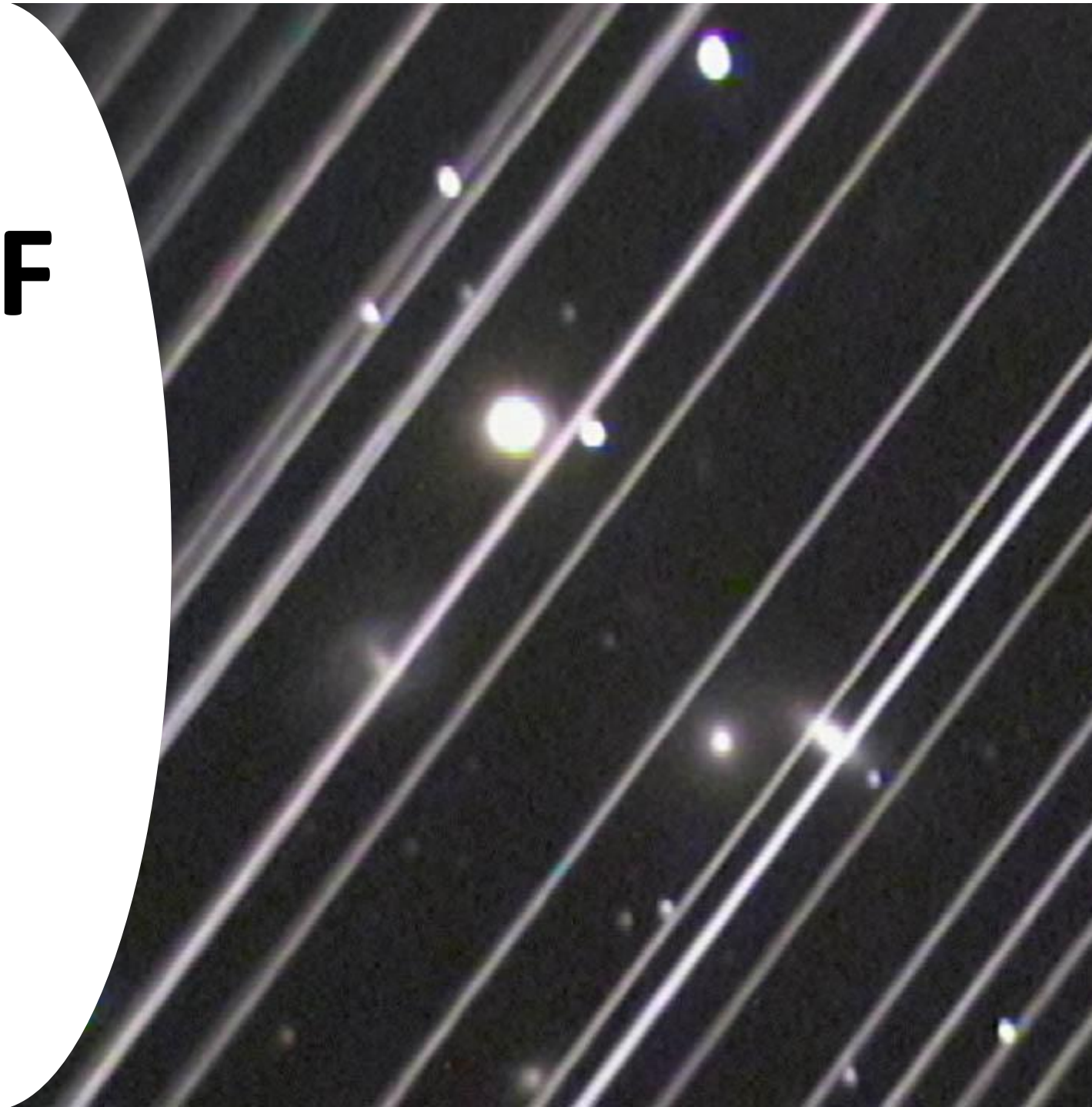
The AAS, CORF & SatCons

Kelsey Johnson

University of Virginia

President, American Astronomical Society



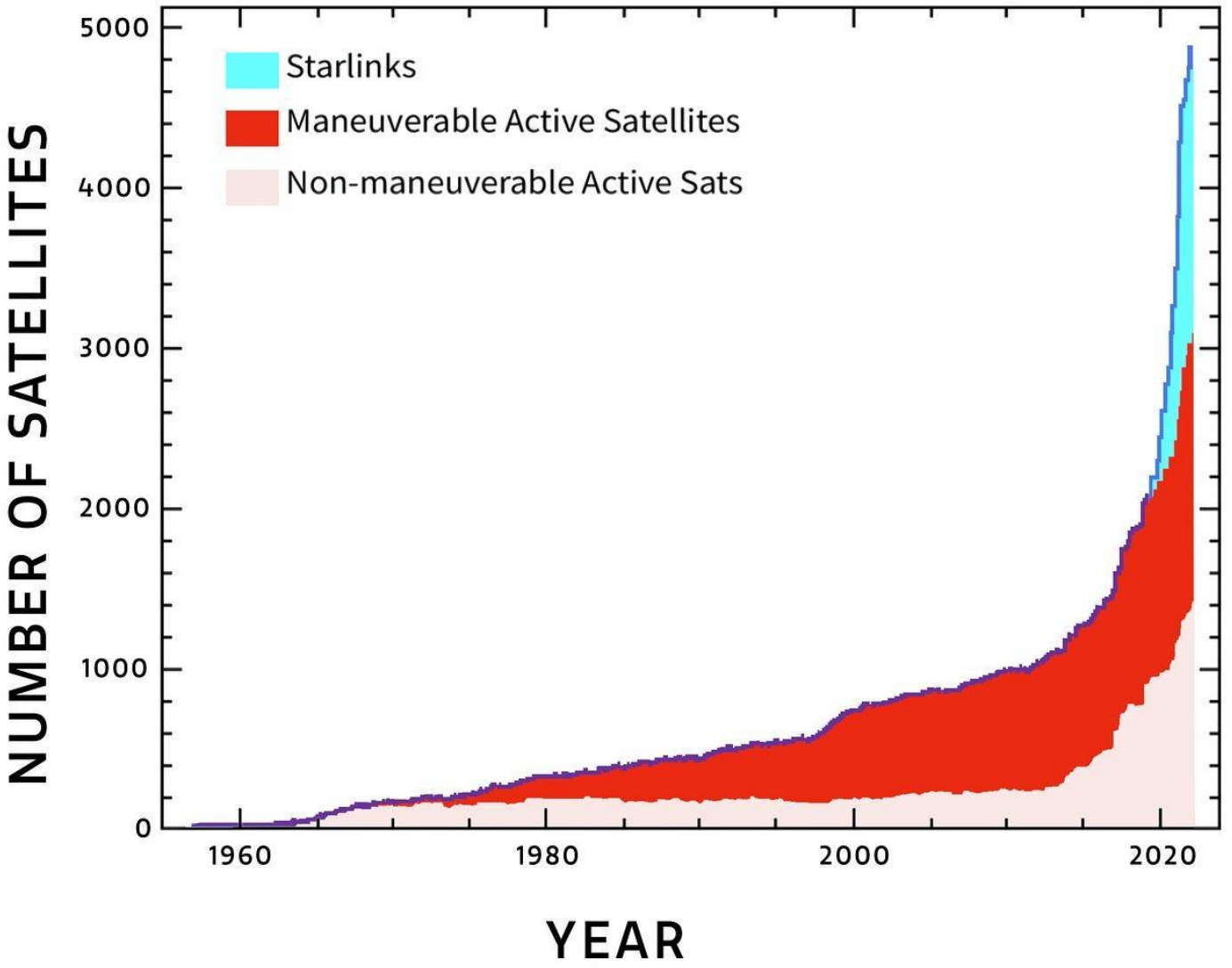
AAS Mission Statement

The mission of the American Astronomical Society is to enhance and share humanity's scientific understanding of the universe as a diverse and inclusive astronomical community.

New Reality in the sky

427,171

Planned Constellation Satellites in constellations (according to FCC and ITU license applications).



Credit: J. McDowell/CFA

Some Good News

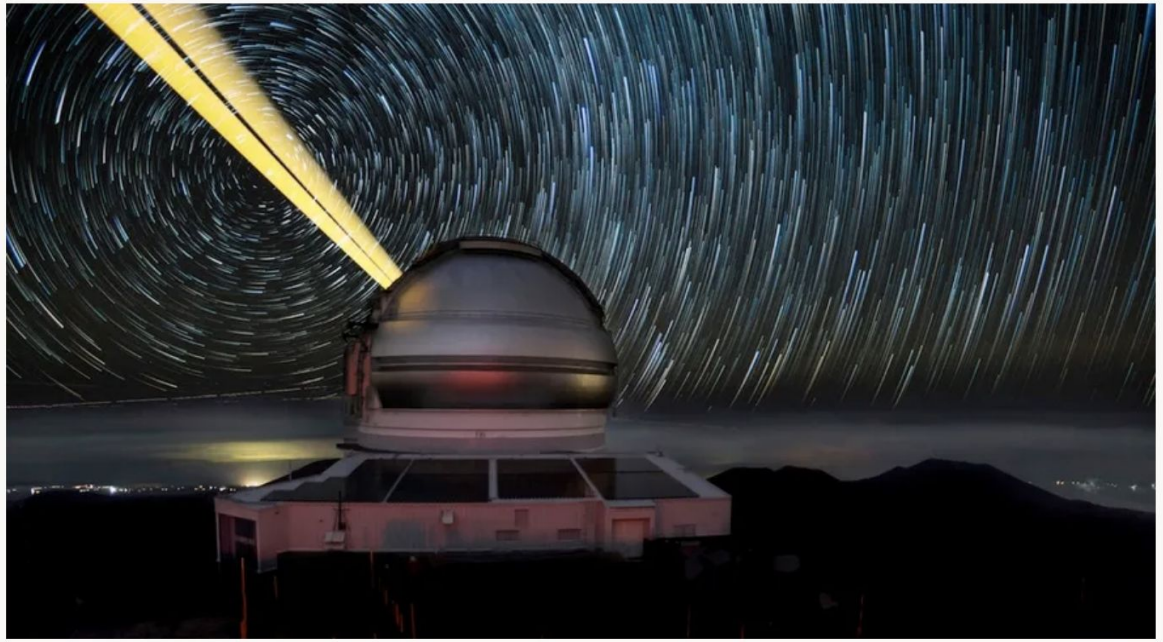
Per FCC 22-91 (135.ff)

“SpaceX must coordinate with NSF to achieve a mutually acceptable agreement to mitigate the impact of its satellites on optical ground-based astronomy. SpaceX must submit an annual report to the Commission, by January 1st each year covering the proceeding year containing the following information: (1) whether it has reached a coordination agreement with NSF addressing optical astronomy; and (2) any steps SpaceX has taken to reduce the impact of its satellites on optical astronomy, including but not limited to darkening, deflecting light away from the Earth, attitude maneuvering, and provision of orbital information to astronomers for scheduling observations around satellites’ locations.”

