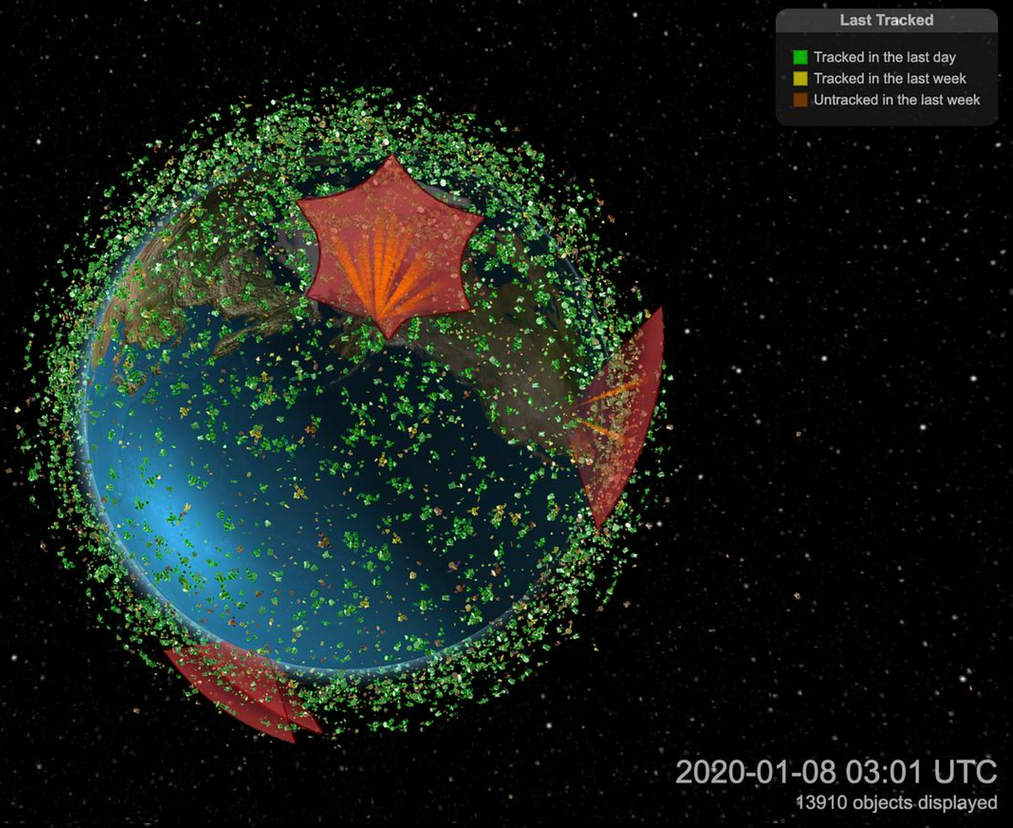
Background

- 2007 Fengyun-1C ASAT test
- 2009 Iridium–Cosmos collision
- 15,000+ satellites planned by SpaceX & Amazon
- Over 550,000 launches projected globally

Collision Risk Modeling

DRAMA

- Functions: estimates debris flux, collision risk, fuel needs, reentry survival, and ground impact risk for mission planning.

