Commercial Debris Removal

Eugene Levin

3rd International Interdisciplinary Congress on Space Debris Remediation

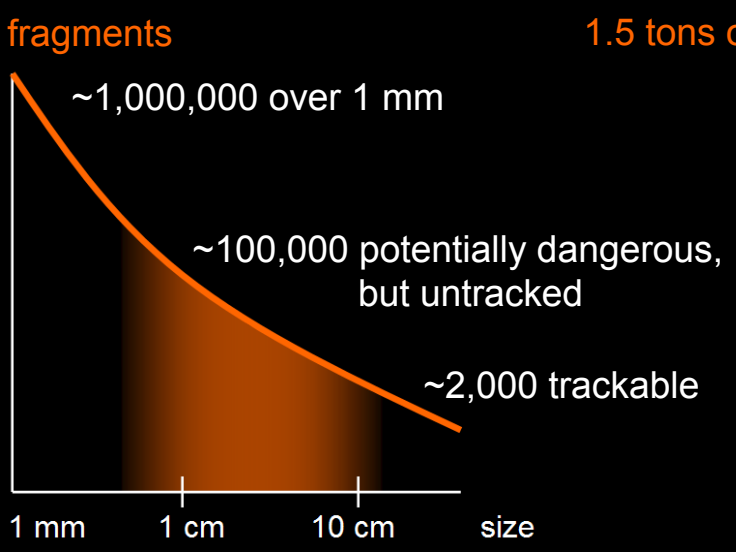
Montreal, Canada, November 11-12, 2011

Jerome Pearson
Star Technology and Research, Inc.
www.star-tech-inc.com

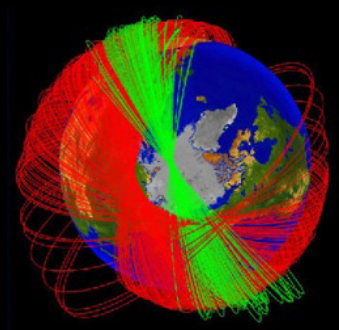
Joe Carroll
Tether Applications, Inc.
www.tetherapplications.com

Unintended ASAT

- The fallout from Cosmos-Iridium similar to Chinese ASAT test



1.5 tons of "shrapnel"



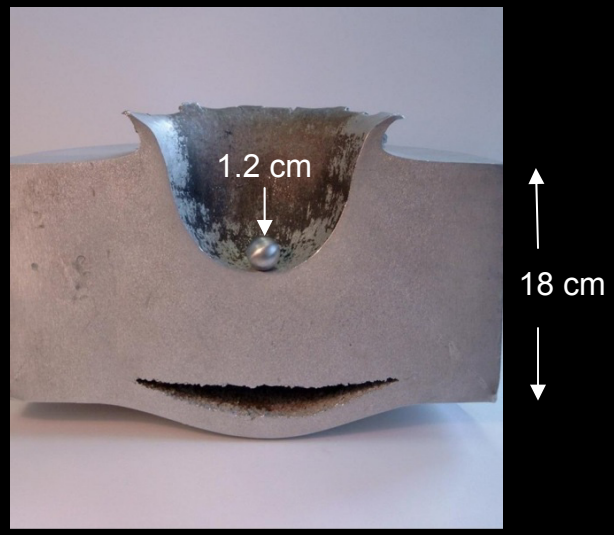
Debris streams spread

- LEO debris: a slow-release random-target ASAT system

Why “Shrapnel” is a Problem

- 30-50 dangerous untracked fragments for each tracked one
- Centimeter size fragments can do serious damage

