Policy Aspects of Space Debris and Space Sustainability

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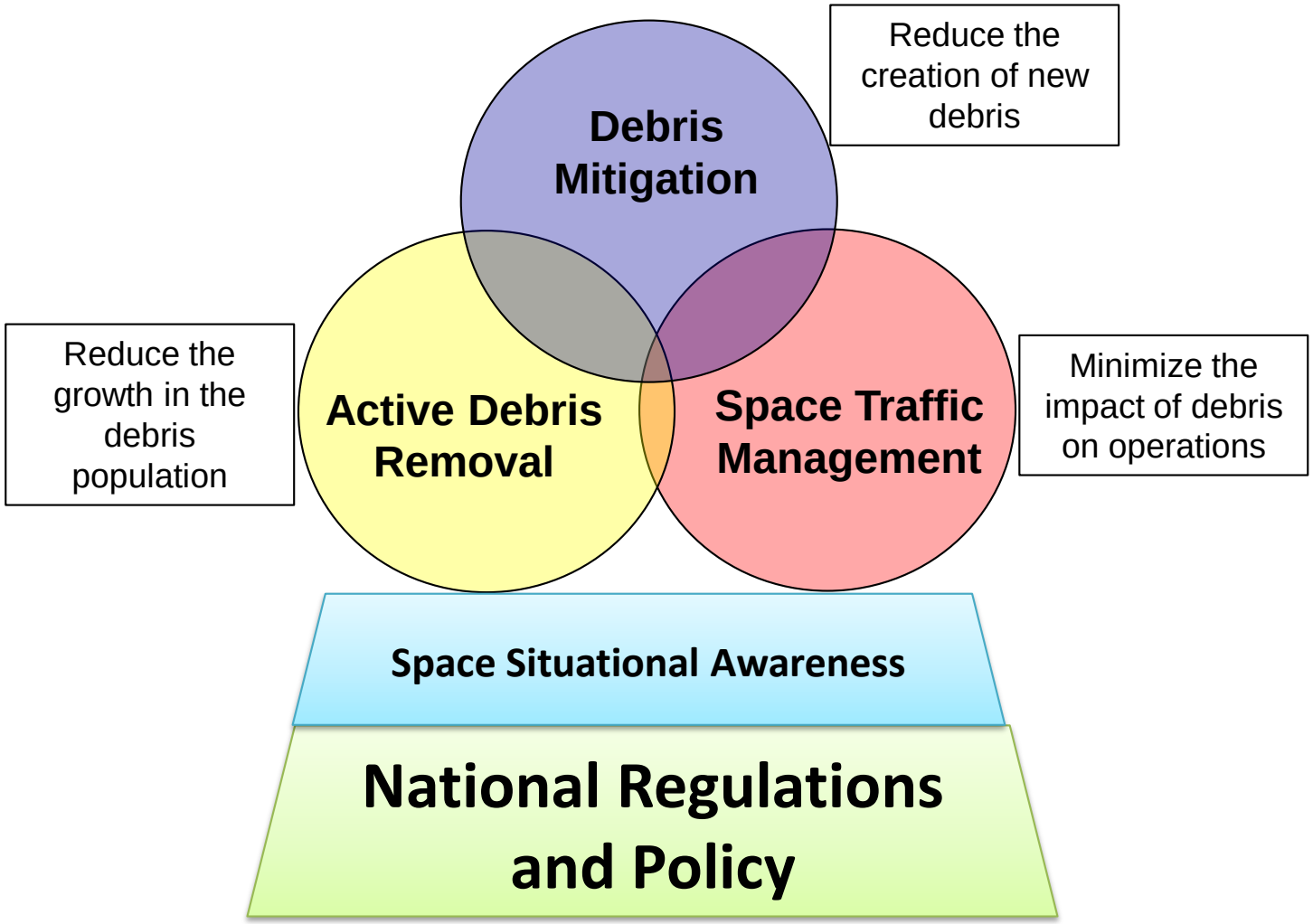
How do we make space sustainability real?



MACRO POLICY CHALLENGES

Why is it so hard to get people to act?

What is public policy?