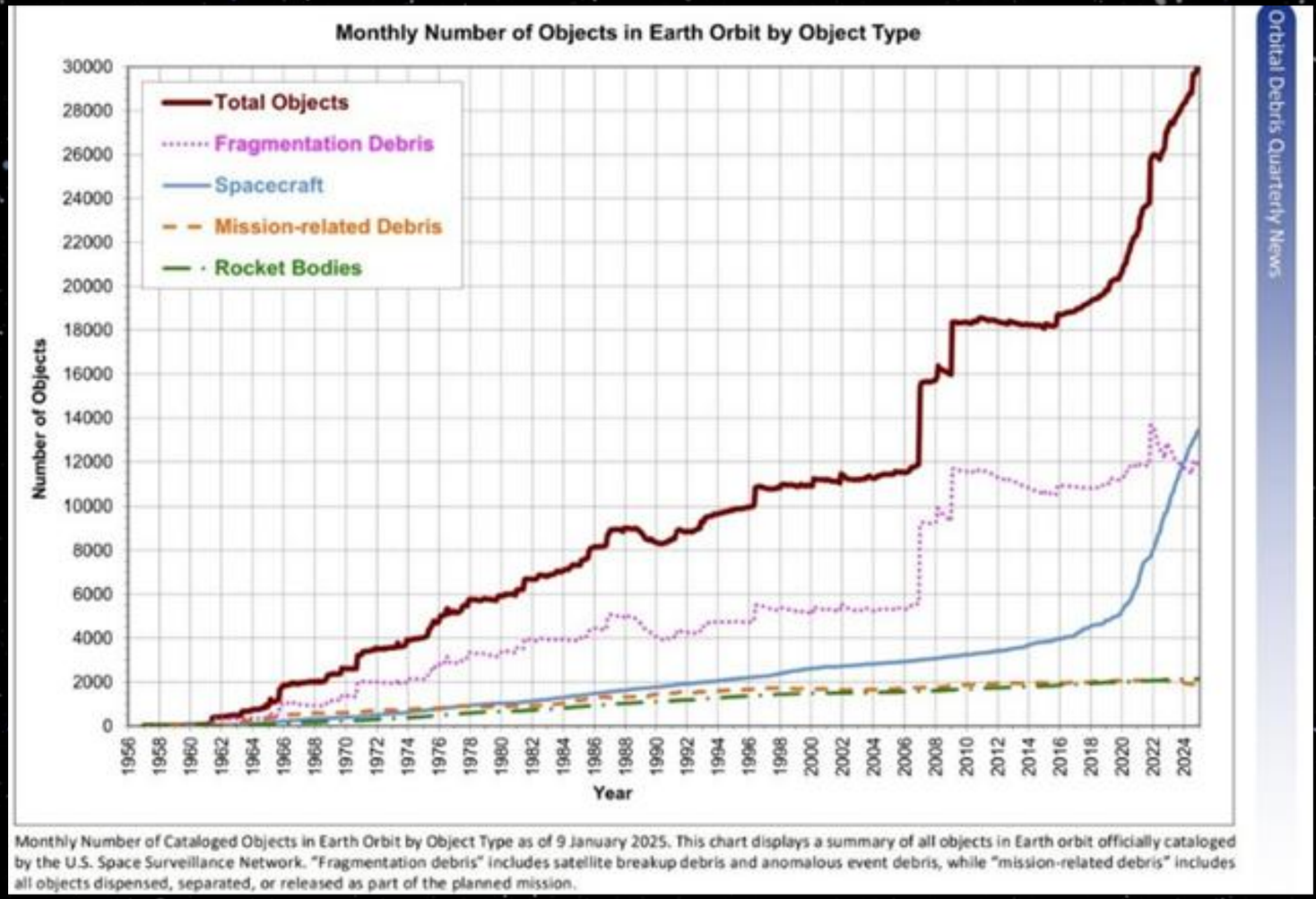


Detection & Tracking Tools

- SSA by US Space Force Delta 2
- Space-Track.org (public catalog)
- LeoLabs Visualization Tool
- NASA ODQN for updates

	LEO/HEO Orbits	GEO Orbits
Catastrophic Collision	X	X
Non-Catastrophic Collision	X + (0.5 – 1) OoM	X

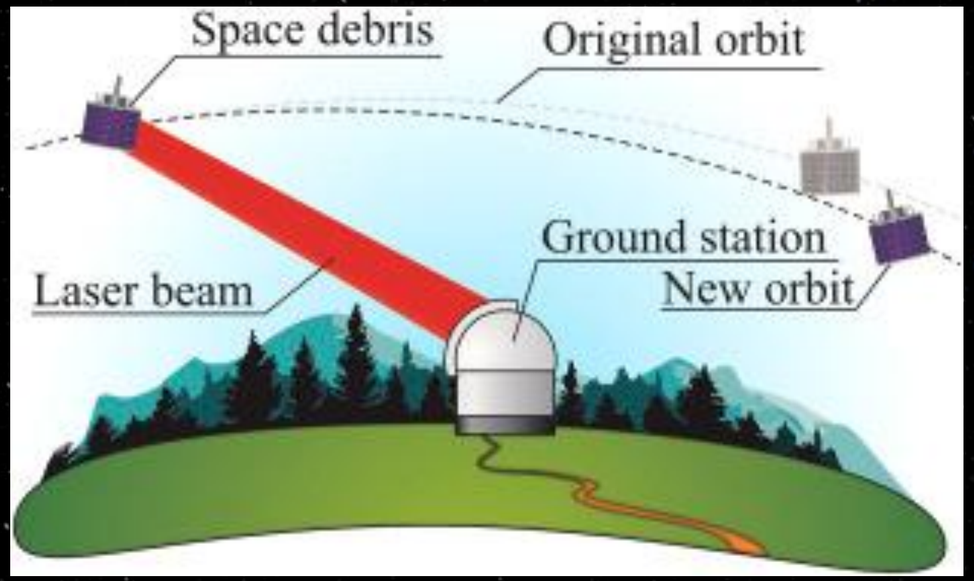
Monthly Number of Objects in Earth Orbit by Object Type



Monthly Number of Cataloged Objects in Earth Orbit by Object Type as of 9 January 2025. This chart displays a summary of all objects in Earth orbit officially cataloged by the U.S. Space Surveillance Network. "Fragmentation debris" includes satellite breakup debris and anomalous event debris, while "mission-related debris" includes all objects dispensed, separated, or released as part of the planned mission.

Mitigation Strategies

- Case-by-case maneuver planning based on fuel, time, and efficiency
- Ground-based lasers apply photon pressure to shift debris orbits
- Autonomous avoidance using linear programming and mission-aware planning



Next Steps

- ESA’s mitigation guidelines promote sustainable operations
- Strategies include deorbiting, fragmentation control, and debris removal
- No global treaty enforces these practices
- Active research continues; future breakthroughs expected

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References