ESA hypervelocity impact test



www.esa.int

Shuttle radiator damage, 2007

ntrs.nasa.gov

Catastrophic Collisions

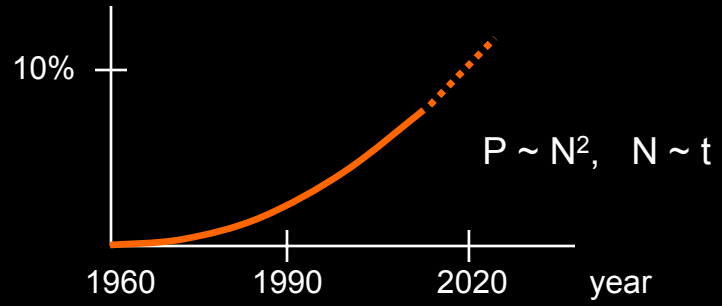
- ‘‘Shrapnel’’ is produced in explosions and collisions
- Collision probability is growing

Delta II second stage

wikipedia.org

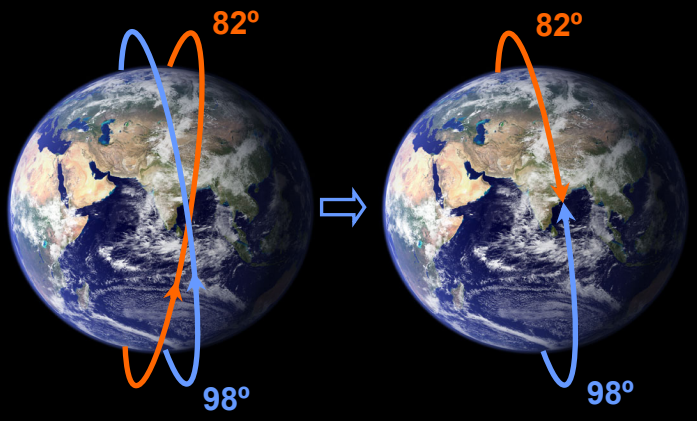
3U CubeSat

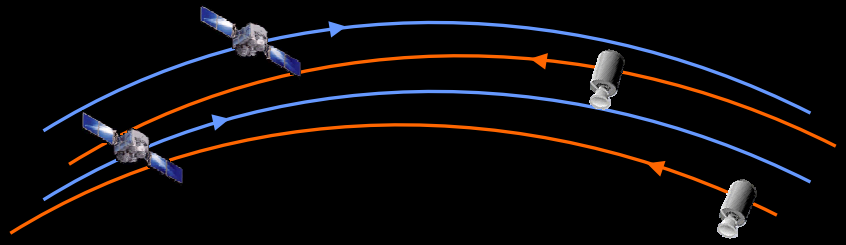
Probability of a catastrophic collision per year



Head-on Traffic

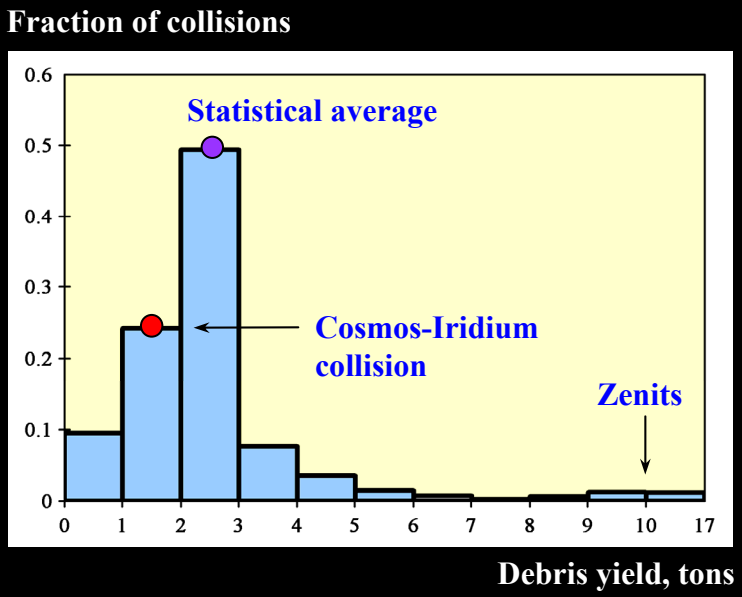
- Inclination pairing between Sun-sync and 81-83º orbits





