SSA Improvement / Collision Avoidance is NOT a Solution to the Orbital Debris Problem

Panel: Space Debris/Space Situational Awareness Sharing

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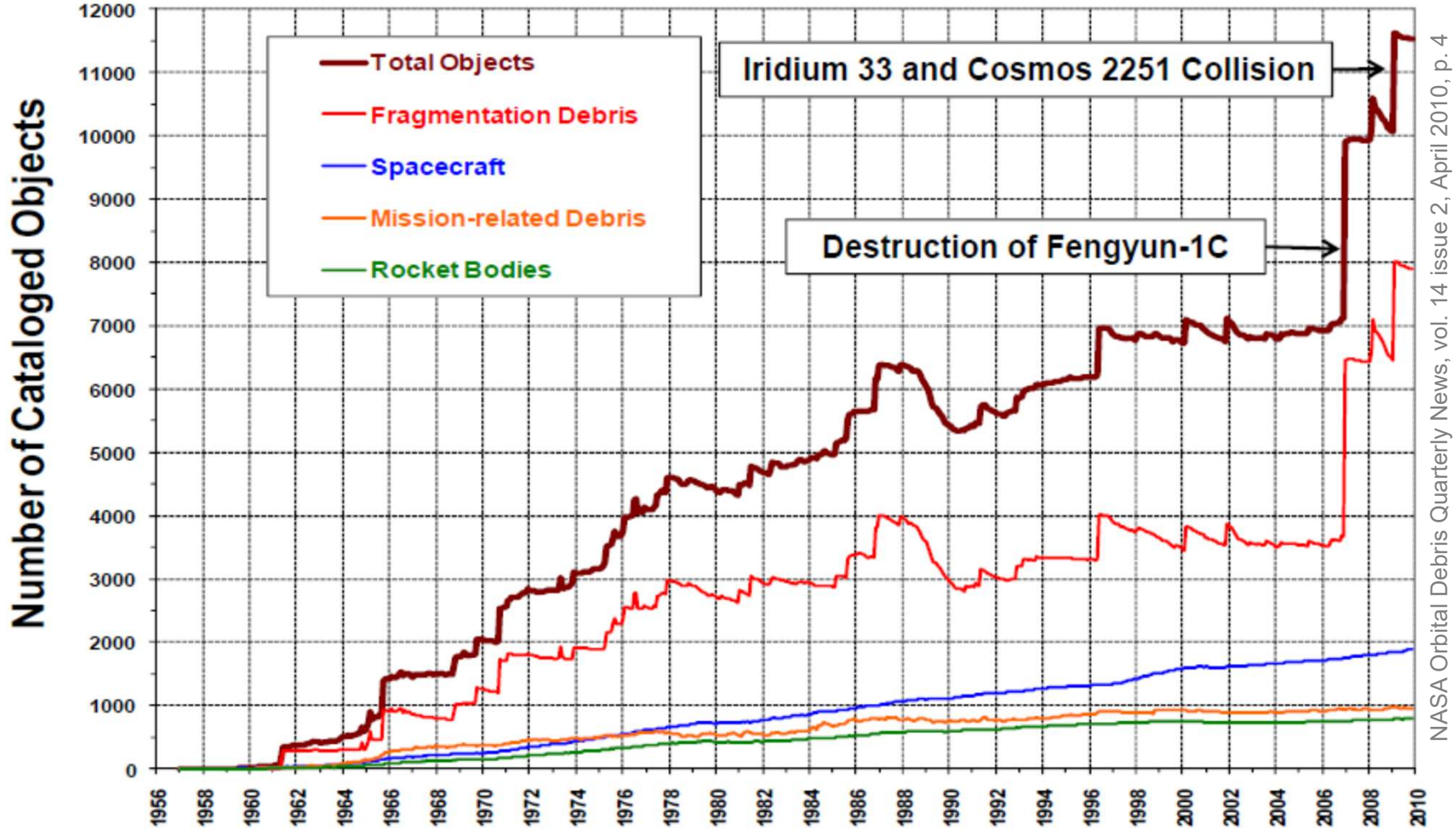
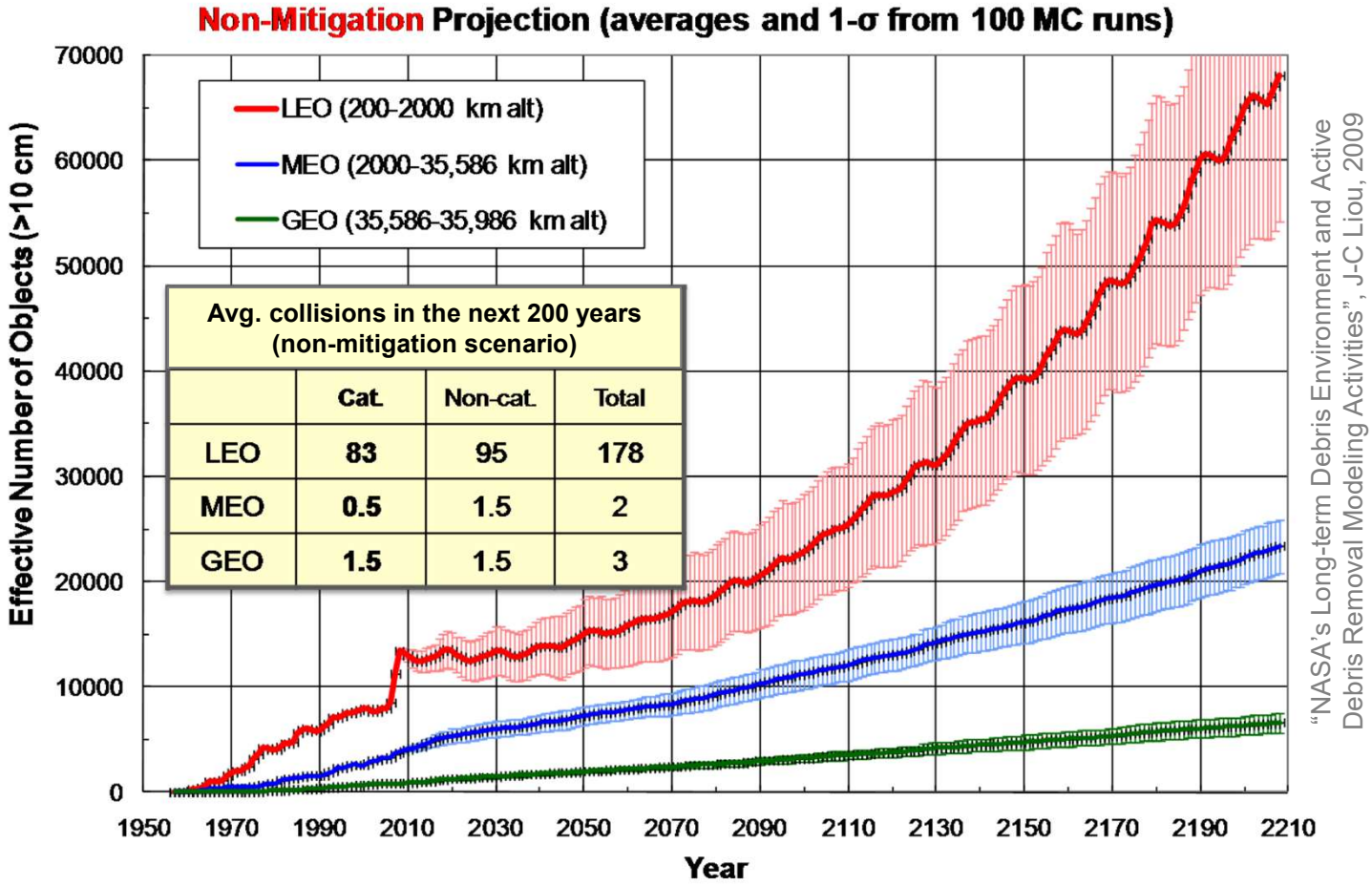
Why We Are Here?