Some Good News

NSF and SpaceX reach agreement to reduce Starlink effects on astronomy

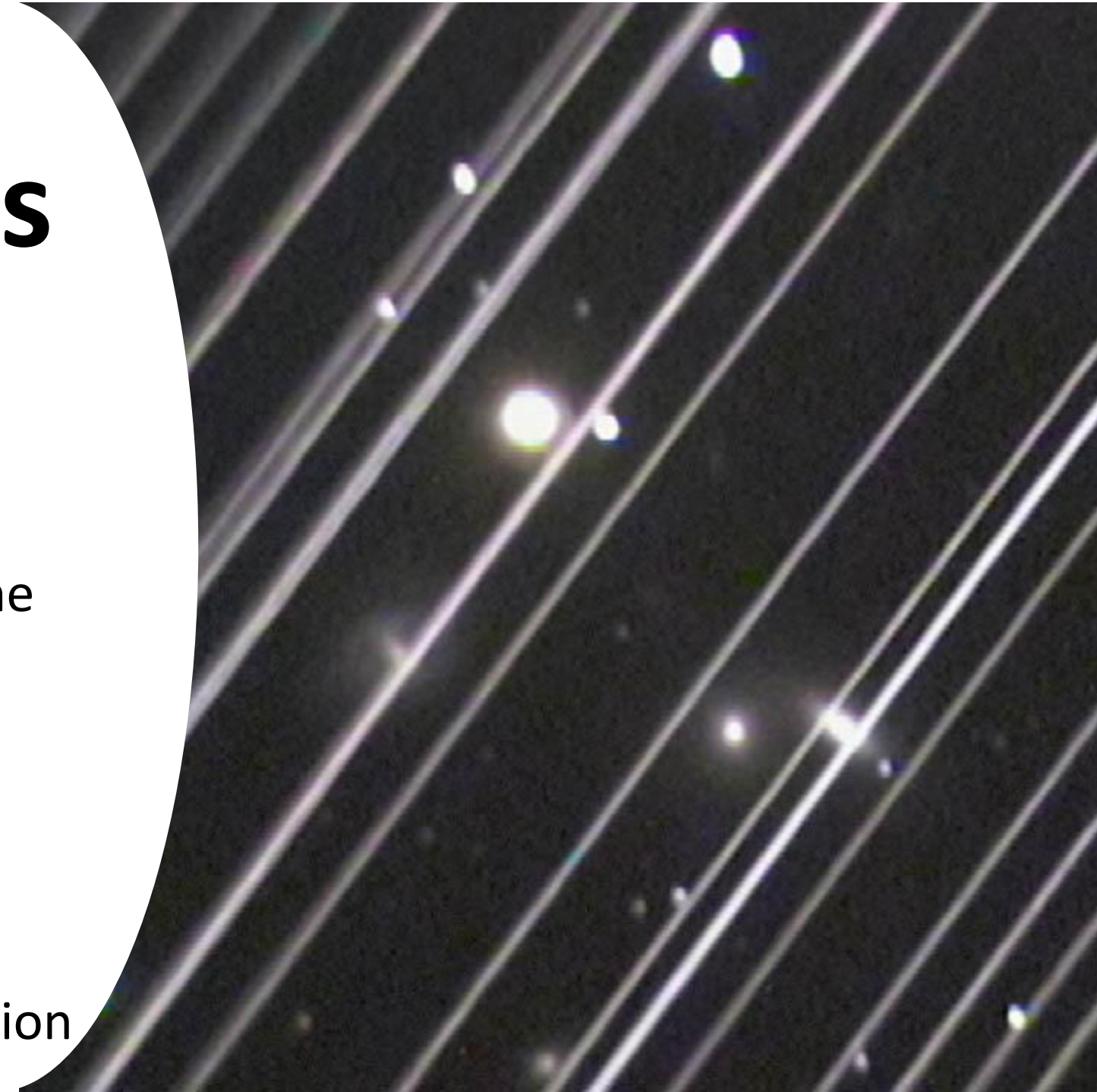
Jeff Foust January 12, 2023



The coordination agreement between NSF and SpaceX includes several conditions intended to reduce the effects of Starlink satellites on astronomy, including SpaceX agreeing not to require observatories to turn off lasers used for adaptive optics systems when Starlink satellites pass overhead. Credit: Gemini Observatory/AURA image by Joy Pollard

Ongoing Issues

- Loss of data (esp. time domain)
- Unpredictable glinting
- Impact on laser guide star usage
- Runaway debris/Kessler Syndrome
- Cultural knowledge & Heritage
- Impact on recruiting/training
- Diffuse sky brightness increase
- Environmental impacts (esp. atmospheric)
- Radio interference/NRQZ protection



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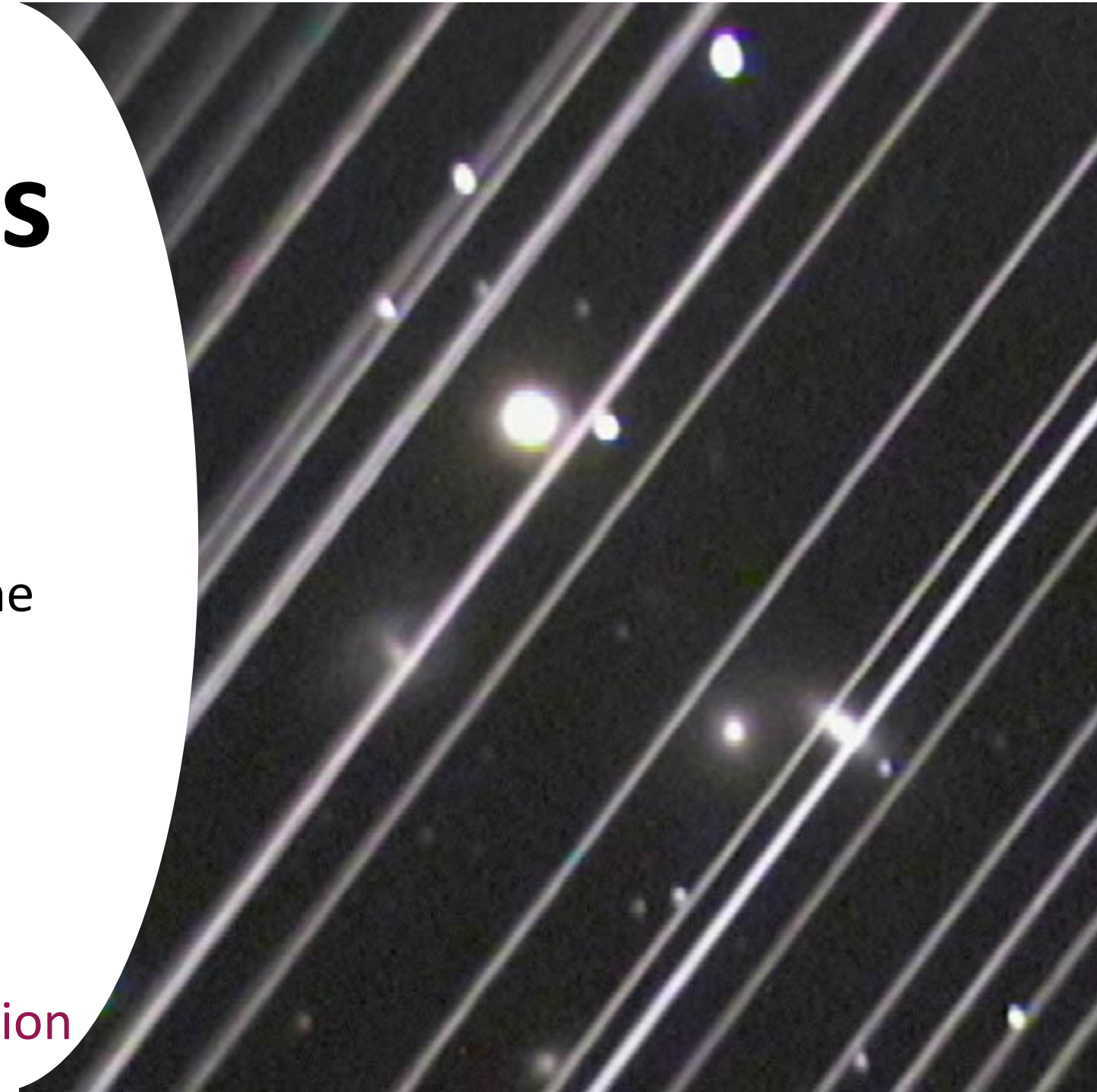


Diffuse Night Sky Brightness

Monthly Notices of the ROYAL ASTRONOMICAL SOCIETY

MNRAS **504,** L40–L44 (2021)
Advance Access publication 2021 March 29

doi:10.1093/mnrasl/slab030

The proliferation of space objects is a rapidly increasing source of artificial night sky brightness

M. Kocifaj,[1,2★] F. Kundracik,[2] J. C. Barentine[3,4★] and S. Bará[5]

"Reasonable estimates based on planned satellite constellations just in the 2020's imply that the night sky could be artificially brightened by as much as 250%"

- SatCon2 Report

Credit: Kyba et al., Science

Full Environmental Impact Unknown

- Projection of 23 satellite reentries per day (for a population of 42,000)
- Deposition of aluminum to exceed that of meteoroids by 10x
- + Black carbon particles, nitrogen oxides, chlorine chemicals, etc.

