

Overview of Orbital Carrying Capacity

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Significant (and growing) public concern over space congestion

Nature
The world must cooperate to avoid a catastrophic space collision
Governments and companies urgently need to share data on the mounting volume of satellites and debris orbiting Earth.
Aug 11, 2021

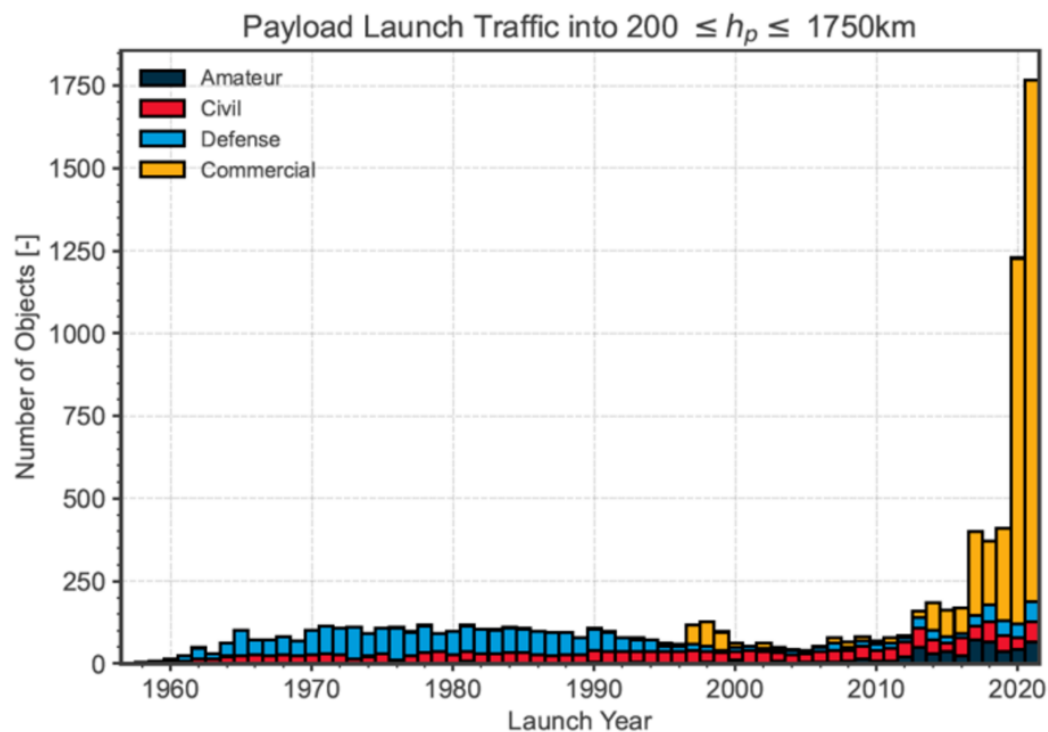
ORF
The race for mega satellite constellations: Crowding and control in Low Earth Orbit
Low Earth Orbit (LEO) is increasingly becoming crowded. The Chinese have announced that they will be launching a mega constellation.
May 1, 2021

MIT Technology Review
Who is Starlink really for?
The boom in LEO satellites will probably change the lives of customers who've struggled for high-speed internet—but only if they can afford...
Sep 6, 2021

Engadget
We're entombing the Earth in an impenetrable shell of dead satellites
A recent study suggests that there is now nowhere on Earth free from the light pollution produced by overhead debris and satellites.
Apr 8, 2021