Growth of the cataloged space object population (diameter > 10 cm)

And It Is Just Going To Get Worse



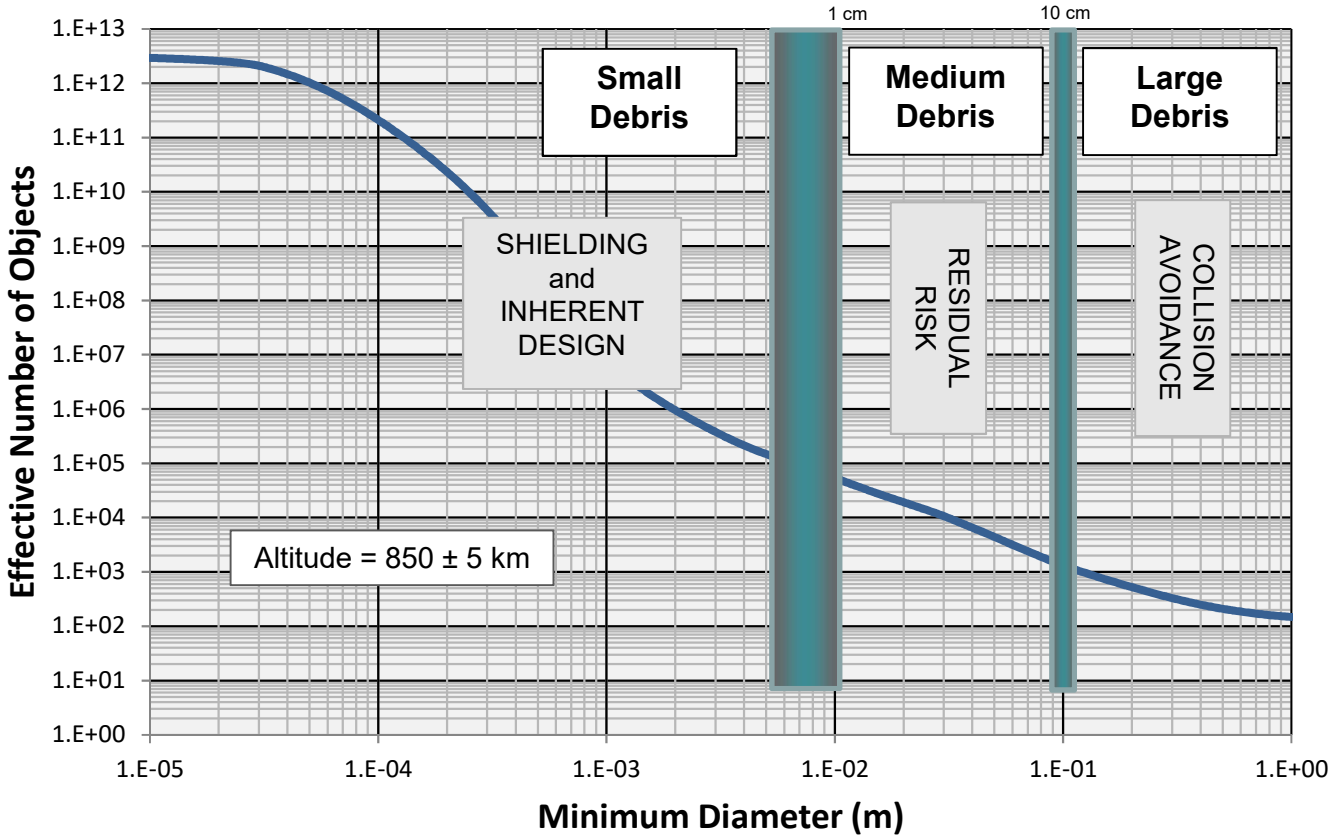
Avg. collisions in the next 200 years (non-mitigation scenario)

	Cat.	Non-cat.	Total
LEO	**83**	95	178
MEO	**0.5**	1.5	2
GEO	**1.5**	1.5	3

NASA's Orbital Debris Office Model

- Future debris environment (>10 cm)
- Assumes "business-as-usual"
- Projects 178 collisions in LEO over the next 200 years – nearly one collision per year
- Debris density (i.e. risk) in LEO will increase by more than a factor of five

Higher Resolution SSA Is Not Enough



SSA Today:

$$\frac{>10\text{ cm}}{>5\text{ mm}} = \sim 1\%$$

10X SSA:

$$\frac{>1\text{ cm}}{>5\text{ mm}} = \sim 35\%$$

- While the vast majority of debris can be shielded against, no countermeasure currently exists for medium debris (> 5 mm to 10 cm).
- Knowledge of large objects (> 10 cm) addresses only ~1% of the risk from potentially mission-terminating impacts.
- Improving SSA resolution by 10X (> 1 cm) would still only address ~35% of the mission-terminating debris threat.
- Tracking smaller debris alone is not enough to eliminate the risk from orbital debris.

