Looking Forward to Cislunar Development
Challenges in an International Lunar Decade

David Dunlop
National Space Society
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- Opportunities for International cooperation in establishing a permanent human presence on the Moon and an essential cislunar economy for global sustainable development requirements can transform the global economy and provide dramatic benefits to humanity & the environment.

The growth of human populations, demands for clean energy, improved material and social living standards and a more just world have outstripped the carrying capacity of the Earth.

We believe that the Sustainable Development Goals adapted by the UN cannot be realized without the development of space based energy and material resources and a cislunar economy complimenting the present global economy and providing for more geometric economic growth. (Recommendation #1)

UN Global Framework of Sustainable Development Goals

- The National Space Society proposes that the Framework of 17 Sustainable Development Goals be expanded to include the economic development of space, utilization of space based resources, and the goal of permanent human settlement of space as the 18th Sustainable Settlement Goal as a critical SDG enabling of those SDGs adapted earlier.

National Space Society

SPACE RESOURCES ARE ENORMOUS

- The vast majority of the material and energy resources of the solar system are in space – not on the Earth
- These resources allow humanity to escape the limits due to the finite resources of Earth – dramatically reducing the difficulty of obtaining sustainable development
- As one example, consider energy
- The sun produces more than TEN TRILLION times the amount of energy currently used by humanity
- By bringing a tiny fraction of this energy to Earth humanity can solve our energy problems

Humanity's Shared Hope of the Future both on Earth & In Space

• Sustainable Cities and Communities	Space Settlement Design with LEED's standards for Green Architecture
• Innovative industrial infrastructure:	Additive manufacturing and advanced design with In Situ materials can be used in construction
• No Hunger	Local Controlled Environment Agriculture Systems hydroponic and aquaponic systems can produce food locally and cost effectively
• Clean water and Sanitation,	Bio-regenerative food production and water purification and waste processing
• Health and Well Being	Adequate nutrition, and clean environment and a lifestyle including more physical fitness
• Decent Work and Economic Growth	Construction of Arcologies which optimize local resources and sustainable practices
• Responsible Production and Consumption	Optimize energy use and a foot print of local production, consumption and recycling.
• Clean Sustainable Energy with no pollution	Utilize solar energy and minimize imported fossil fuels

Our Space Economy Must Understandably Address Urgent Human, Environmental and Economic Requirements so that it is understood as an economy of help and hope.

- The global public must understand that the space economy is essential for a sustainable Earth. (Recommendation #4)

Are Space ResourcesObtainable?

- The twin economic forces of human economic demand (pull) and the technology development (push) are virtually unstoppable baring catastrophe.

- Reusable launchers are lowering the cost per flight and increasing affordable access
- We can establish the early economic use of in situ space resources for space manufacturing
- New global satellites can eliminate the digital divide between wealthy developed and nations in earlier stages of development.
- We must face up to threats to space access to space resources by active remediation of space debris. Recommendation #3

What Can an International Lunar Decade Achieve? (Recommendation #4)

- 1 Extend international collaboration and participation on a Deep Space Gateway Station Near the Moon.

- 2 Create Cislunar Infrastructure for communications, navigation & positioning.

- 3 Innovative action to remediate space debris through new technology demonstrations using the International Space Station and including space to space power beaming must be started