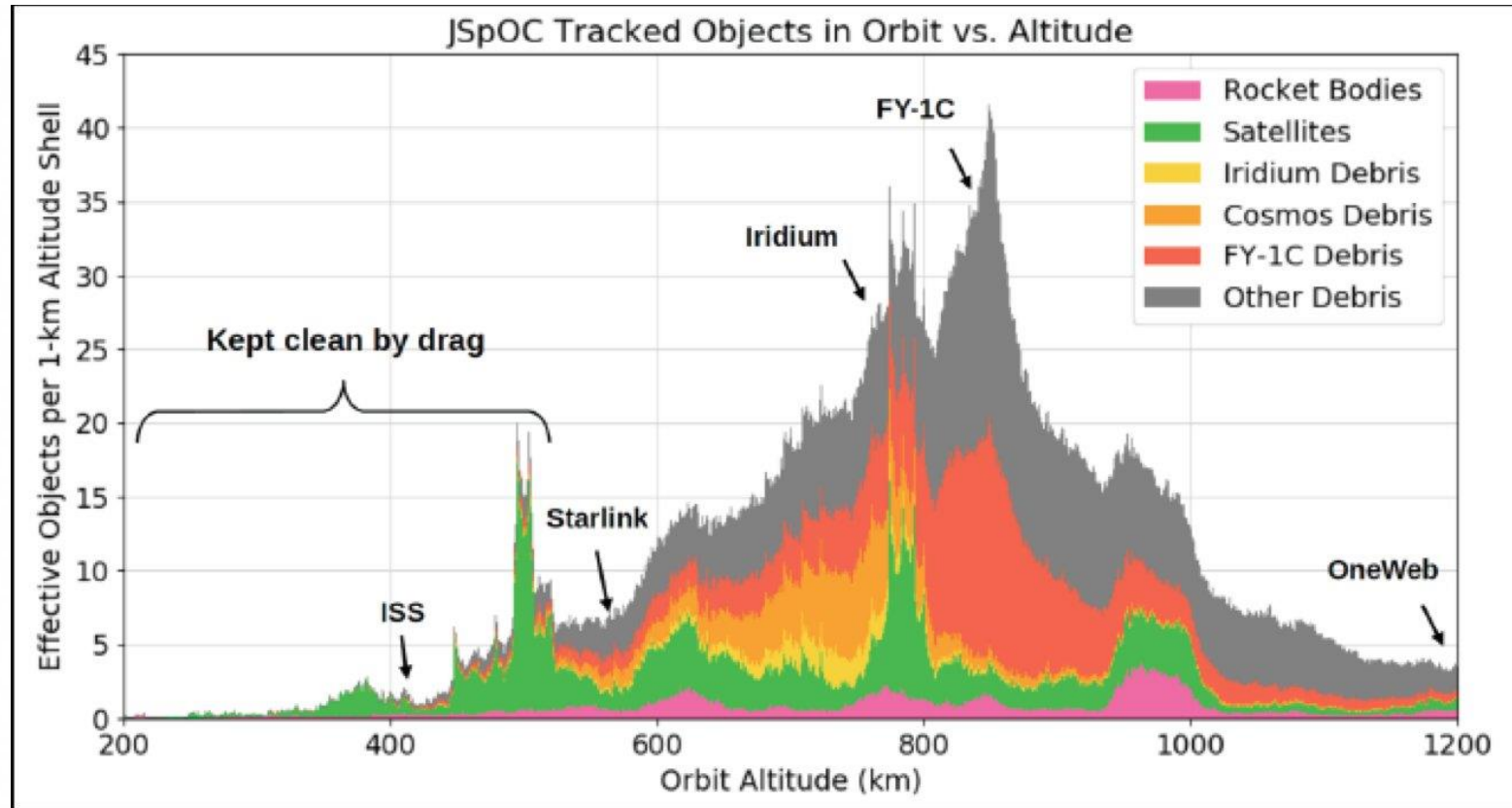
...That has some basis in reality



Source: [ESA \(2022\)](#)

Constellation	Total Sats	Altitude (km)	Country
Starlink G1	4,408	550 – 560	US
OneWeb	6,372	1,200	UK
Starlink G2	30,000	340 – 614	US
Kuiper	7,774	590 – 650	US
GW	12,992	590 - 1145	China
Cinnamon	327,320	550 – 630	Rwanda
LightSpeed	1,969	1,015 – 1,325	Canada

Source: [Jonathan McDowell \(2021\)](#)



Source: SpaceX FCC Filing



SWF Carrying Capacity Workshop

- SWF convened a diverse assortment of international researchers who are examining orbital carry capacity for a virtual workshop in March 2022
- Objective: **Understand** the current state of research efforts related to orbital carrying capacity and measuring orbital congestion & **assess** its suitability for policymaker engagement



Workshop Participants

- European Space Agency
- University of Southampton
- Politecnico di Milano
- EPFL Space Center
- Massachusetts Institute of Technology
 - Dept. of Aeronautics and Astronautics
 - Media Lab
- University of Colorado-Boulder
- LeoLabs
- COMSPOC Corporation
- CNES
- Middlebury College
- European Space Policy Institute
- University of Bordeaux



Existing Work

Environmental
“What is the long-term impact on the environment?”

Astrodynamics
“How many active satellites can we closely pack together?”

Impact to Ops
“How do we minimize costs to current satellite operations?”

Metrics
“How can we measure the impact of a satellite/ constellation?”

Norms
“What behaviors should we encourage or discourage?”

Economics
“How might different incentives affect operator behavior?”



Our Assessment

- Very unlikely to ever get to a specific number to “cap” satellites at
 - Too difficult to measure/assess, depends greatly on orbital altitude and other factors
- Very likely to have multiple models based on different conceptual approaches
 - How do we build interoperability between the models?
 - How can communicate uncertainties (like what it done for climate models)?
- Better tracking/SSA is necessary but not sufficient
 - Plays a huge role in almost every approach and potential solution
 - More accurate data makes everything much easier and some problems go away



Our Assessment (2)

- Need to shift from just orbital debris mitigation to space environmental management
 - Need to look at the bigger picture & develop more holistic approaches
- Timeframe matters
 - Long-term (200 year) view might obscure serious short-term (today-10 yr) impacts
- Models and policies need to take behavior into account
 - Focus should be to drive behavior (nudge) towards specific goals
 - Study unintended consequences from other domains
 - Designing markets often better than implementing taxes (more positive innovation)



Our Assessment (3)

- Oversight of large constellations is largely done by spectrum regulators
 - Do they have the capacity/expertise/authority to look at other aspects beyond RFI?
- Oversight is largely done on a national basis via market access
 - (Apparent) lack of coordination/exchange between national regulators
 - Assumption that others are “taking care of it”?



Recommendations

- Need more engagement between technical community and policymakers
 - Likely to be an on-going process rather than a problem that gets “solved”
- Need more research funding, especially on questions of most value to policymaking
 - Which mitigation proposals have the highest efficacy?
 - How to measure the cost/benefit tradeoffs?
- Need to assess/evaluate how to apply carrying capacity models/tools/insights to regulatory process