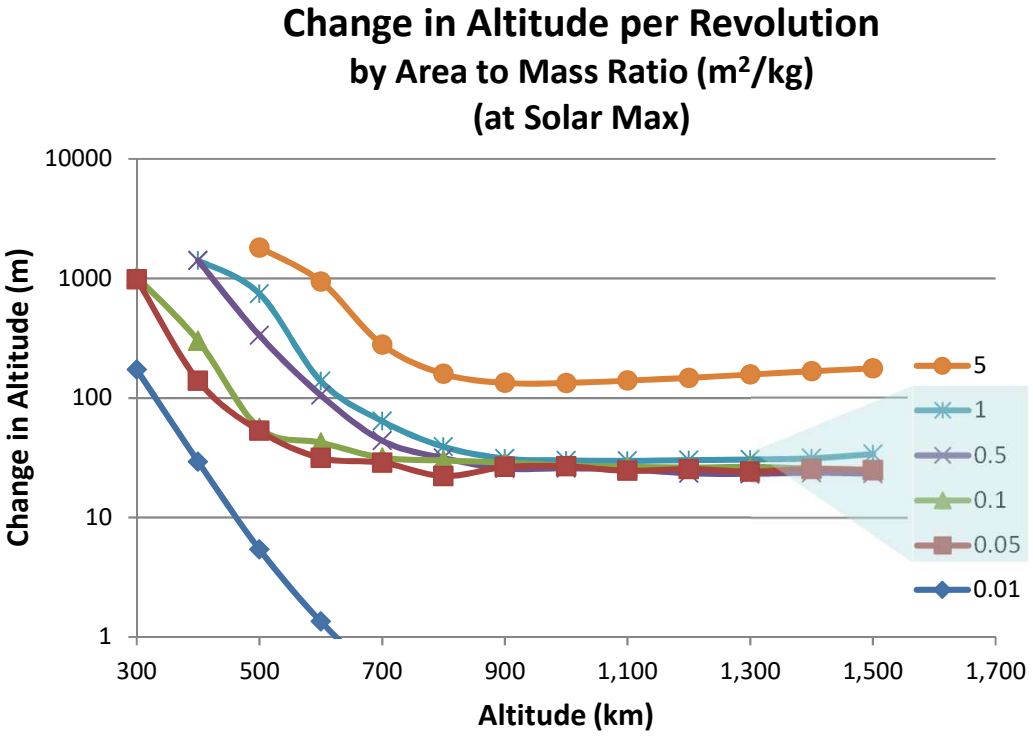
Increased Conjunction Information Is Not Enough

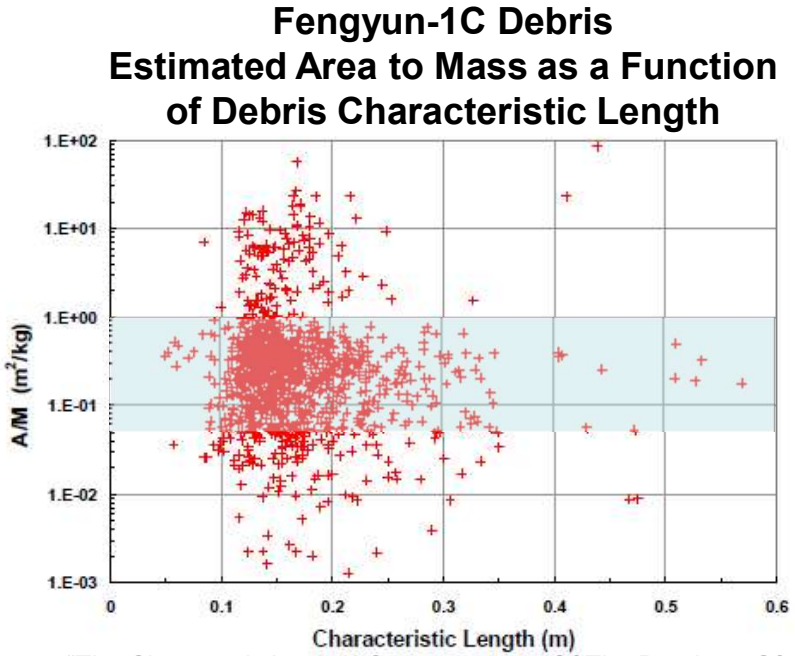
Payloads Screened	Daily Predicted Conjunctions	Threshold	Notes
120	5	> 10 cm	Screening Prior to Iridium-Cosmos Collision
330	25	> 10 cm	Screening Shortly After Iridium-Cosmos Collision
800+	50	> 10 cm	Current Screening: All Maneuverable Satellites
1,300	~75	> 10 cm	Goal for 2010: Screening All Active Satellites
1,300	~2,625	> 1 cm	Improved resolution SSA (projection)

"The Joint Space Operations Center and Orbital Debris", C. Moss, Dec. 2009

- The 35:1 ratio of > 1cm objects to > 10 cm objects implies there may be tens as many collision avoidance maneuvers if we were able to track 1 cm objects with no improvement in position uncertainty ellipsoids.
- Even if we can detect smaller debris particles, we need more accurate trajectory knowledge to avoid expending fuel on false-positives.
- Improvements in state vector accuracy are required, but even that may not be sufficient.