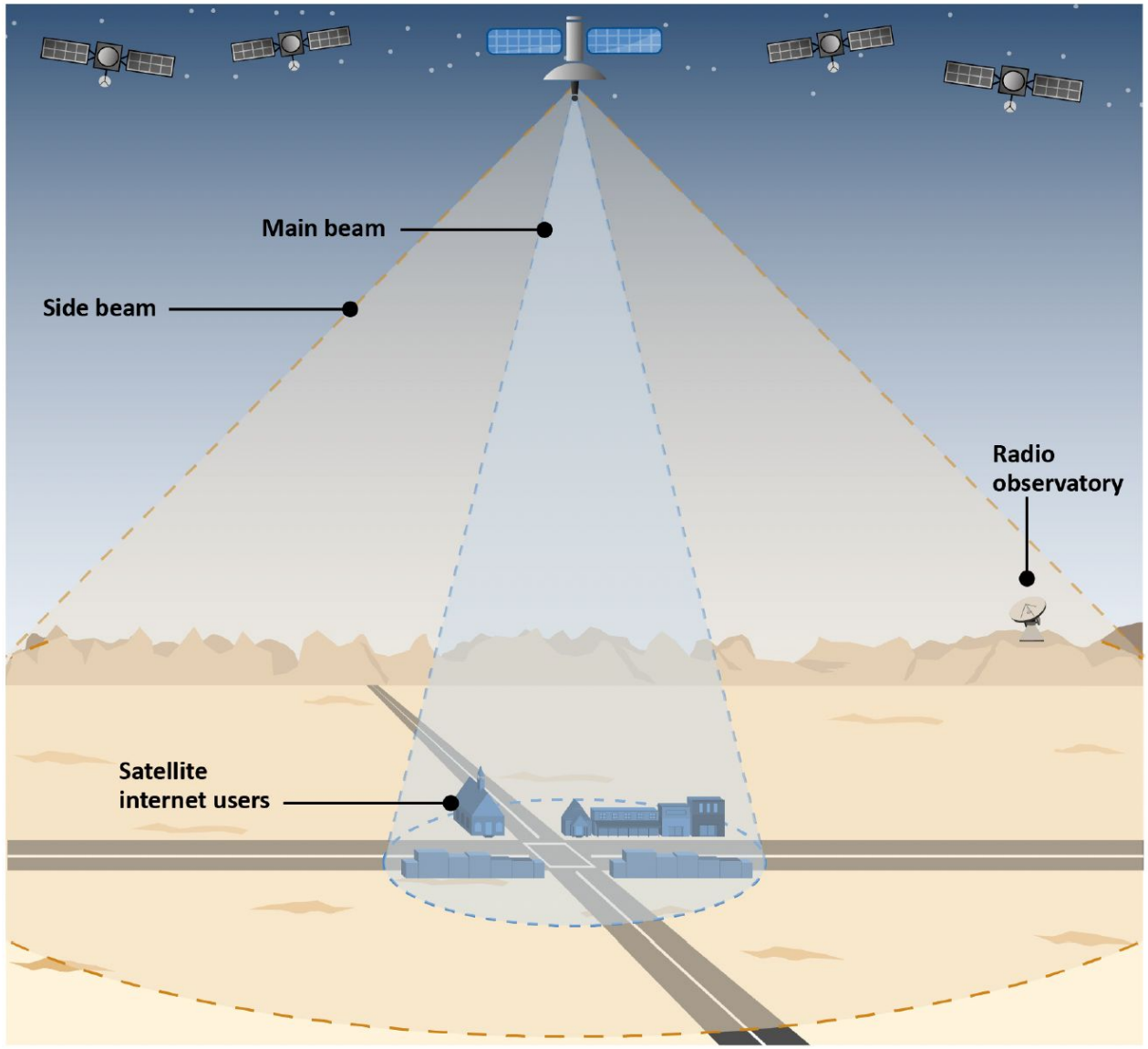
"Rocket launches and satellite reentries produce emissions that can affect Earth's upper atmosphere.10 However, there is large uncertainty in understanding how emissions will affect the atmosphere because of the lack of observational data"

- GAO Report, 2022

Radio Astronomy

Little to no regulatory oversight of “unintentional” radiation (harmonics, out-of-band emissions, sidelobes, etc)

Figure 8: Satellite effects for radio astronomy: Side beam transmissions



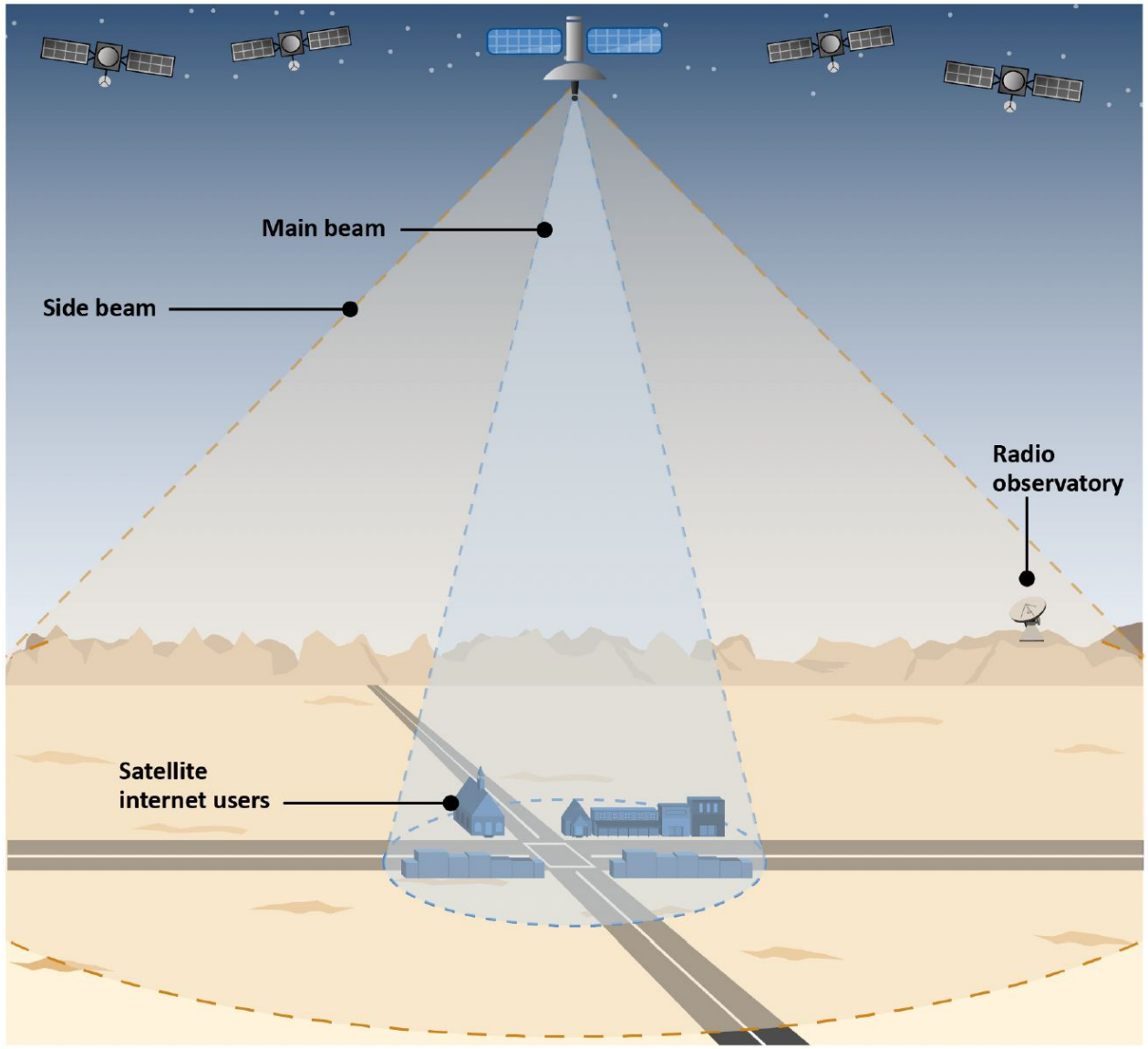
Source: GAO. | GAO-22-105166

Radio Astronomy

"In the opinion of JASON, the current regulatory framework is insufficient to protect many modern radio astronomy observations."