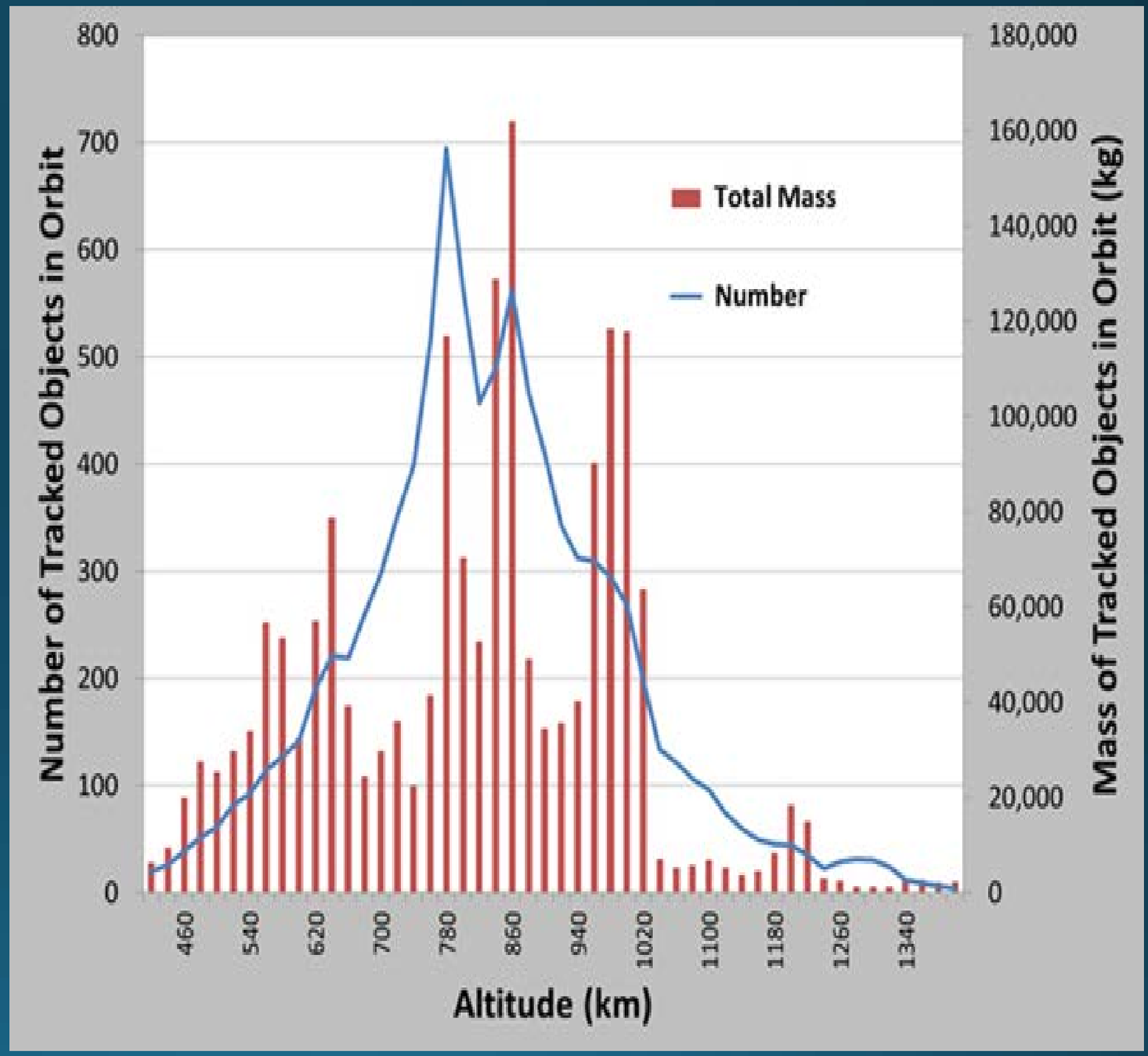
1) 22,000 debris objects > 10 cm.

2) 700,000 *untrackable* debris objects between 1 - 10 cm.

3) Relative impact velocities in LEO reaching 35,000 mph.