Improvements To State Vector Accuracy Will Be Difficult

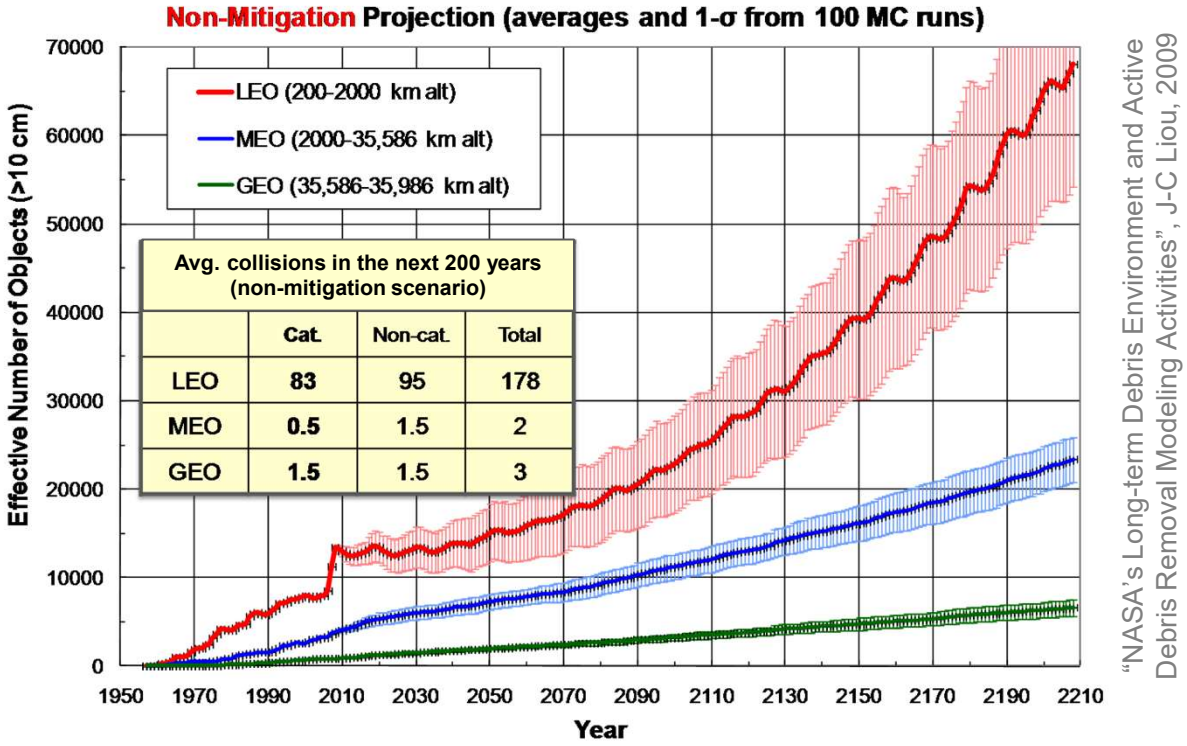




"The Characteristics And Consequences Of The Break-up Of The Fengyun-1C Spacecraft", N. Johnson, etal. 2007

- It is hard to tell where an object is located, and even when it is located, it is hard to tell where the object will be in a subsequent orbit (majority of debris will change altitude by 30m/rev.).
- This is worse for smaller objects (i.e. higher A/M ratios) – larger covariance matrices make the probability of collision less precise.
- More frequent updates are required to keep uncertainty low.

Enhanced SSA ≠ Reduced Future Debris Risk



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"NASA's Long-term Debris Environment and Active Debris Removal Modeling Activities", J-C Liou, 2009

- There are about 1,800 rocket bodies and 3,200 payloads in orbit.
- About 800 of those payloads are maneuverable - roughly half in GEO.
- As a result, most of the mass in orbit (about 80%) cannot avoid catastrophic collision, even if warned in advance.
- The LEO risk will grow, even with enhanced collision avoidance warnings, and will at some point overwhelm our improvements in SSA.
- Large derelict objects must be removed now to reduce the future risk from orbital debris.

Thank You