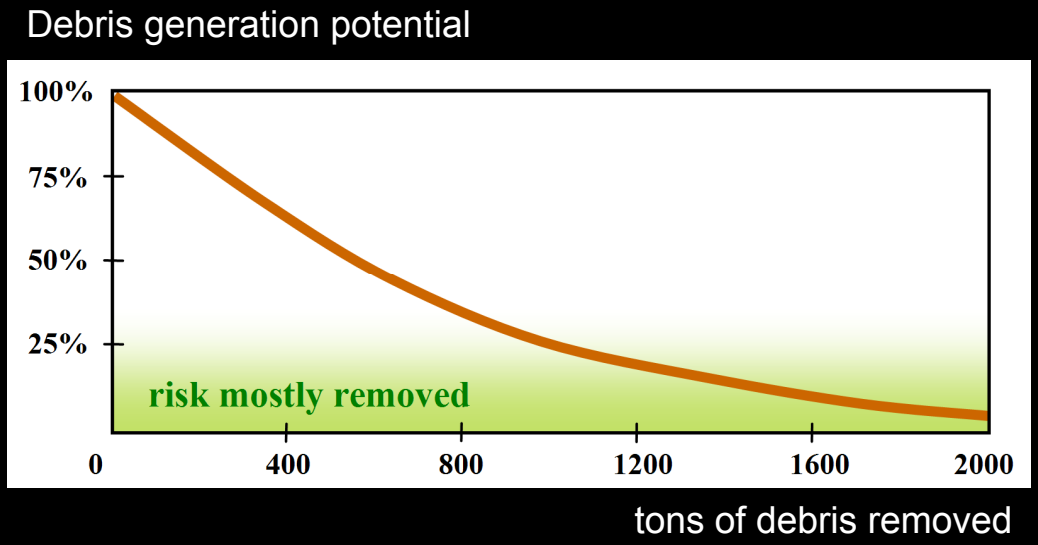
Next Catastrophic Collision

- Statistically, like 2007 ASAT and Cosmos-Iridium combined



How Much to Remove

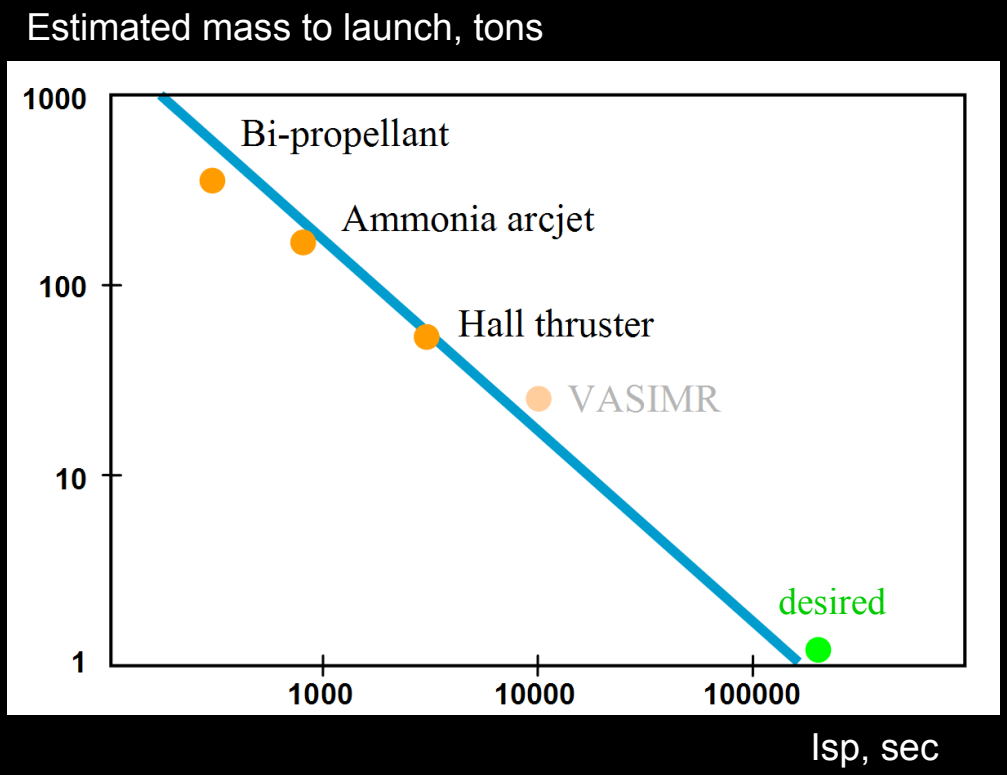
- Statistical yield of fragments in collisions: $R = \sum M_n \cdot P_n$



