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CEU Session #2 - Satellite Maintenance: An Opportunity to Minimize the Kessler Effect

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Satellite Maintenance: An Opportunity to Minimize the Kessler Effect

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Today's Agenda

- Overview: The Orbital Debris Problem
- The Kessler Effect
- Current Debris Mitigation Efforts
- Strategic Approach to Reduction – Things to Consider
- Satellite Maintenance – An Opportunity

Overview: Orbital Debris

Humans have been launching objects into space for more than 50 years

-Inoperable satellites
-Payloads
-Rocket motors
-Debris from collisions

Orbital Environment

-Orbital debris can reach speeds up to 5 miles per second. That is almost 7 times faster than a bullet!

- Many satellites contain components which are vulnerable to space radiation
- -Variability of the environment itself makes it difficult to diagnose operational failures

Let’s Talk Numbers

-1950 out of 5000

-22,300

-34,000

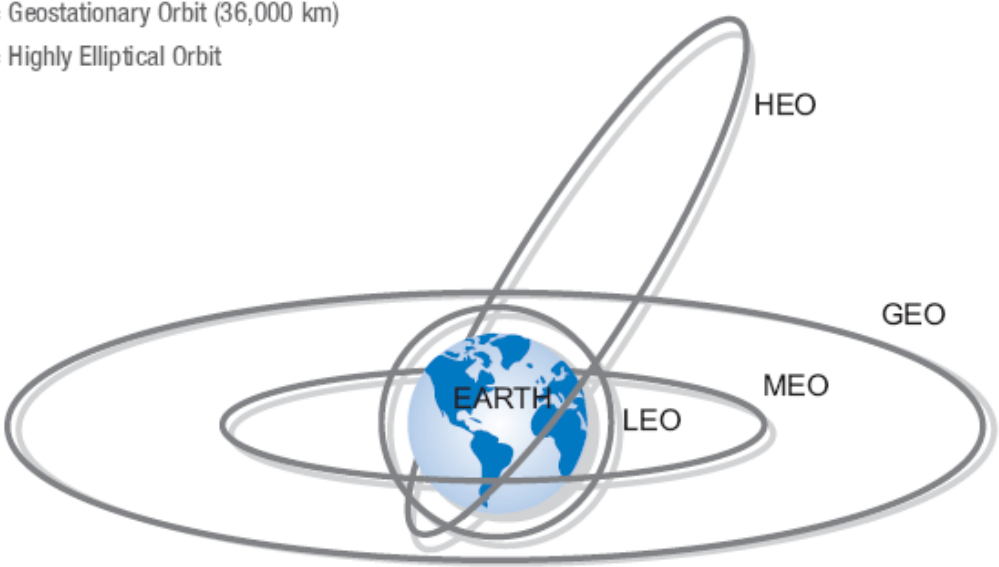
Does Location Matter?

LEO = Low Earth Orbit (100-1,500 km)

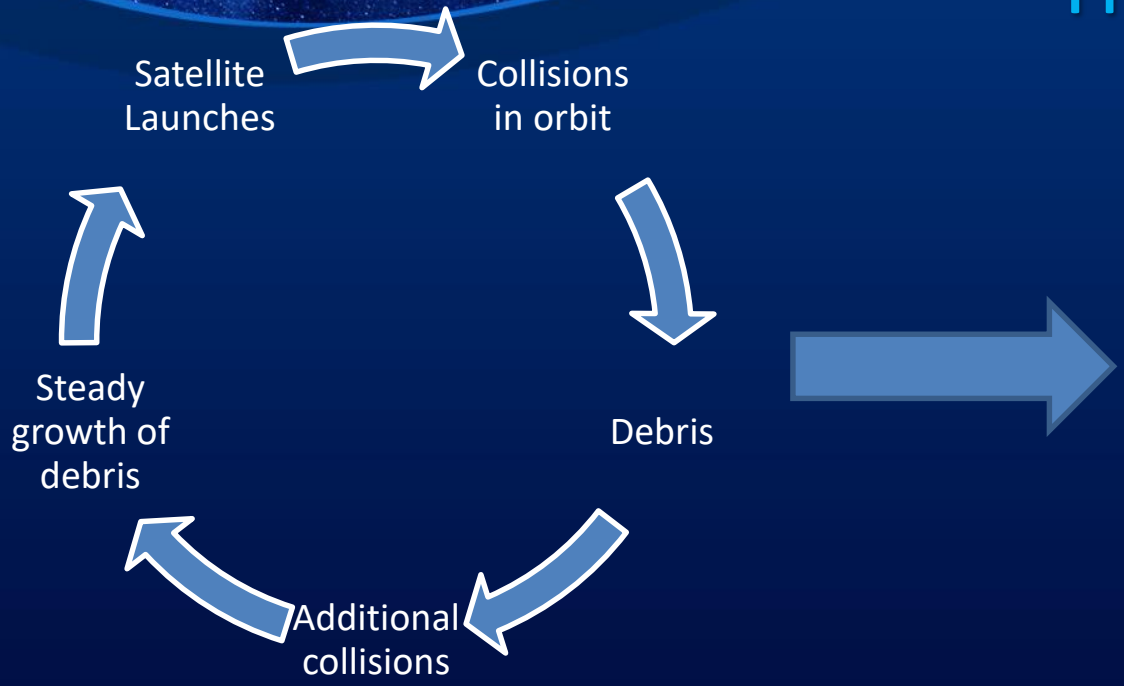
MEO = Medium Earth Orbit (5,000-10,000 km)