- JASON Report, 2021

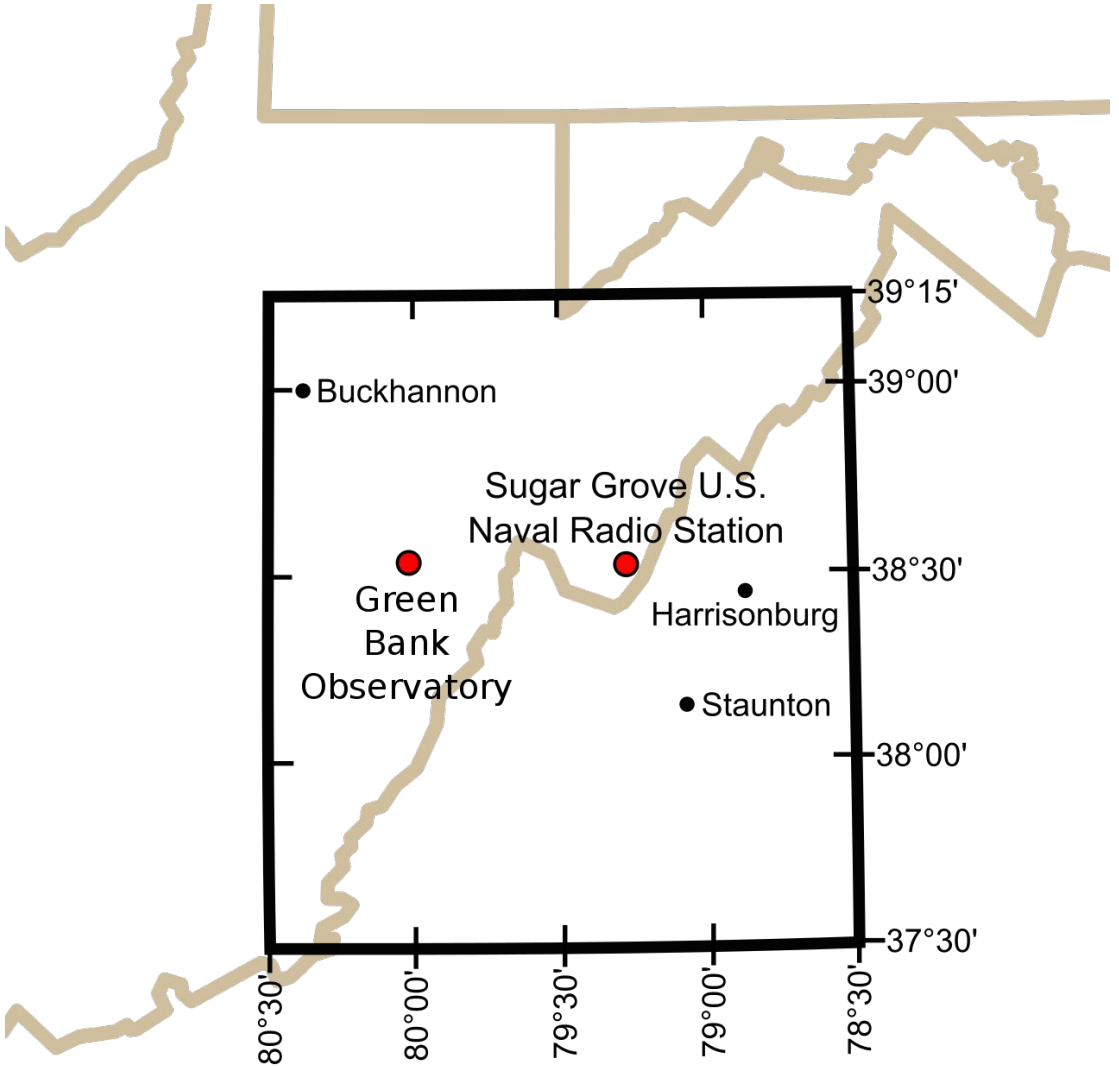
Figure 8: Satellite effects for radio astronomy: Side beam transmissions



Source: GAO. | GAO-22-105166

Radio Quiet Zones

"coordination is required for all new or modified, permanent, fixed, licensed transmitters inside the NRQZ"



Credit: Joel Bradshaw

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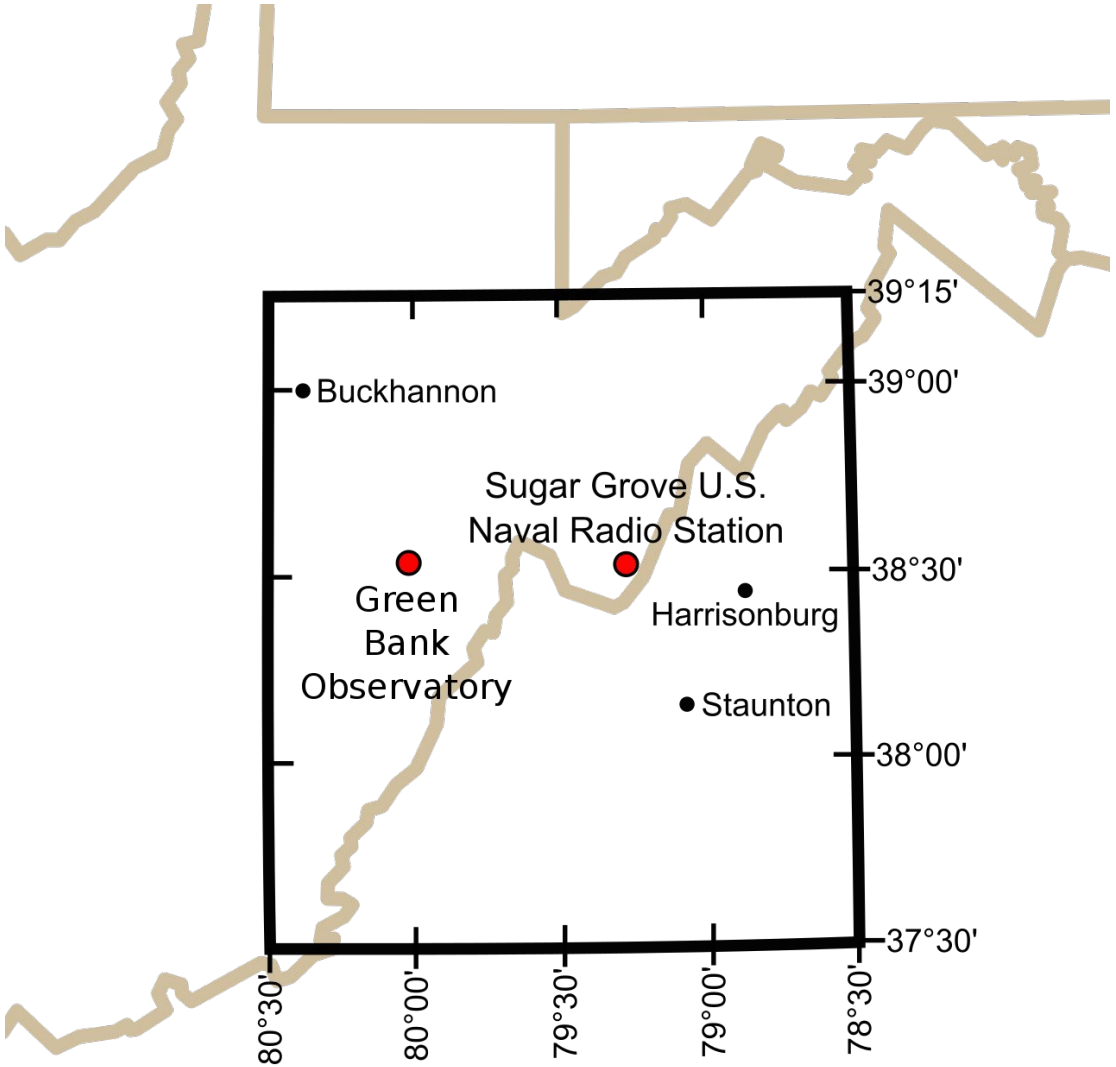


Credit: Joel Bradshaw

What is AAS Doing?

- Immediate Mitigation

Maintain relations with industry to ensure coordination and collaboration to achieve mutually acceptable agreement to mitigate the impact of its satellites on space and ground-based astronomy.

- Long-term Policymaking

Work with policymakers to ensure there is federal coordination and oversight on mitigation of the negative impacts on astronomy from satellites in Low-Earth Orbit by operators throughout all phases mission lifetime including design, ascent to operational orbit, in-orbit operations, and controlled de-orbit.

What is AAS Doing?

~~**Committee on Light Pollution, Radio Interference, and Space Debris**~~

Committee to Protect Astronomy and Space Environments (COMPASSE)

Chairs: Teznie Pugh & Aparna Venkatesan

James Sweitzer

Jeff Hall

Dan McKenna

Charles Mudd

Connie Walker

Pat Seitzer

Daniel Caton

Richard Green

Presentations, Panels, Briefings…

2021:
SATCON2
AAS 237 Special Session
AAS 238 Town Hall
IAU Symposium 367
Space Generating Fusion Forum
NSF
AURA Board
NOIRLab MOC
Office of Science and Technology
CAA at NAS
Space Studies Board at NAS
US National Committee for the IAU
IAU Executive Committee
Committee on Space Research
FCC
Satellite Industry Association

17 November, 2022

Marlene H. Dortch
Secretary
Federal Communications Commission
45 L Street NE
Washington DC 20554

Re: Starlink Gen2 Proposals Nos. SAT-LOA-20200526 and SAT-AMD-20210818-00105

Dear Ms. Dortch:

The American Astronomical Society (AAS) is the preeminent organization for U.S. astronomers and the U.S. astronomical community and has been since 1899. Over the last few years, the emergence of satellite mega-constellations prompted work among astronomers and within the astronomical community to assess the real threat to scientific studies of the Universe through optical, infrared, and radio astronomy. This resulted in the SATCON 1 and 2 workshops and substantive reports that followed[1, 2, 3, 4]. This statement does not seek to reiterate those issues in detail. However, certain satellite operators have recently submitted filings that obscure or ignore the nuances of perspectives within the astronomy community. Rather than allowing others to speak for astronomers, the AAS believes that the best source for their perspectives is astronomers themselves, and the comprehensive nuanced reports they have created on a rapidly evolving situation in orbital space. And, given its role within the U.S. astronomical community, the AAS is well positioned to provide this perspective.

Legislation AAS is Monitoring

Active Legislation in this, 118th Congress:

- **H.R. 1338, the "Satellite and Telecommunications Streamlining Act,"** clarifies the FCC's authorities under the Communications Act to promote the responsible use of space, encourage investment and innovation as well as advance U.S. leadership in next-generation satellite communications networks. Reintroduced this Congress.
- **H.R. 675, the "Secure Space Act"** would prohibit the FCC from granting a license or U.S. market access for a non-geostationary orbit (NGSO) space station system owned or operated by an entity deemed to be a national security risk.
- **S.447 - Orbital Sustainability (ORBITS) Act of 2023**, bipartisan bill to establish a first-of-its-kind demonstration program to reduce the amount of space junk in orbit. The bill passed the Senate unanimously in previous Congress. Reintroduced this Congress.

Legislation AAS is Monitoring

Legislation from previous 117th Congress that could be introduced:

- **Spectrum Innovation Act of 2022**, “makes available additional frequencies in the 3.1–3.45 GHz band for non-Federal use, shared Federal and non-Federal use, or a combination thereof, and for other purposes” and will have potential impact on radio astronomy.
- On Mar 10, House Energy and Commerce Subcommittee on Communications and Technology Chair Bob Latta (R-OH) delivered in his opening statement at hearing titled "Defending America’s Wireless Leadership":
  - “Last week, the House passed Chair Rodgers’ legislation to extend the FCC’s auction authority to May 19. Unfortunately, the Senate failed to pass both the Spectrum Innovation Act and Chair Rodgers’ extension measure. **We must now work quickly to agree on a long-term extension of spectrum auction authority that preserves Congressional oversight of spectrum policy and directs auction proceeds** to reduce the deficit and fund important initiatives."