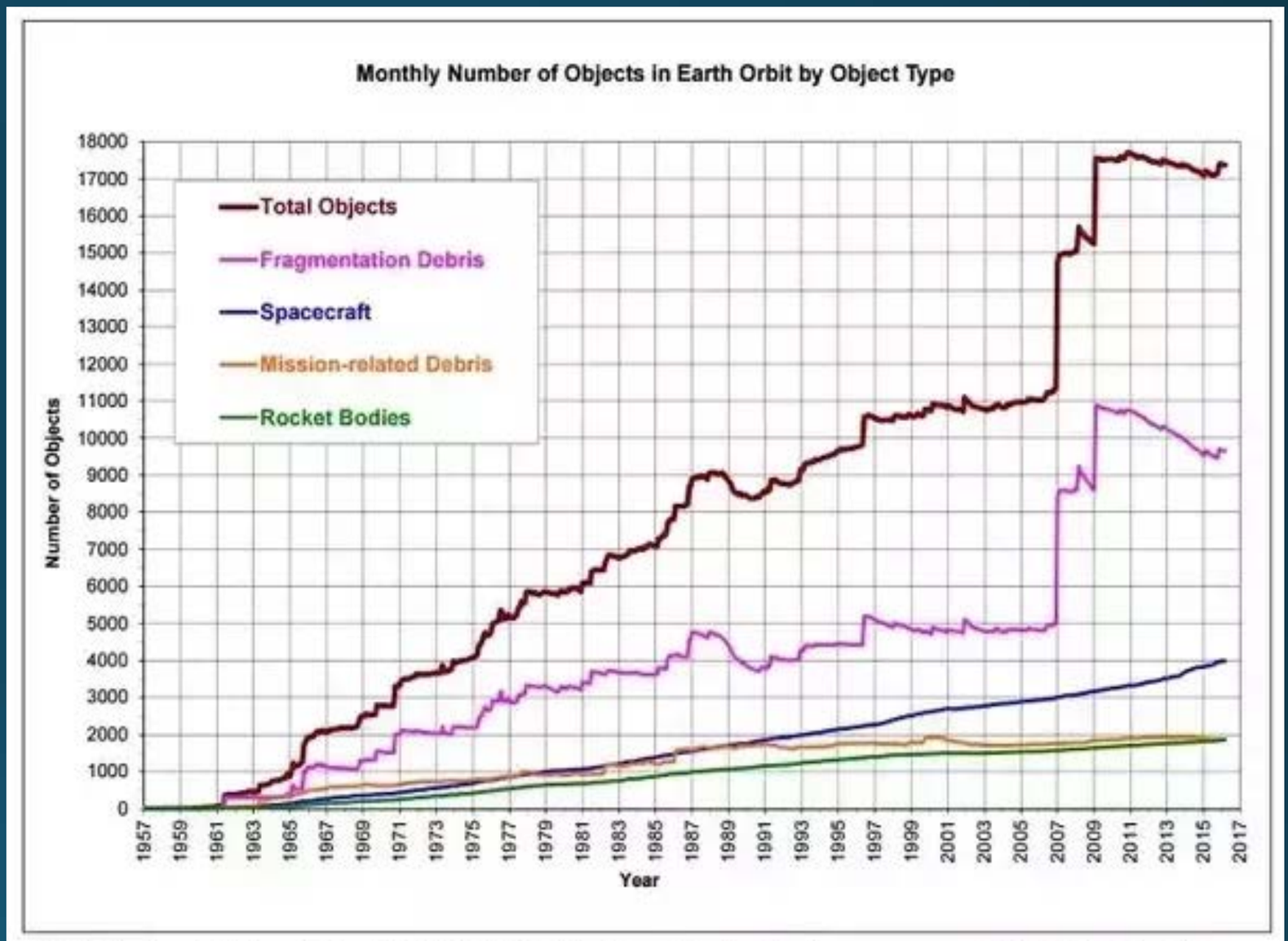
4) *> 6300 tons of debris already orbits the Earth. (i.e. 9 x mass of ISS)*

5) Debris will grow for 200 years *without any new launches.*



Mega-constellations of satellites will soon number more than 13 x the number of operating satellites in *all* Earth orbits & 20 x the number in LEO!

(800 functioning sats in LEO, 1500 sats overall.)