GEO = Geostationary Orbit (36,000 km)

HEO = Highly Elliptical Orbit



The Kessler Effect



No longer economical to launch satellites due to intense concentration of debris

Major Collisions

Notable collisions in which two sizeable objects in Earth orbit accidentally collided at high speeds:

1996: Fragment from a long-disintegrated rocket hit a French military satellite

2007: Chinese anti-satellite test, which used a missile to destroy an old weather satellite, added more than 3,000 pieces to the debris problem.

2009: A defunct Russian satellite collided with and destroyed a functioning U.S. Iridium commercial satellite. The collision added more than 2,000 pieces of trackable debris to the inventory of space junk.

The Kessler Effect – Current Research

- How many satellites need to be removed to stabilize the effect? Approx. 5 per year, but could rise to as many as 8 per month by the year 2040
- Large debris is not the only issue – small debris poses problems as well
- A range of technologies that could aid in minimizing the effect (sensors, robotics, navigation aids, etc.)

Satellite Survivability

- Optimize cost structures
- Extend current lifespans

The Kessler Effect – Current Research

- 11,631: Current projection estimate for small satellites (including constellations) by 2030, which is approx. 1000 per year

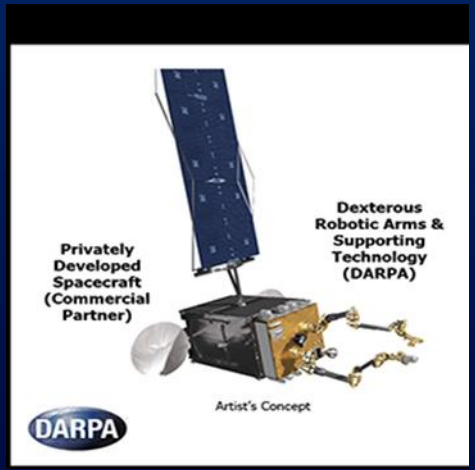
- What is the relationship between launches and debris? A 2017 article cited the below competitors for the satellite constellation market:
  - Samsung: 4600 satellites
  - SpaceX: 4000 satellites
  - Boeing: 2960 satellites
  - OneWeb: 720 satellites

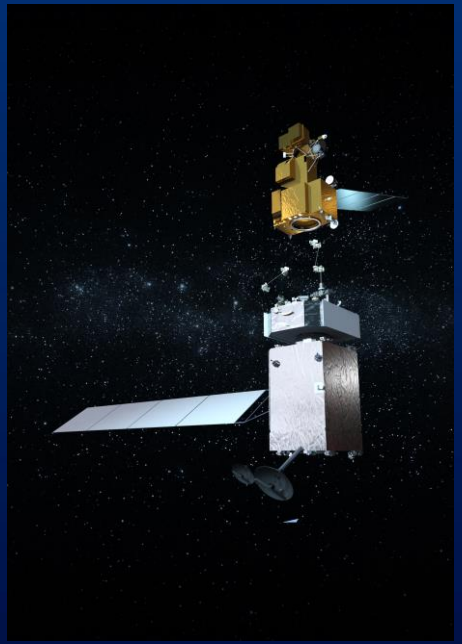
Regulatory Support Needed!