Legislation AAS is Monitoring

Legislation to be introduced in 118th Congress:

The House Space, Science and Technology Committee, "Will consider legislation that supports a strong American aerospace industry, continued leadership in human spaceflight, **exploration of new frontiers in planetary science, astronomy and astrophysics,** the development of novel earth science capabilities, and policies that preserve U.S. leadership in space and aeronautics."

- Prioritize **NASA reauthorization bill**
- **Commercial space legislation** to, "Support the commercial space sector, including bills that streamline regulations, support commercial remote sensing, improve space situational awareness, and address space launch and reentry activities at the **FAA**."

  When we briefed FAA in early 2022, we learned they can only consider individual launches and not aggregate effects (of many launches, or of the consequences of the payloads). Advocate for language for consideration of aggregate effects in licensing.

Co-Sponsorship of SatCon1 & 2

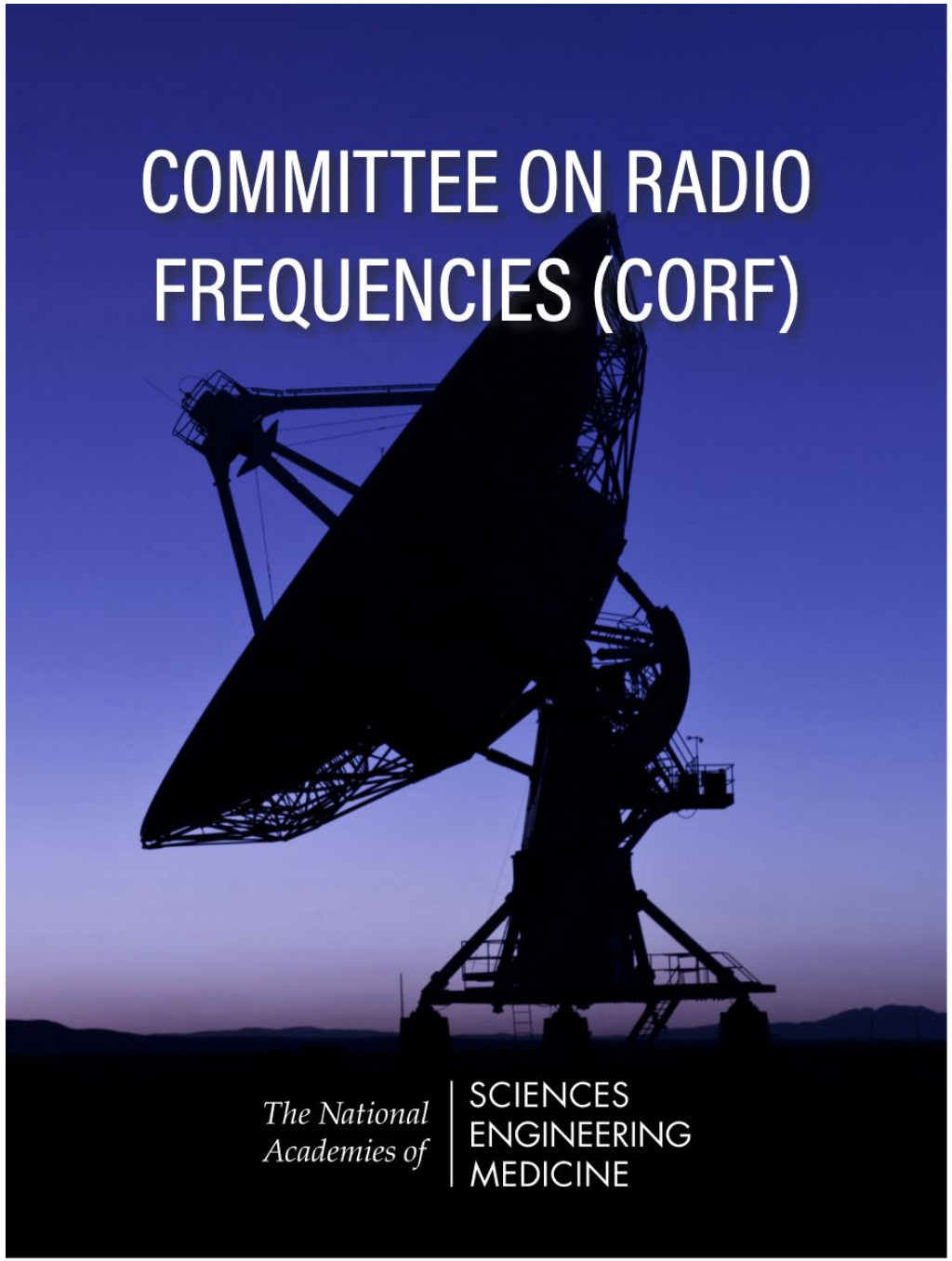
Public Policy & Advocacy

- Advocated for language supporting study of impacts of satellite constellations successfully passed **CHIPS and Science bill**.

- Congressional visits and continued relations with key members of Congress

The Committee on Radio Frequencies

- Members of ITU-R Working Parties 7C and 7D (Earth & Remote Sensing, Radio Astronomy)



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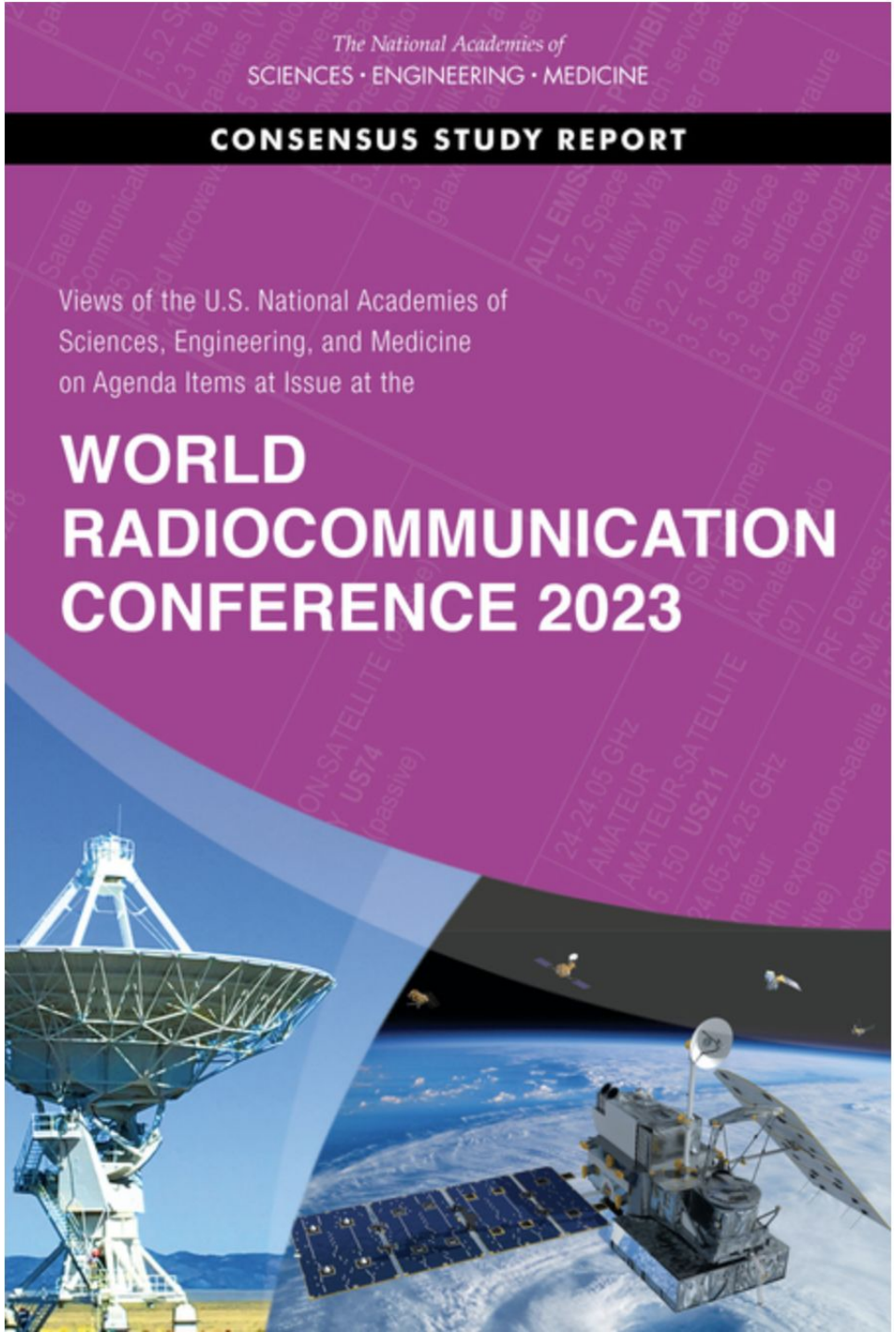
- Author WRC Views Reports

Recommendation: The committee recommends that studies of sharing between EESS (passive) at 36-37 GHz and non-geostationary orbit (GSO) emissions at 37.5-38 GHz are guided by the requirements defined in ITU-R RS.2017. These studies should explicitly consider aggregate emissions from a large number of orbiting non-GSO emitters, consistent with the size of the constellations being developed in other bands, in addition to existing and planned ground-based sources. Studies should consider interference from signals reflected off Earth's surface, and those coupling directly into both the Earth-viewing and cold-sky calibration beams of the EESS (passive) sensor. Attention should also be paid to the potential for permanent damage to EESS (passive) sensors should emitting non-GSO satellites pass close to an EESS (passive) platform.



The Committee on Radio Frequencies

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- Author WRC Views Reports
- File comments in public proceedings of Federal Communications Commission (FCC)

"(passive) observations require continued protection from interference from spaceborne emissions, especially those associated with current and future deployments of large LEO satellite constellations. As a general principle, waivers for satellites to operate in bands not allocated by the ITU to satellite services should be avoided, due to the uncertain and unstudied nature of the impact to other spectrum users, particularly passive scientific services."