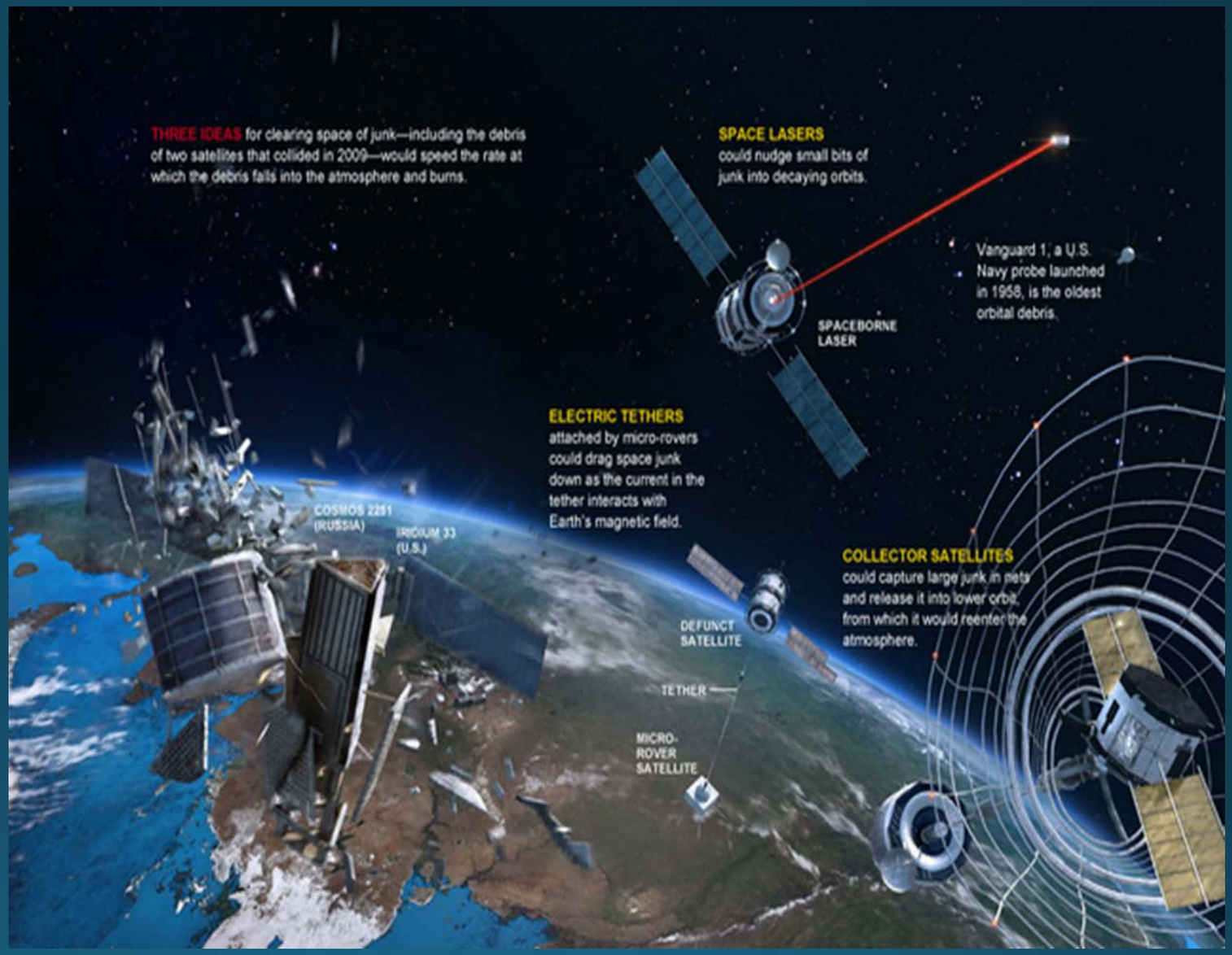
Monthly Number of Cataloged Objects in Earth Orbit by Object Type: This chart displays a summary of all objects in Earth orbit officially cataloged by the U.S. Space Surveillance Network. "Fragmentation debris" includes satellite breakup debris and anomalous event debris, while "mission-related debris"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

Also, we need much better worldwide & comprehensive

Space Traffic Management (STM)

i.e., National & international systems to carry out enhanced SSA, ADR, & OOS.

Here are just 3 ideas about how to realize ADR of orbital debris.



Recommendation #1:

The ISS has a large power-generation capacity, is *international*, & is already in LEO.

More orbital debris ADR/cleanup technologies could be could be tested either on the ISS or in conjunction with the ISS

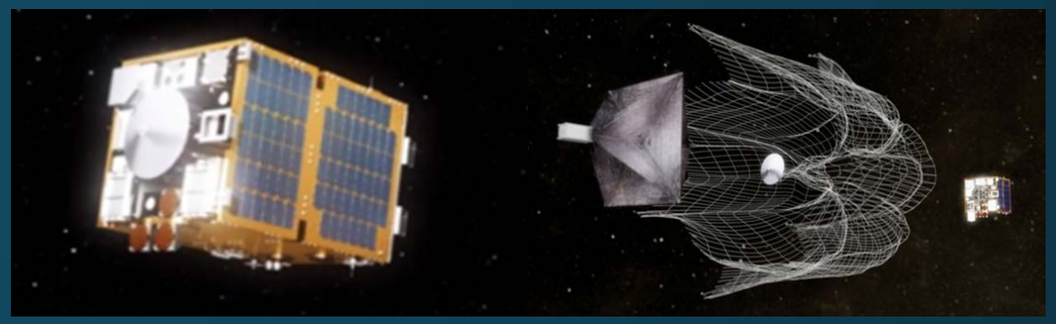
Examples of orbital debris tracking &/or cleanup technologies that could be tested on/off ISS:

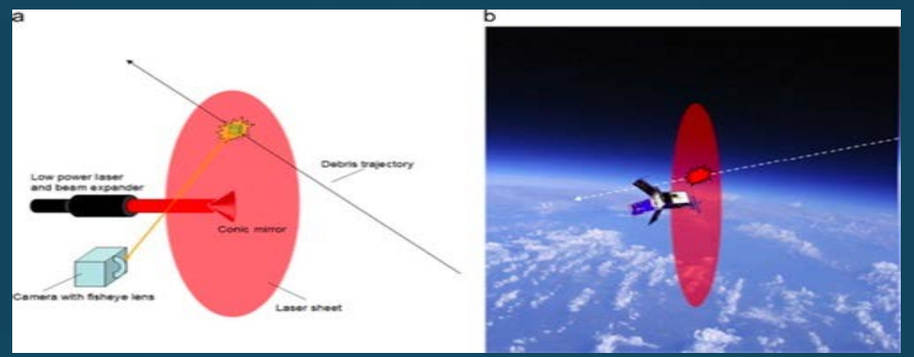
1) The Surrey Space Centre RemoveDEBRIS satellite to test net, harpoon, rendezvous navigation, and dragsail technologies.

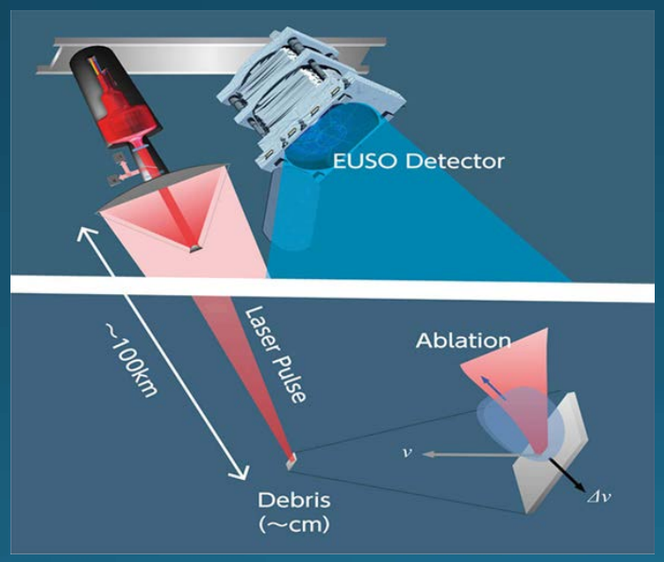
2) U.S. Naval Research Lab's Optical Orbital Debris Spotter (OODS)

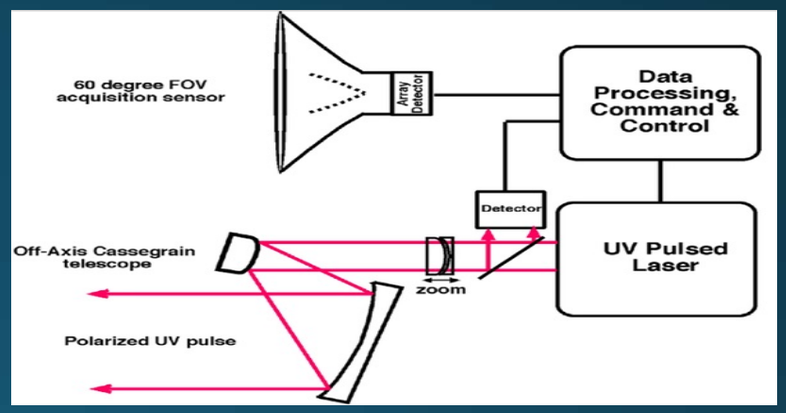
3) Laser Ablative Debris Removal by Orbital Impulse Transfer (L'ADROIT) System

4) JEM-Extreme Universe Space Observatory (EUSO) Cosmic Ray, Neutrino, & *Orbital Debris Detector*, scheduled for after 2020.









Other Emerging Cleanup Technologies and Public-Private Entities:

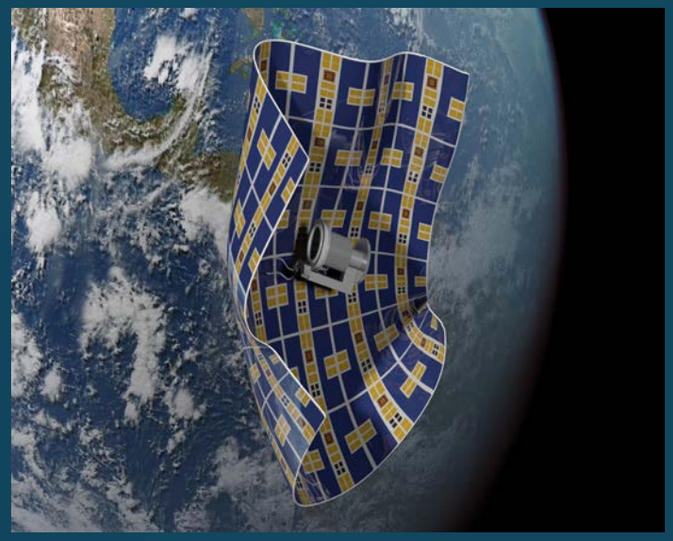
1) EPFL's CleanSpaceOne

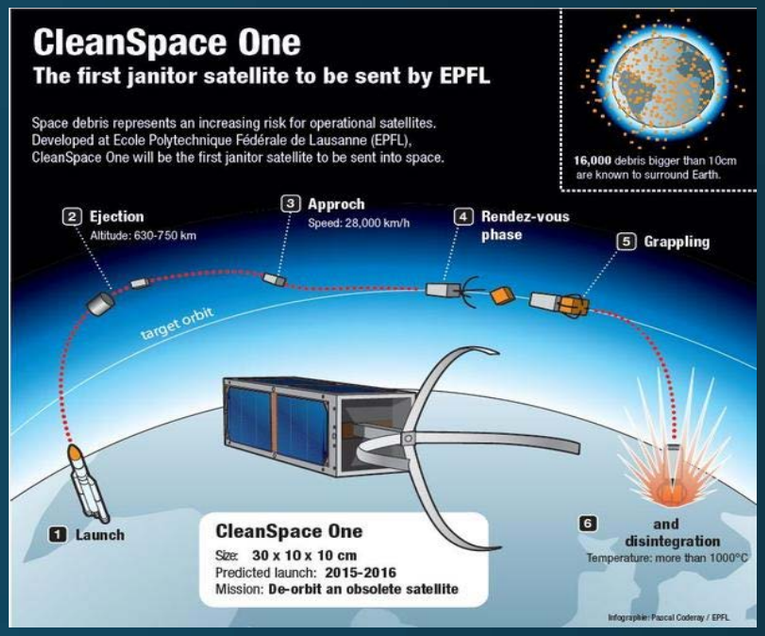
2) Hanspeter Schaub's Electro-static "touchless" Technology

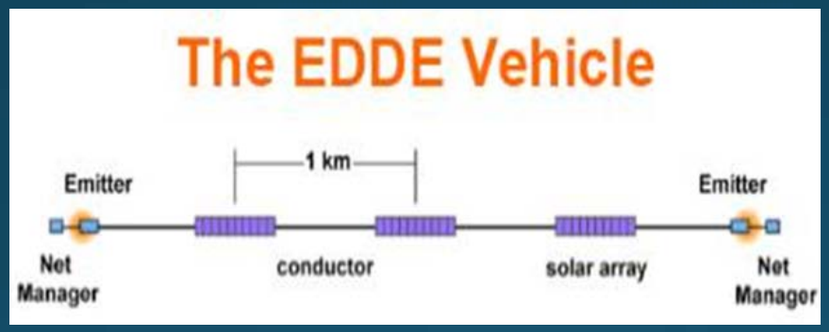
3) Aerospace Corporation's Branecraft

4) Star Technology & Research Inc.'s Electrodynamic Debris Eliminator (EDDE)

5) Tethers Unlimited Inc.'s de-orbiting Terminator Tapes & Terminator Tethers.