- Small-scale removal won't make a difference
- Need wholesale removal

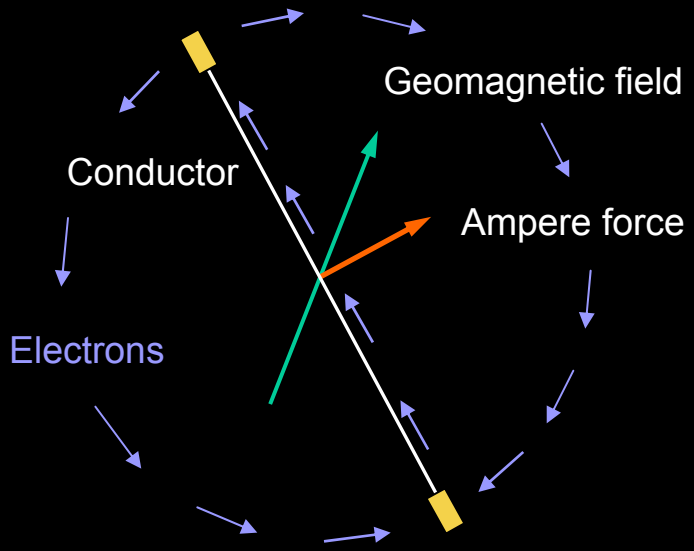
How Much to Launch

- 2200 dead satellites and spent stages all over LEO, 2000 tons total
- Too demanding for rockets



Electrodynamic Propulsion

- Propellantless, electrical, solar powered



Electron emitter

Hollow cathode

Electron collector

Aluminum tape

- Circuit closing demonstrated in orbit by Plasma Motor Generator in 1993 and Tethered Satellite System in 1996

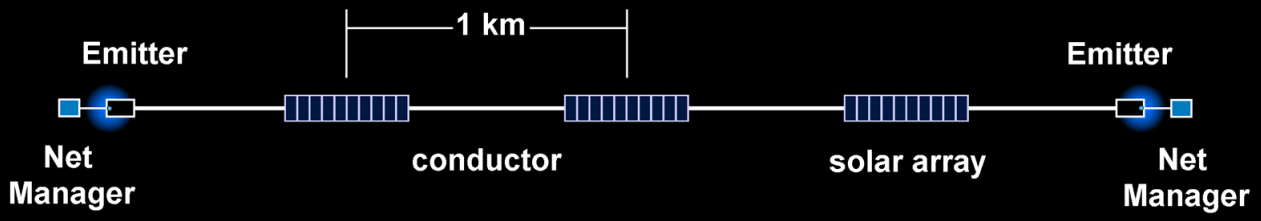
How to Think About It

- Like sailing in the ionosphere

Key West, 2006

- NRL Tether Electrodynamic Propulsion Cubesat Experiment (2012)

Electrodynamic "Garbage Truck"



- ElectroDynamic Debris Eliminator (EDDE)
- Only 100 kg, two fit into one ESPA secondary payload slot
- Nano-satellites "taped" together, but can move tons