- Who is responsible?
- How do we enforce policies?
- How do we regulate safety now and in the future?
- Lessons learned from ICAO

Debris Mitigation Efforts: Large-Scale

- NASA (Restore-L)
- DARPA (Robot Servicing of Geosynchronous Satellites (RSGS)





Debris Mitigation Efforts: Small-Scale (Passive)

- Compliance with post-mission procedures (especially for constellations)
- Debris spotters (for detection)
- Atmospheric drag
- International Debris Mitigation Guidelines

Debris Mitigation Efforts : Small- Scale (Active)

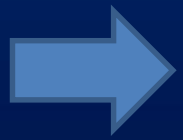
- Throw nets
- Canopy/collection devices
- Ion Beam Shepard
- Electrodynamic tethers
- Robotic arm

Satellite Maintenance: An Opportunity

While we are not approaching the Kessler Effect at an accelerated rate currently, we are making our existing and future space operations less safe and more expensive

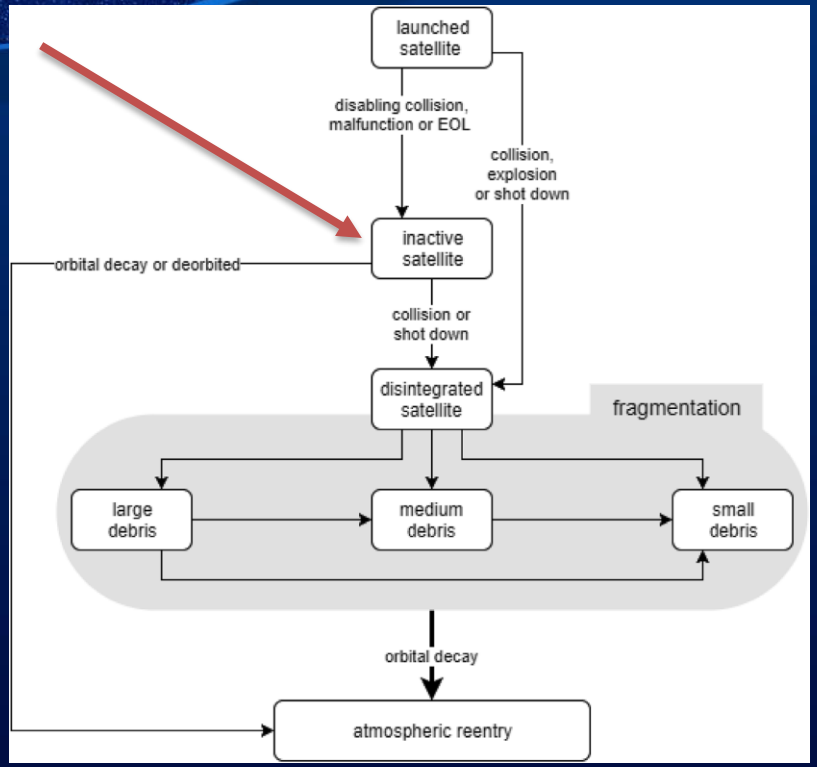
Satellite maintenance and on-orbit servicing

-Maximize use of resources (satellite service life)
-Improve adherence to post mission procedures