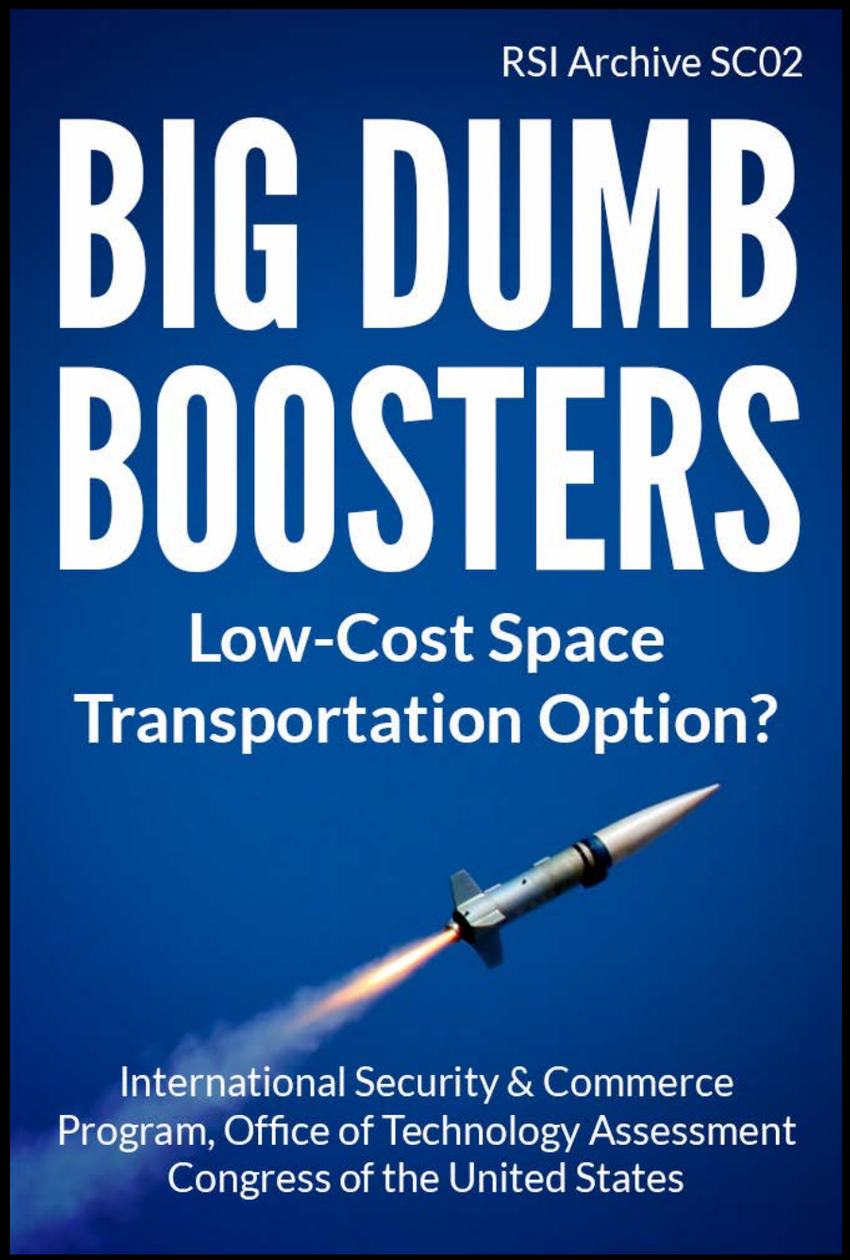


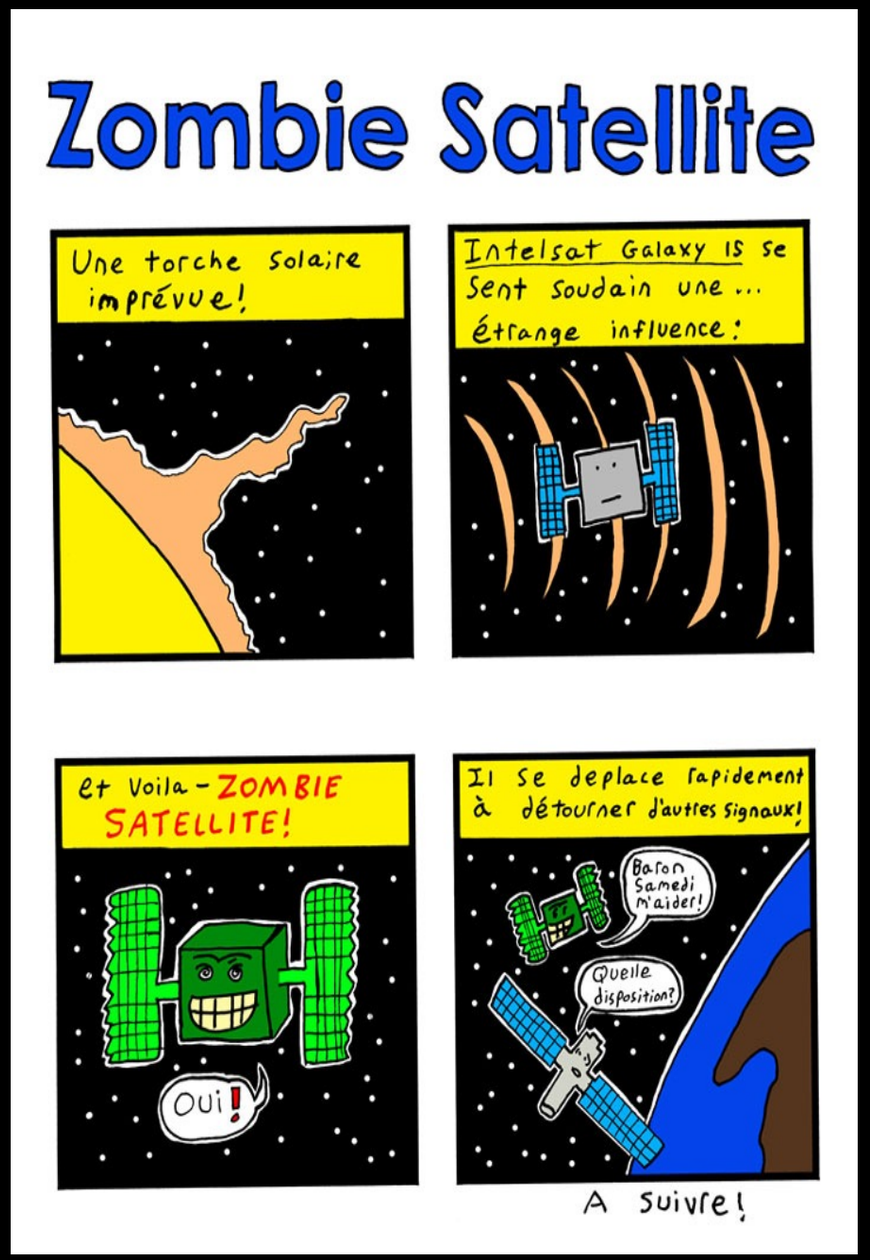
“Just One Tank”