- "The principled guide to action taken by the administrative executive branches of the state with regard to a class of issues in a manner consistent with law and institutional customs" (Wikipedia)

- "The public and its problems" (Dewey 1927)

- "How issues and problems come to be defined, and how they are placed in the political and policy agenda" (Parsons, 1995)

- "How, why, and to what effect governments pursue particular courses of action or inaction" (Heidenheimer et al, 1990)

Policy analysis

- Policy analysis has come to be dominated by economics
  - Definition of several alternative courses of action
  - Weighing the costs and benefits of each alternative
  - Choosing the alternative that best satisfies all the criteria

- Continual push for a more "scientific" (i.e., factual and unbiased) approach to developing, choosing, and implementing a policy option

- In the real world, the process by which policy happens and the people involved in the process play as big (if not a bigger) role than the "science"

Wicked vs tame problems

- Tame problems (mathematics, chemistry, chess) have ***clear objectives and resolutions,*** and can be resolved through application of scientific methods

- Wicked problems are those for which a ***purely scientific/rational approach cannot be applied (Roberts 2000)***
  - Cannot explicitly define all the variables
  - Stakeholders have radically different worldviews and timeframes
  - Constraints and resources change over time
  - Problem is never resolved definitively

Characteristics of a wicked problem

1. Cannot fully describe the problem without knowing what the solution is (the two are intertwined)
2. No “stopping rule” (no explicitly-defined end state when you know you’re done)
3. Solutions are not right or wrong, but better/worse or good/good enough
4. Each wicked problem is unique and novel
5. Every solution is a “one-shot operation”
6. There is no explicitly defined set of all possible solutions from which the “best possible one” can be chosen

It gets worse…

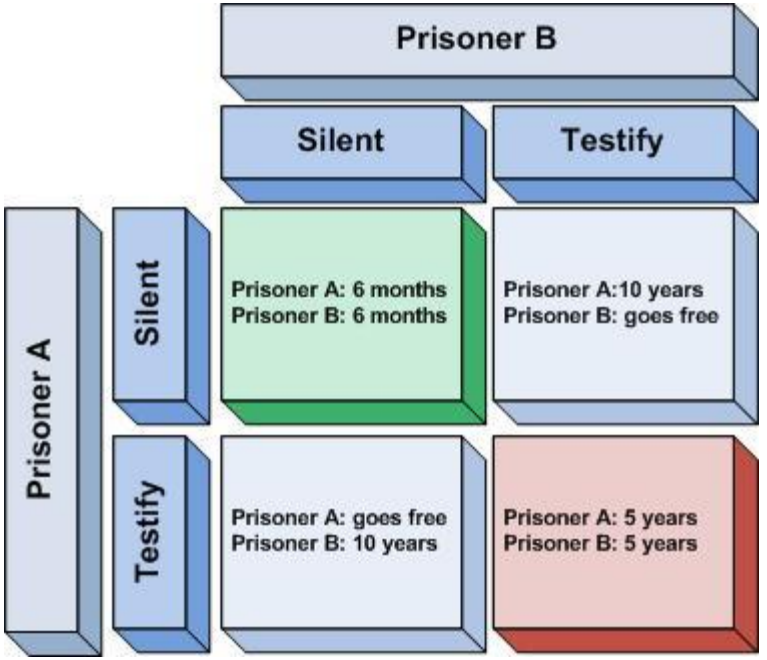
"**Super Wicked Problems**" have all of the characteristics of wicked problems, plus:

- Time is running out
- Those who are causing the problem are also seeking to provide a solution
- Central authority to resolve the problem is weak or non-existent
- Policy responses discount the future irrationally

…sounds a lot like space sustainability!

Root cause: Collective action problems

- Problems where the group would benefit from everyone taking a particular action, but the cost of doing so makes it implausible for any one individual to do so
- Categorical example:
  Prisoner's Dilemma
- Many real world examples
  - Pollution
  - Cyber security
  - Management of natural resources
  - Voting



https://www.sovereignman.com/lifestyle-design/the-prisoners-dilemma-10293/

Strategies for tackling wicked problems

- **Authoritative**
  - Put solving the problem in the hands of a few stakeholders who have authority to define problem & develop solution
  - Makes decisions & action easier, but the "experts" can be wrong
- **Competitive**
  - Many players all compete to solve the problem in their own way
  - Improves odds of finding a good solution, but wasteful & can lead to violence (war is a free market with harsher penalties)
- **Collaborative**
  - Seek "win-win" solution instead of zero-sum
  - Shared costs & pooled resources, but increased transaction costs in developing/implementing solution

Conditions for employing a strategy (Roberts 2000)

- Power is concentrated and uncontested -> **Authoritative**
- Power is distributed and contested -> **Competitive**
- Power is distributed and uncontested -> **Collaborative**