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Expediting Initial Processing of Satellite and Earth Station Applications	)	IB Docket No. 22-411
	)	
	)	
Space Innovation	)	IB Docket No. 22-271

COMMENTS OF THE NATIONAL ACADEMY OF SCIENCES' COMMITTEE ON RADIO FREQUENCIES

The National Academy of Sciences, through its Committee on Radio Frequencies (hereinafter, CORF[1]), hereby submits its comments in response to the Commission's Notice of Proposed Rulemaking ("NPRM"), released December 22, 2022, in the above-captioned dockets. In these Comments, CORF urges the Commission to properly protect use of the spectrum for critical scientific research and operational applications. Accordingly, while CORF generally opposes grants that are inconsistent with ITU allocations, if any waivers of ITU allocations are to be allowed in the processing of satellite applications involving transmission in bands allocated to scientific services or neighboring those allocated to scientific services (or transmissions with significant harmonics in or neighboring bands allocated to scientific services), then the applicant must be required to demonstrate practical and effective protection of the neighboring scientific bands. Moreover, new space-to-Earth applications that are inconsistent with ITU allocations should incorporate geographic protections for RAS facilities subject to

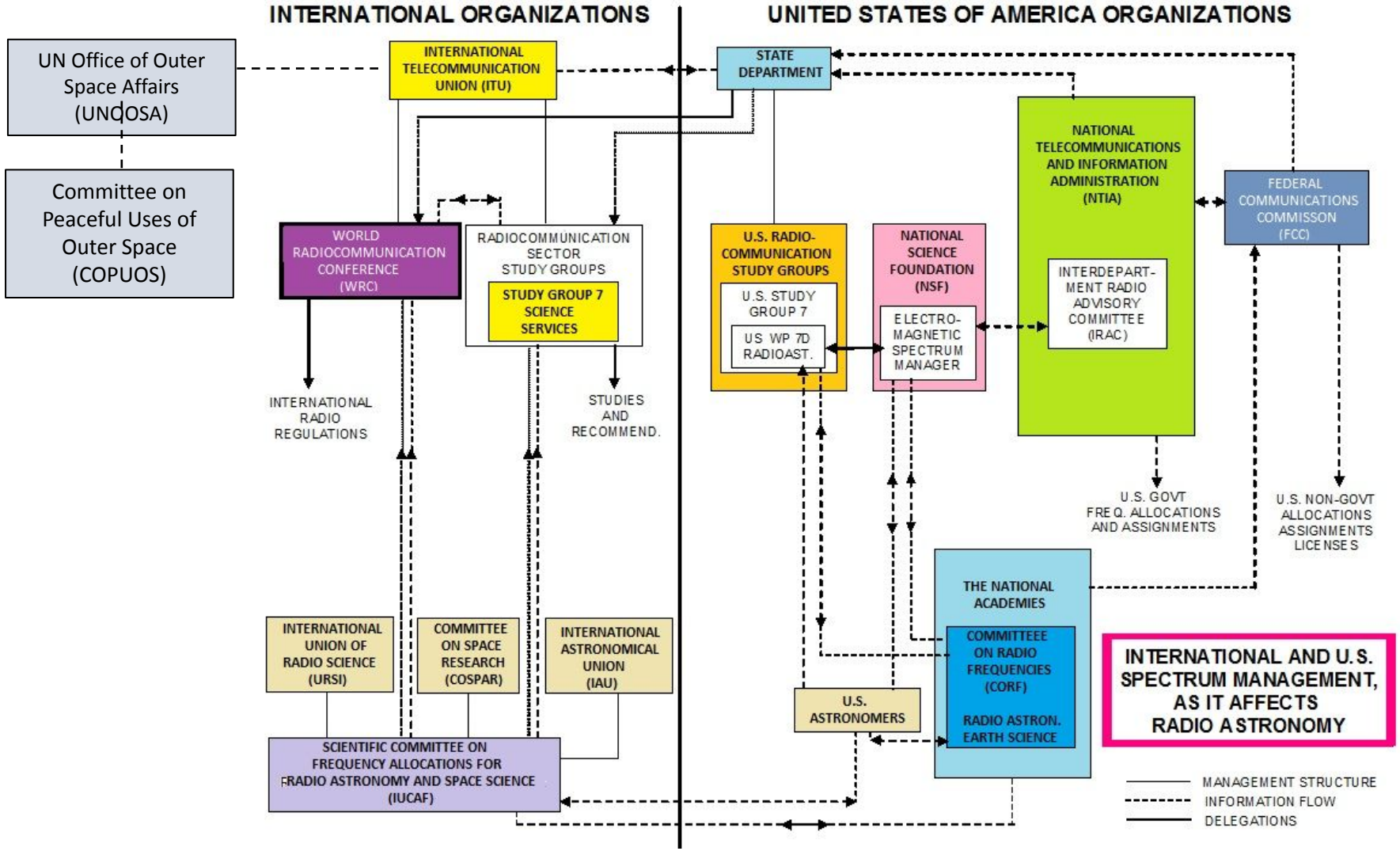
[1] See the Appendix for the membership of the Committee on Radio Frequencies.

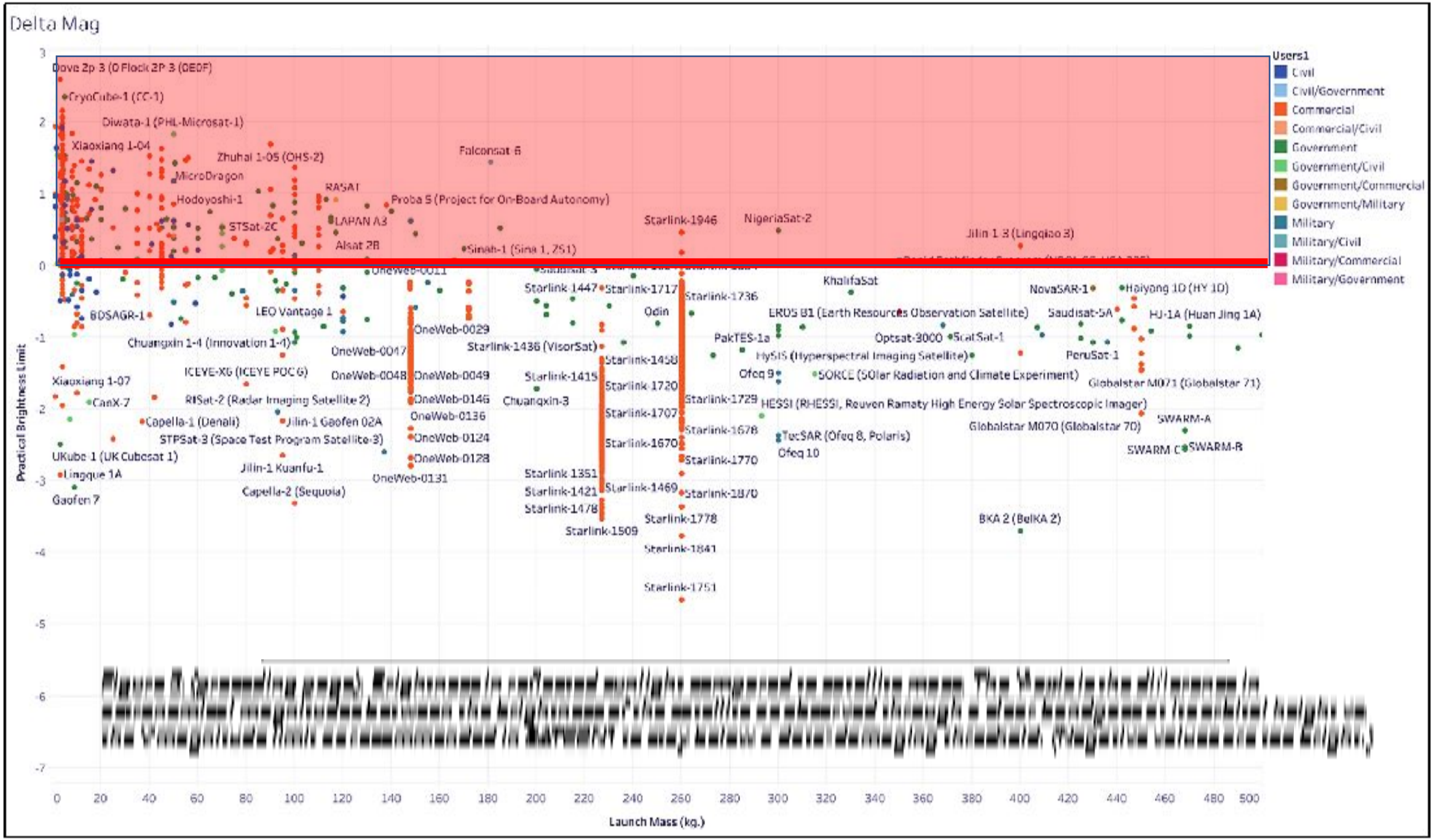
For Consideration

- How do we plan toward rapid expansion of international operators not subject to FCC regulations?
- What unknown affects need to be quantified?
- How can we support the dedicated *volunteers* doing this work?
- Can the NAS take a role in establishing a committee similar to CORF?
- Can the NAS take a role in establishing a group on Space Ethics?