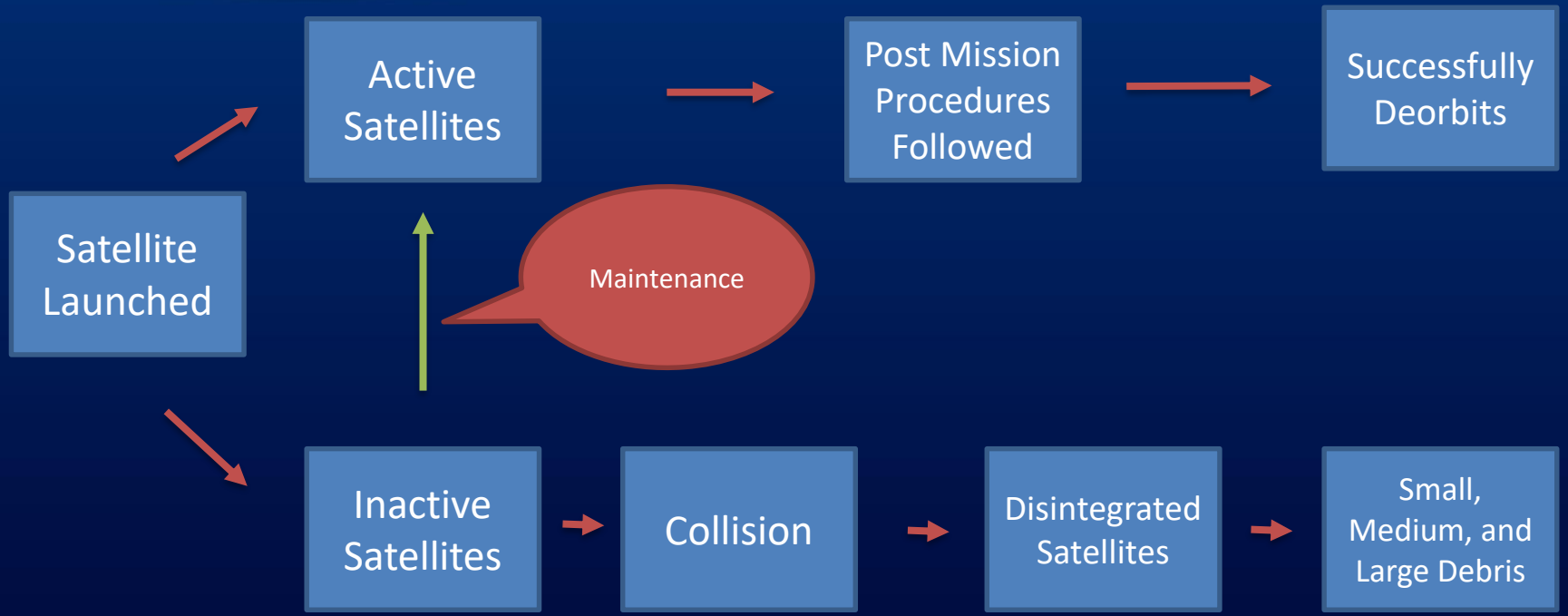


Minimize debris collisions

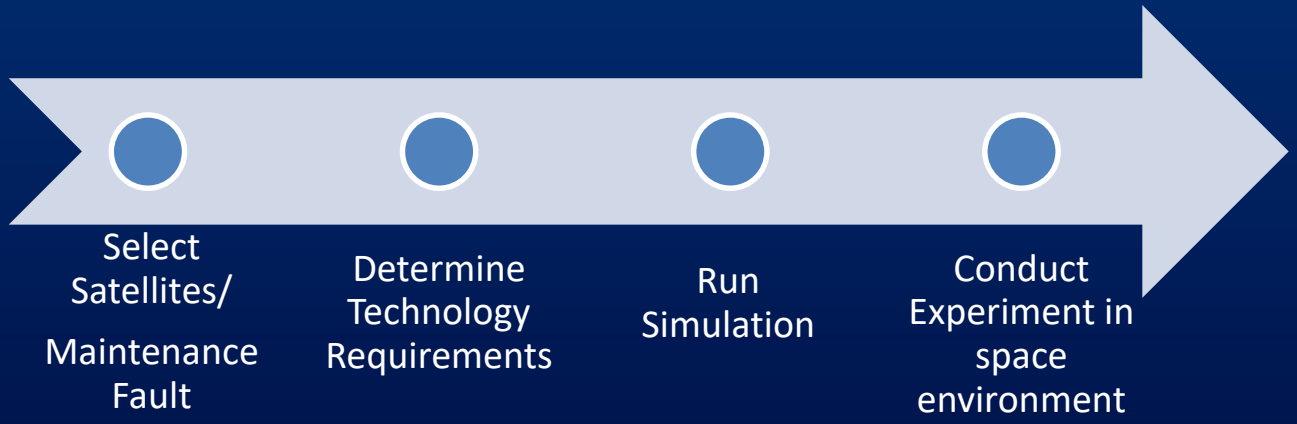
Satellite Maintenance: Potential Impact



Satellite Maintenance: Big Picture



Satellite Maintenance: Strategic Approach



Let’s Get Real

-Lessons learned from aviation = proactive maintenance approach

-Shift responsibility to satellite manufacturers = MRB; reliability, improved performance

-Satellite maintenance is only one piece of the puzzle, additional ADR efforts are needed (compliance with post-mission procedures, regulatory support, research on most effective maintenance methods)

Thank you for your attention!

Questions?

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