- Research shows that people often have to fail into collaboration
  - Only after personal experience with authoritative and competitive strategies can people really understand their shortcomings
  - People have to learn what does not work before they are willing to absorb what are perceived as the “extra costs” of collaboration
  - Goes for interagency process within a government as well as between governments

MICRO "POLICY" CHALLENGES WITH SPACE DEBRIS

Policy, legal, and economic considerations

Main legal challenge is uncertainty

- Just about all of the legal challenges can be grouped into two areas:

  1. ***Lack of clarity and consensus on foundational principles***

  2. ***50+ year old legal regime that was intended to stabilize the Cold War relationship between nuclear superpowers (but not do much else)***

- It's a framework that provides broad guidance and direction, but not a lot of specificity

- Nothing explicitly prohibits removing space debris, but the ***uncertainty creates resistance to action***

How many "space objects" are there?

Online Index of Obj

Important Note: Information in square brackets ([and] United Nations. Reference to external websites does no views expressed are those of the authors and do not ne

Search Object

found 7316 Objects

So there a

International Designator	National Designator	Name of Space Object
[2016-001A]		[BELINTERSAT 1]
[2015-083A]		[GAOFEN 4]
[2015-082A]		[EXPRESS AMU1 (EUTELSAT 36C)]
[2015-081A]		[ORBCOMM FM 114]

	IN ORBIT				
COUNTRY	UNASSIGNED	PAYLOAD	ROCKET BODY	DEBRIS	TOTAL
UKRAINE (UKR)	0	1	0	0	1
URUGUAY (URY)	0	1	0	0	1
UNITED STATES OF AMERICA (US)	0	1275	669	3418	5362
UNITED STATES/BRAZIL (USBZ)	0	1	0	0	1
VENEZUELA (VENZ)	0	2	0	0	2
VIETNAM (VTNM)	0				3
ALL (ALL)	3	4156	2053	11264	17476

Not according to USSTRATCOM

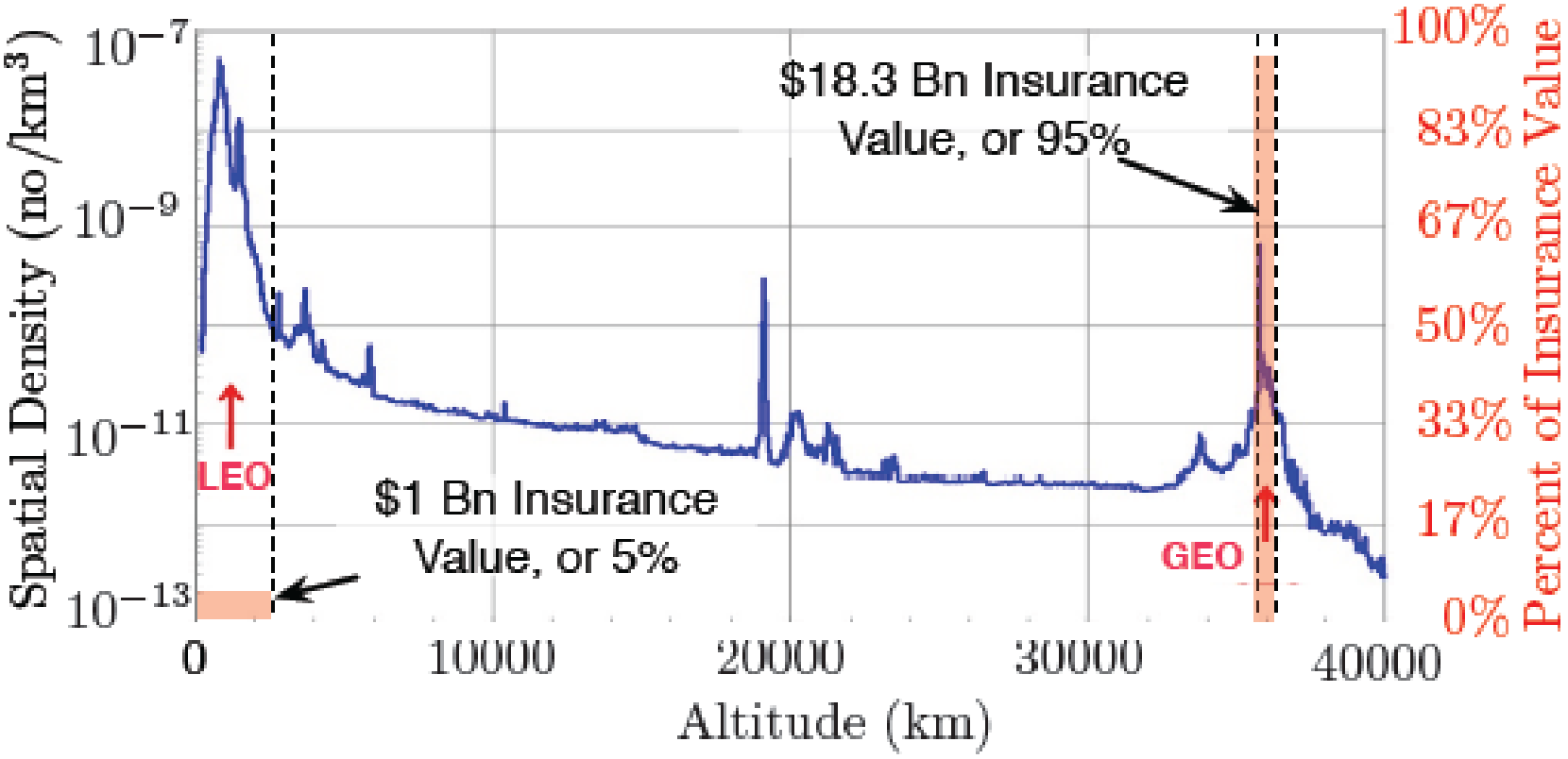
Costs from space debris to any one operator are low