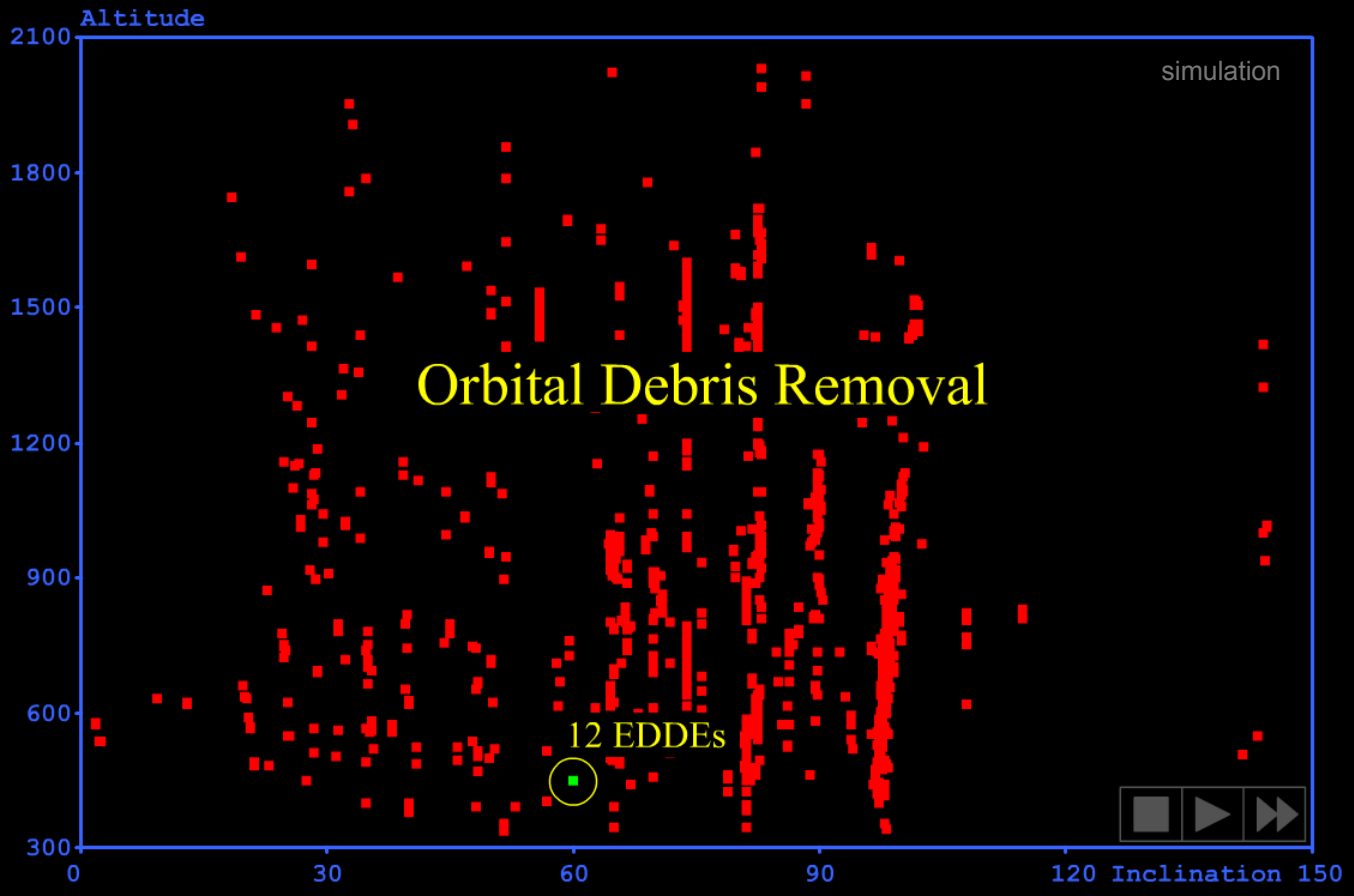
Reinforced aluminum tape

www.tetherapplications.com

ESPA ring

www.csaengineering.com

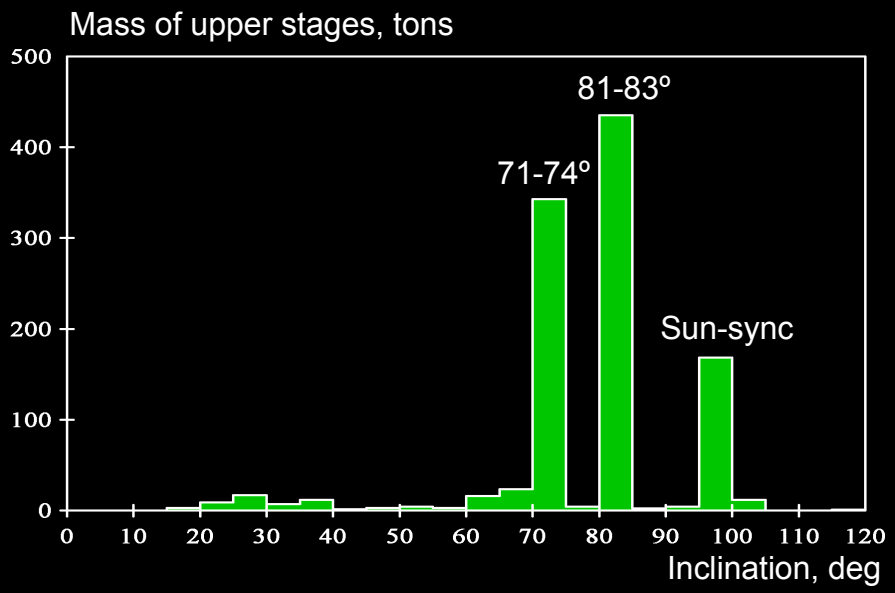
Wholesale Debris Removal



View: http://www.star-tech-inc.com/papers/EDDE.swf

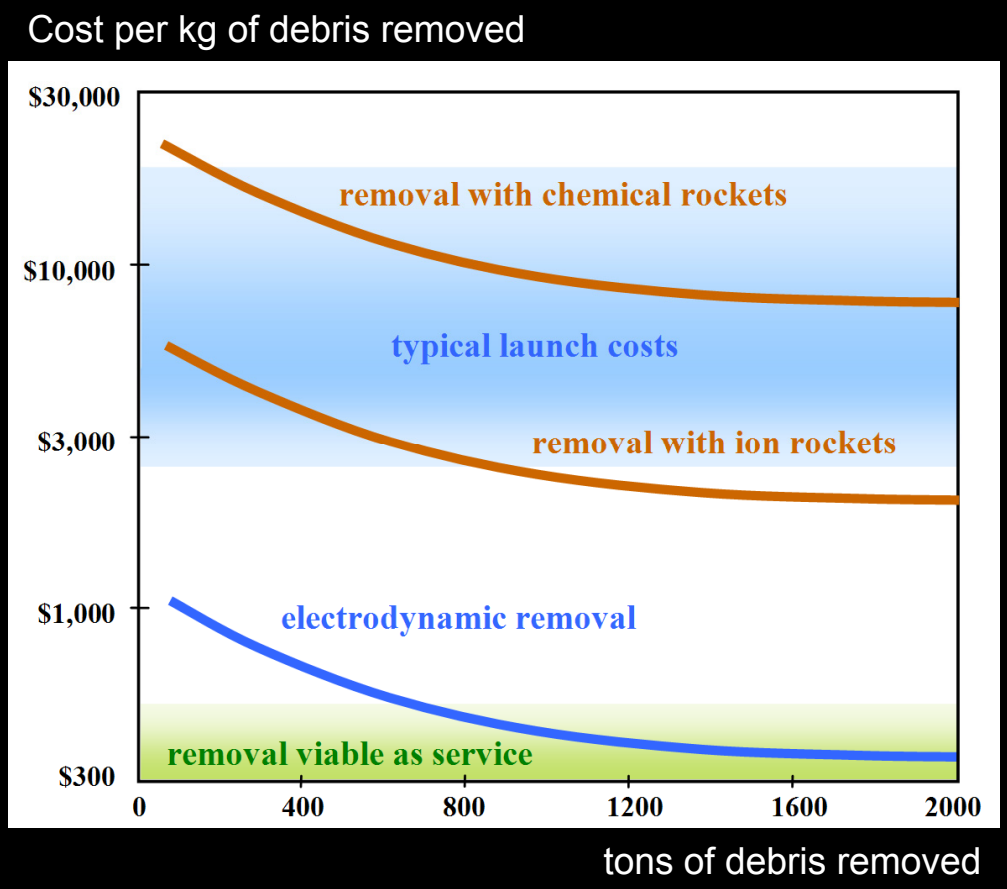
Debris Collection

- Avoid mass reentry
- Can use 1000 tons of mostly aluminum in upper stages



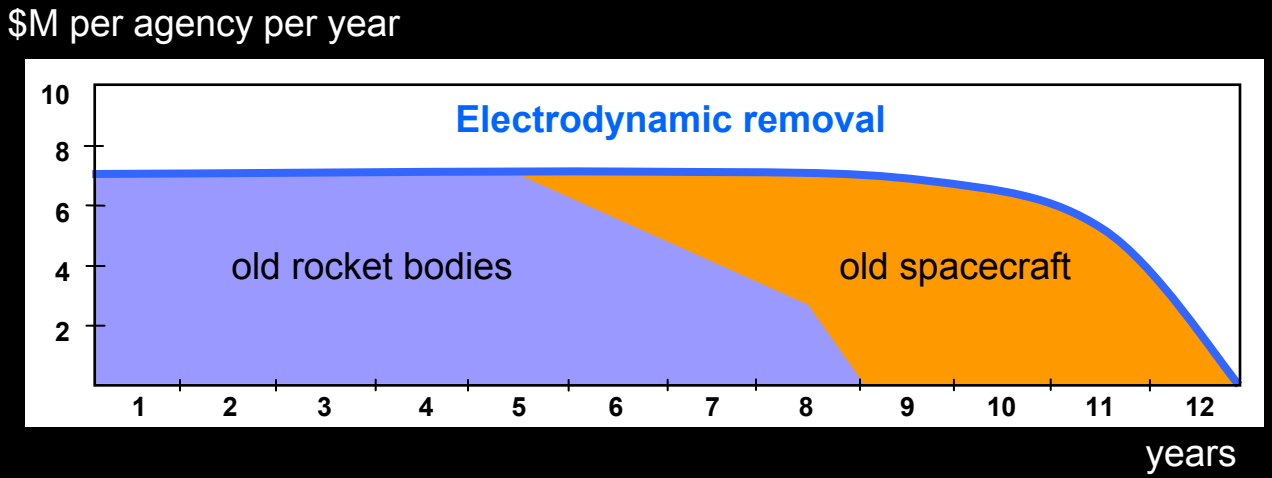
Commercial Service

- Removal should cost much less than launch to make economic sense



Wholesale Removal Campaign

- If the IADC member agencies decide to share the expense



- Competitive bidding from service providers

New Rules

- Legacy debris: states paying for its removal set rules going forward
- New debris: promptly remove spent stages and failed satellites
- Prototype: 25-year rule in U.S., but much shorter grace period
- Enforcement: participating states supervise their subjects
- Standard practice of removal will redefine fault
- Core group: states represented in IADC
- Enabler: affordable debris removal service
- Mechanism: salvage contract for each object

Three Scenarios for LEO

- Doing nothing

- Selective removal with rockets

- Wholesale removal with electrodynamic vehicles