Bonus Slides

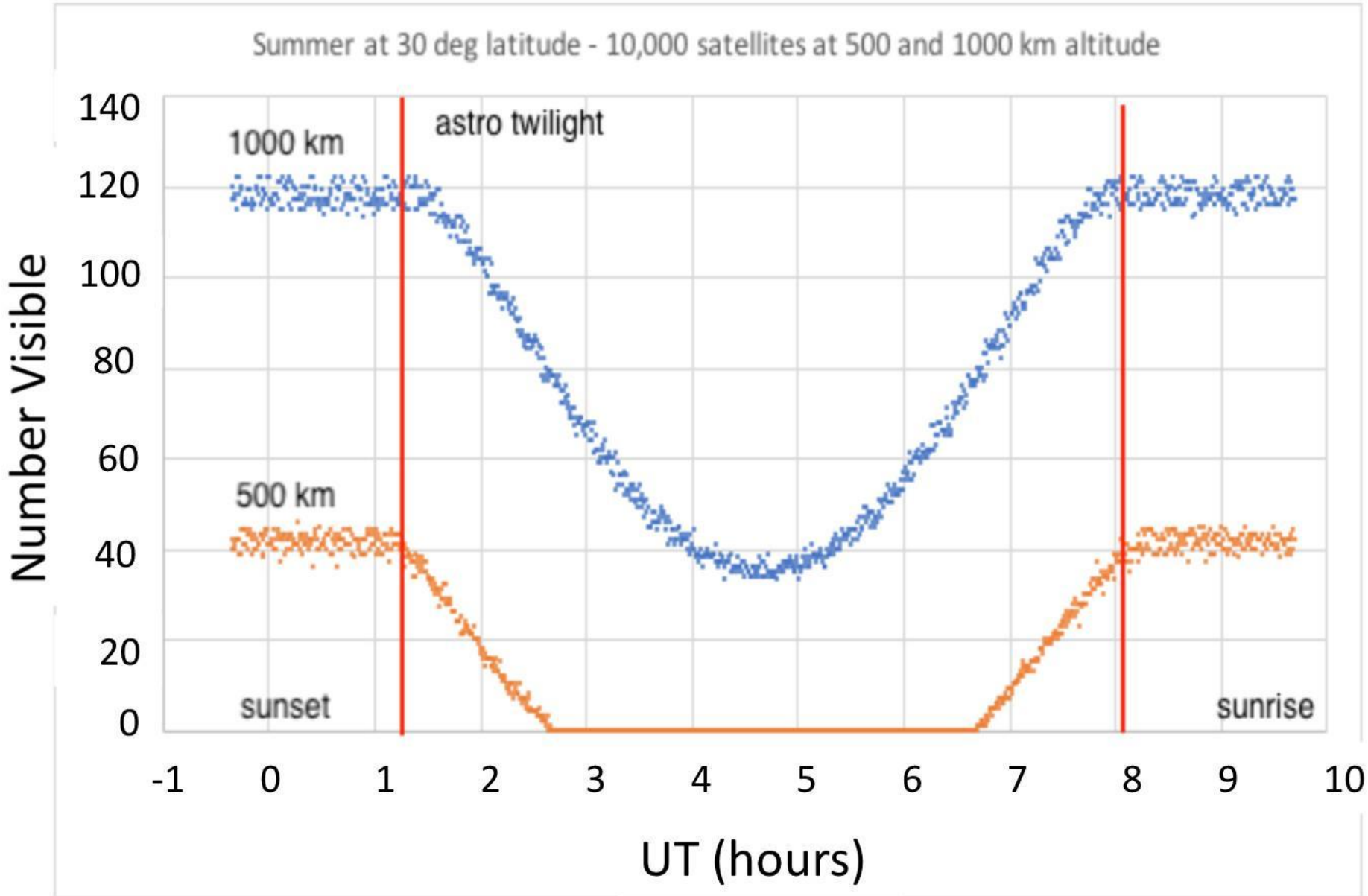
Radio Astronomy



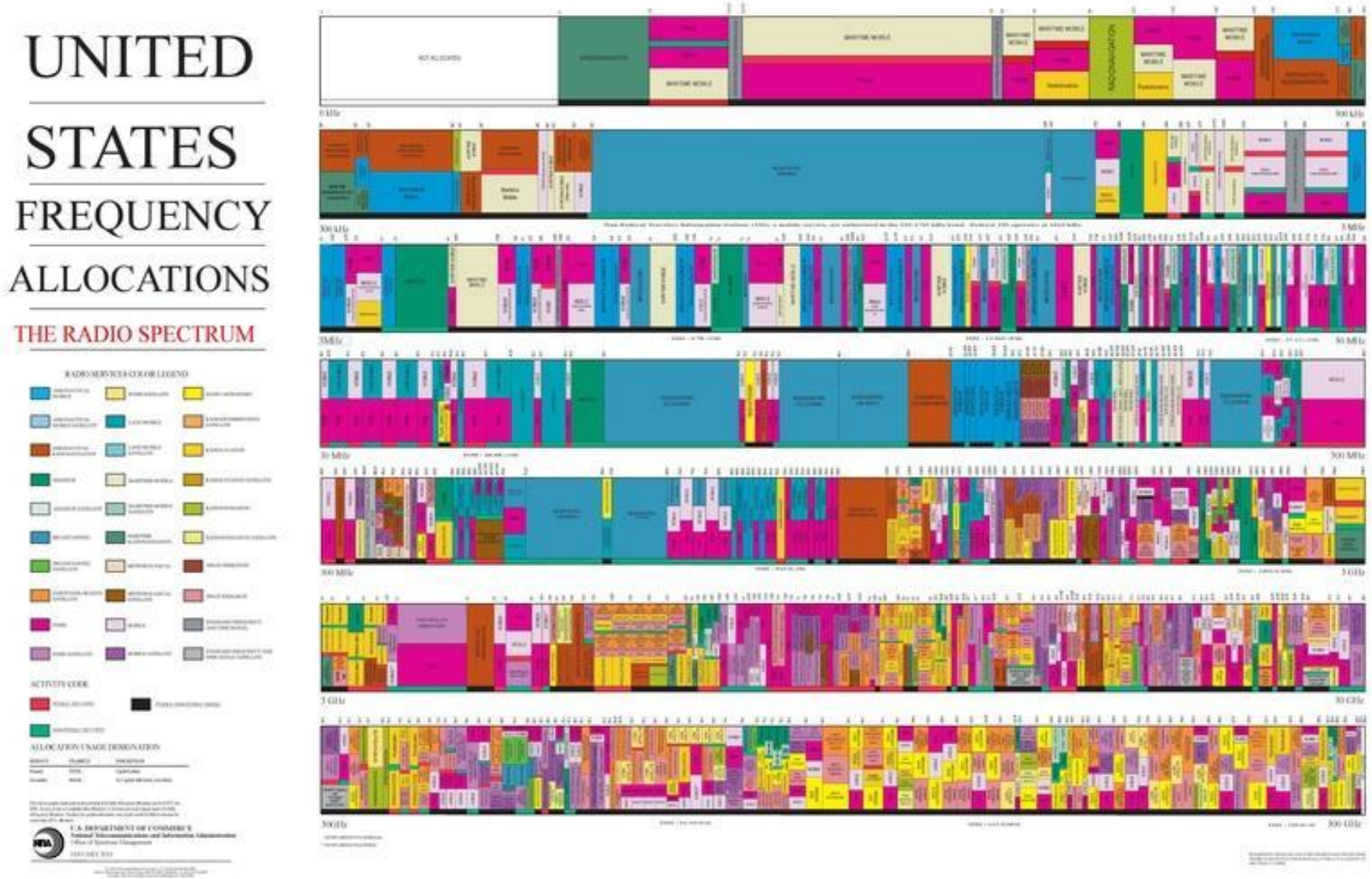


Source: SatCon2 Report

Number of Visible Satellites above Horizon



Credit: P. Seitzer (U. Michigan)

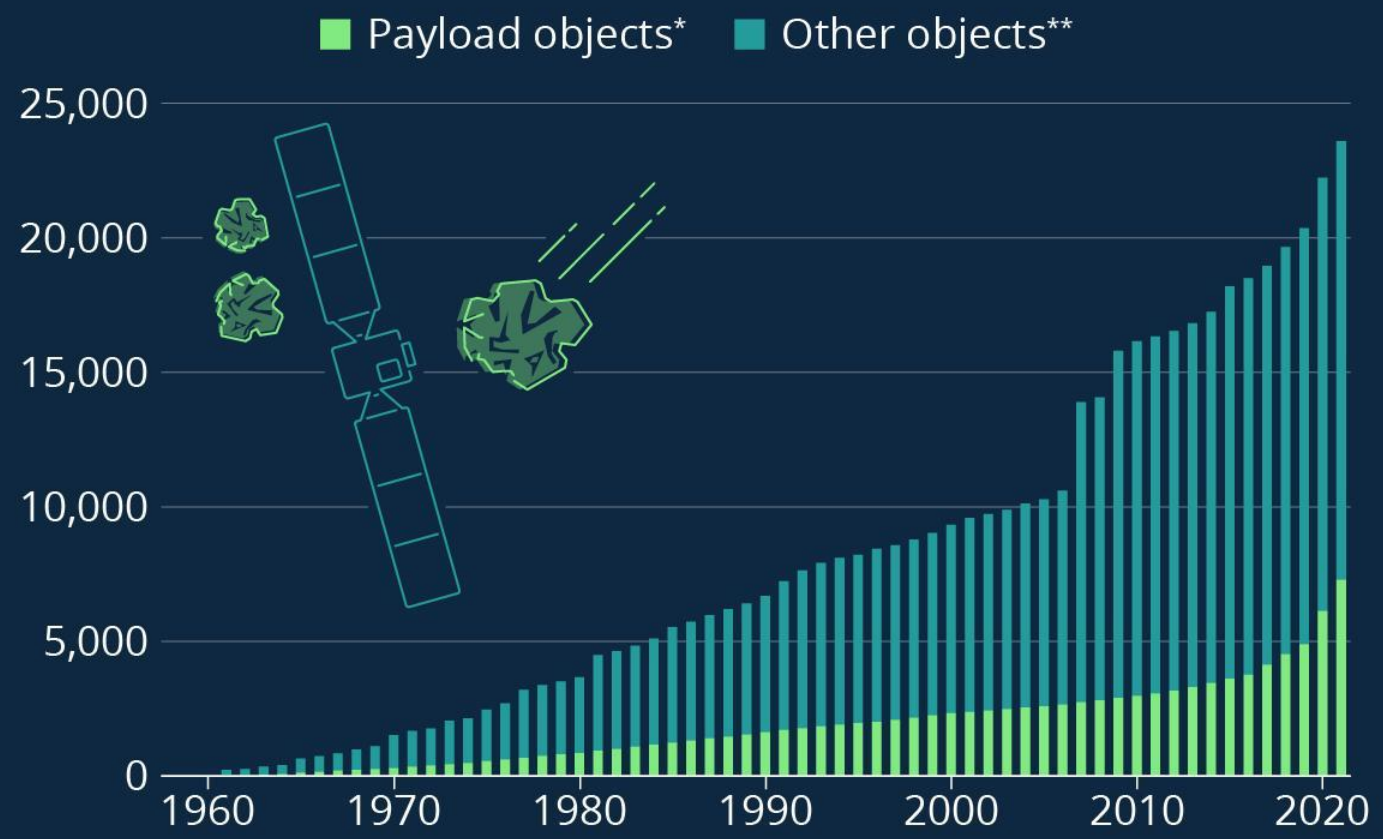


Nearly all Radio Astronomy protections were established more than 40 years ago, with almost no modification as the science and engineering has advanced*.