- Annual risk of collision in the worst region is about 0.8% per year
- ***Worst-case analysis:*** Cost to maintain a satellite constellation at 850 km for 20 years

Constellation Size	Replenishment Cost ($B, No debris)	Replenishment Cost ($B, Fatal only)	Replenishment Cost ($B, All impacts)
Small (5 sats)	$19.1	$20 (+5%)	$20 (+5%)
Medium (20 sats)	$15.5	$16.5 (+6.5%)	$17.16 (+11%)
Large (70 sats)	$7.6	$8.68 (+13%)	$9.57 (+26%)

Ailor, Womack, Peterson, and Murrell (2010)

Insurance is not going to help (much)



Schaub, Jasper, Anderson, and McKnight (2014)

The stark reality of economics

- The odds of developing an economic incentive mechanism for removing space debris in LEO are ***extremely small*** because there's ***little direct economic value in LEO*** (right now)
  - Nearly all the economic activity in space takes place in GEO
    - Total value of global space activities: $280 billion
    - Total private benefits from LEO: ~$3 billion
  - Almost all users of LEO are public entities deriving social benefits
- The ***debris problem was almost entirely created by governments*** using public money (legacy debt that needs to be dealt with)
- Any ***funding of debris removal or mitigation activities is likely to come from public money***
  - Either as governments conducting missions themselves or purchasing services from private sector

STEPS TOWARDS A SOLUTION

The tragedy of the global commons

- Concept of "Tragedy of the Commons" was popularized by a 1968 Science article by Garrett Hardin
  - "Multiple individuals, acting independently and rationally consulting their own self-interest, will ultimately deplete a shared limited resource, even when it is clear that it is not in anyone's long-term interest for this to happen" – Wikipedia

- Hardin suggested only two ways to avoid this tragedy
  - Leviathan (single hegemonic entity to manage the resource)
  - Privatization of the resource

Tragedy is that you can't solve the problem without destroying the commons

Space as a Common Pool Resource (CPR)

- **Excludable:** can prevent others from using the resource
- **Rivalrous:** someone else's use of the resource precludes your own use of it

	Excludable	Non-excludable
Rivalrous	**Private goods** food, clothing, cars, personal electronics	**Common goods (Common-pool resources)** fish stocks, timber, coal
Non-rivalrous	**Club goods** cinemas, private parks, satellite television	**Public goods** free-to-air television, air, national defense

Outer space as whole is a public good, but heavily used regions of Earth orbit (LEO, GEO) are Common-Pool Resources (CPRs)

Elinor Ostrom

- Won 2008 Nobel Prize in economics for her work on common-pool resources (CPRs)

- Discovered that there are many cases where the tragedy of the commons is false
  - Resources can be managed sustainably without either Leviathan or privatization
  - Resource appropriators self-organize to develop governance model that is suited to local conditions

- Distilled 8 principles which were common to all cases of successfully managed CPRs