Step A:

Each launching state designates a big dumb booster or “zombie” sat for de-orbiting or removal to a safe storage orbit by a commercial salvor.

Credit for Zombie Satellite: Quick Draw Free Comics.





Step B: One, two, or more launching states, including state(s) that nationally register the launches, agree to *license a private company* to remove (or move to a salvage orbit) a big dumb booster.

Caveat 1: Per OST Art. VIII, the nationally registering State Party/launching state retains "jurisdiction & control" (ownership) of the launched spacecraft.

Caveat 2: Per OST Art. VI, all launching states involved bear "international responsibility" for ADR by governmental & *non-governmental* entities (such as private salvors) & must carry out "authorization" & "continuing supervision" of their activities.

Step 3: Launching state(s) pay the commercial salvor, only if it safely de-orbits the debris object or moves it to a storage orbit. Per the OST, the nationally registering state(s) retain ownership/jurisdiction/control & license the salvor. All involved launching states carry out authorization & supervision. Removal or salvage costs & eventual salvage profits are shared per agreement.

Recommendation 3:

Convene an International Space Anti-Dumping & Salvage Convention, informed by customary international law & maritime tradition & law.

- 4 Demonstration of removal and reuse of of the 6200 metric tons of space debris (9 times the mass of the ISS) as the low hanging fruit of space ISRU and space manufacturing.
- 5 Expanded Public Private Partnerships to accelerate open access to space via private investment
- 6 A permanent human presence on the Moon open to all UN countries for exploration and development
- 7 New legal agreements that facilitate cooperative investment in infrastructure and resource development.

- We can use the legal mechanism of a Lunar Development Trusteeship to both create incentives for concentration of international collaborative investments in required infrastructure while insuring access to lunar resources to an open and growing cislunar bounded terrestrial market. (Trusteeships have successful track records of establishing both post war reconstruction and national development and independence.)

- The Antarctic Treaty is another successful model for peaceful internationally transparent and collaborative scientific exploration of the harsh environment of the Earth’s 7th Continent to apply to “the Earth’s 8th Continent, The Moon”. We can apply this model as well for peaceful Lunar Development.

- The UN COPUOS must not only fulfill the UN’s founding agenda to prevent another world war and the avoid the grim prospect of Nuclear War via ballistic missile &Mutual Assured Destruction.

- The UN COPUOS must also fulfill the UN agenda to avoid the grim prospect of mutual assured destruction of the Earth’s environment and climate system.

- The UN and its Member Nations, must encourage hopeful prospects of mutual growth and sustainable development on Earth and in space, including peaceful and open investment and collaboration in the development of space resources essential to humanity’s requirements and the preservation of the Earth’s living evolutionary heritage.

- An International Lunar Decade is place to begin as we anticipate UNISPACE +50

Thank You