Ostrom's Principles

1. Clearly-defined ***boundaries of the CPR*** (effective exclusion of external unentitled parties)
2. Rules regarding appropriation and provision of resources are ***adapted*** to local conditions
3. Collective-choice arrangements ***allow most resource appropriators to participate in the decision-making process***
4. ***Effective monitoring*** by monitors who are part of or accountable to the appropriators
5. ***Graduated sanctions (penalties***) for resource appropriators who violate community rules
6. Low-cost and easy-to-access ***conflict resolution mechanisms***
7. Self-determination of the community is recognized by higher-level authorities
8. In the case of larger common-pool resources: organization in the form of ***multiple layers of nested enterprises***

Template for what political/legal/economic Mechanisms we might need for space

Success of debris mitigation

- Inter-Agency Space Debris Coordination Committee (IADC)
  - Members are national space agencies
  - 2007 published debris mitigation guidelines
  - Established “protected zones” in LEO and GEO, 25 year rule
  - UN endorsement in 2008, urged States to adopt on voluntary basis
- Some progress on national implementation
  - US, France, Germany, Russia, Canada, UK, Japan, and China have implemented or are working on implementation
- ESA research indicates 40-60% compliance with 25-year rule
  - Less compliance in LEO than GEO
  - No significant increase (or decrease) over last 13 years

UN Group of Governmental Experts (GGE)

- UN Group of Governmental Experts (GGE) on Transparency and Confidence Building Measures (TCBMs) for Outer Space Activities
  - 15 experts (P5 + "representative" 10) nominated by countries
  - Asked to make recommendations for improving security & stability

- Delivered their report in October 2013
  - Information exchange and notifications
  - Risk reduction
  - Contact lists and consultative mechanisms

- Big issue: What next?

Space Code of Conduct

- EU Code of Conduct
  - Started with the French presidency of the EU in 2007
  - One of the first few exercises of EU foreign and security policy powers post-Lisbon Treaty
  - Adopted by EU in 2008, and offered up for international participation

- International Code of Conduct
  - Created in 2012, uses EU Code as basis
  - Multiple rounds of formal and informal international negotiations
  - August 2015 meeting ended with deferring entire issue to UNGA
  - Major disagreements
    - Definition of self-defense in space
    - Inside or outside the UN
    - Focus on security space, “peaceful” space, or both?

UN Long-Term Sustainability Guidelines

- Working Group under the Scientific and Technical Subcommittee (STSC) of the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS)

- Build on success of space debris mitigation guidelines and create voluntary "best practices" for space sustainability
  - Space debris and space operations
  - Space weather
  - National regulations and oversight
  - Sustainable use of space for sustainable development on Earth

- Formally began in 2009, hope to reach consensus by June 2016

General lessons going forward

- Learn from other domains, but don't copy/paste ideas
  - Air Traffic Management ≠ Space Traffic Management, but there are some useful concepts that might help
- Technical definitions/approaches are good places to start, but don't ignore politics
  - Wicked problems by definition cannot be solved through purely scientific/rational means
  - Need to have a cultural/behavioral/political dimension as well
- Push for a collaborative solution, but don't be surprised if it's the last thing that gets tried
- Recognize that not all stakeholders have the same perspective/priorities
  - Developed spacefaring countries have a different perspective from developing countries

General lessons going forward (2)

- Focus on developing policy interventions at multiple levels
  - International, national, and individual actor
- Don't discount value of incremental policies, or starting from coalitions of the willing
  - Start with a core constituency, and increase it over time
- Pay attention to the process & actors involved as much as the actual "solution"

Policy priorities moving forward

- Increased harmony between technical standards and national regulations on debris mitigation across all space actors
  - Increases benefits to those actors who adopt them
  - Creates a path dependency that makes it hard to go back
- Develop norms of responsible behavior in space that reinforce debris mitigation guidelines and other policy interventions
  - Reward good behavior, and criticize bad
  - Polite peer pressure (from NGOs?)
- Increased access to SSA data for all space actors (and the public)
  - Increases awareness of the problem, builds common understanding
  - Reinforces norms of behavior and costs of acting outside the norms

High-level plan of action

- Bilateral and multilateral discussions between States
  - Define self-defense in space
  - Rules of engagement (ROE) for military interactions
  - Are there behaviors/actions that should be off limits?
- National regulation and policy
  - Oversight of commercial on-orbit activities through "space traffic management"
  - Establish civil SSA and space safety authorities/responsibilities
- Satellite operator cooperation
  - Develop and implement best practices and norms of behavior
  - Set example for States, and push them to help make space more predictable for commercial development

Thank You. Questions?

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