* Notable exception: WRC-00 protection at 75-275 GHz.

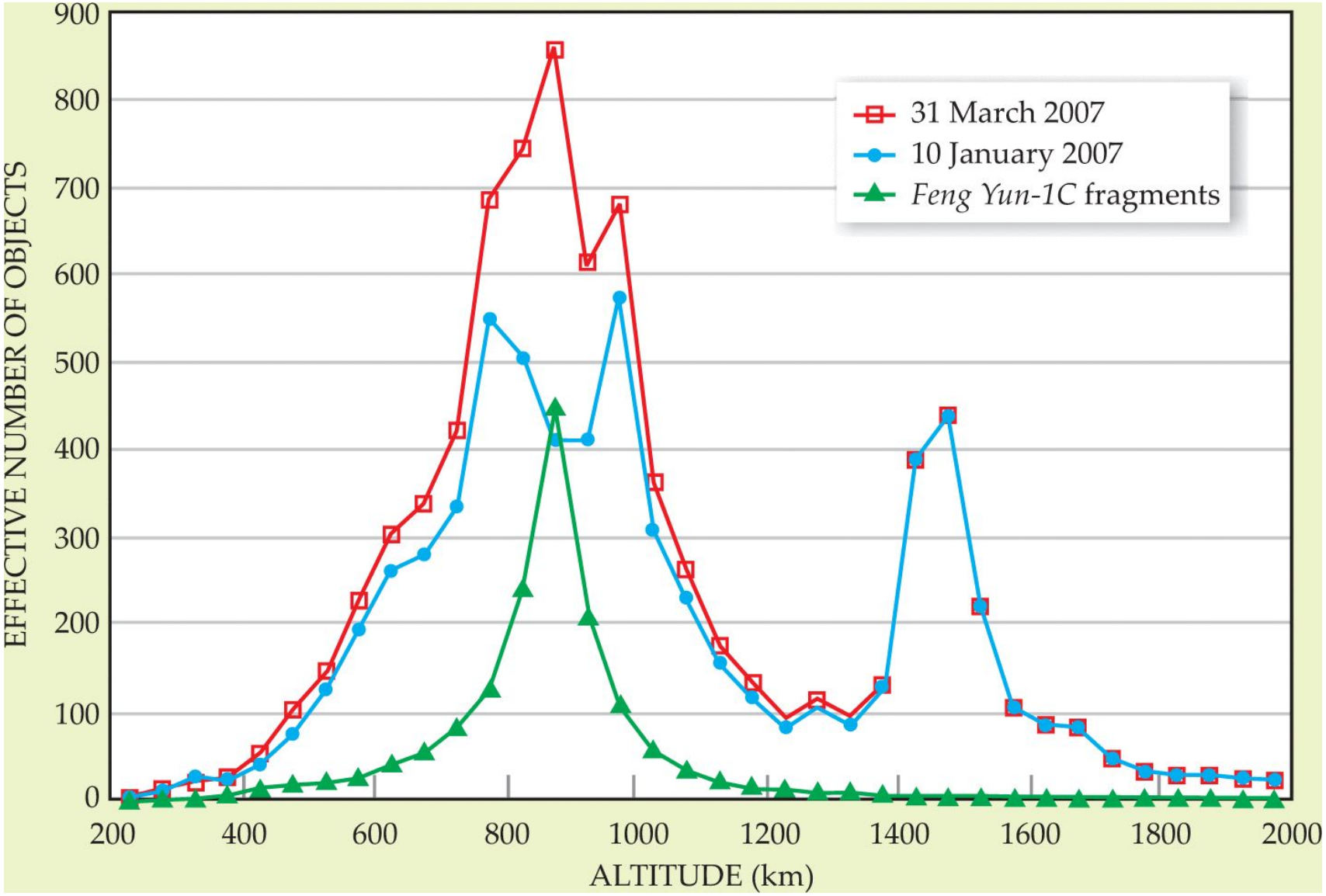
It's Getting Crowded up in Space

Artificial objects in Earth's orbit by year of launch/separation



* Former transport good of a rocket (spaceship or more typically, a satellite)
** space mission components, debris, rocket stages

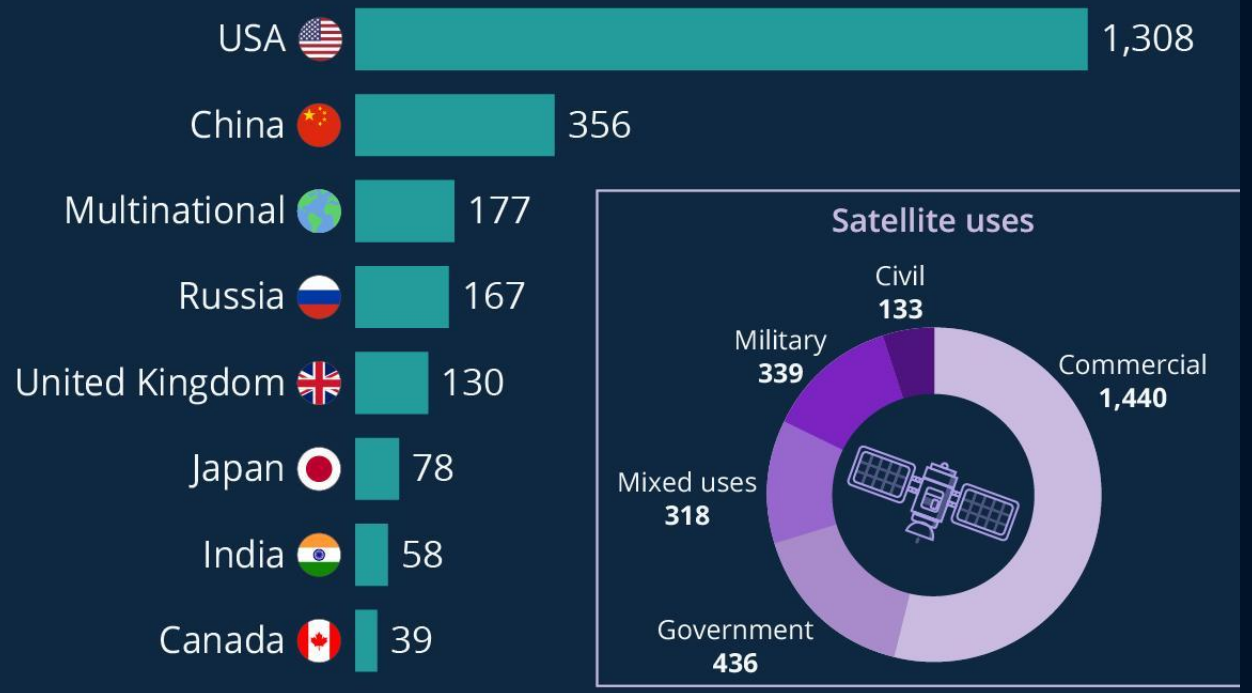
Source: J. McDowell, General Catalogue of Artificial Space Objects



Result of China Anti-Satellite Test (Defunct Weather Satellite) Wright, 2007

The Countries With the Most Satellites in Space

Satellites currently orbiting Earth by country* (as of April 2020)



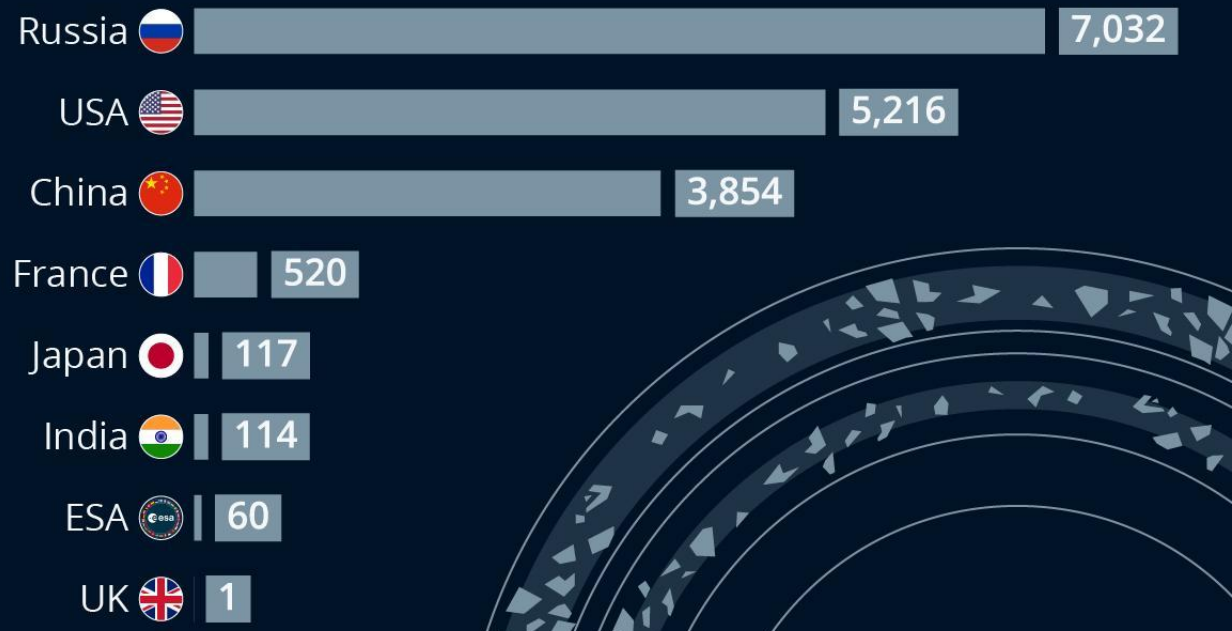
* Country of operator/owner

Source: Union of Concerned Scientist Satellite Database

statista

Who's Responsible for Space Junk?

Number of spent rocket bodies and other pieces of debris



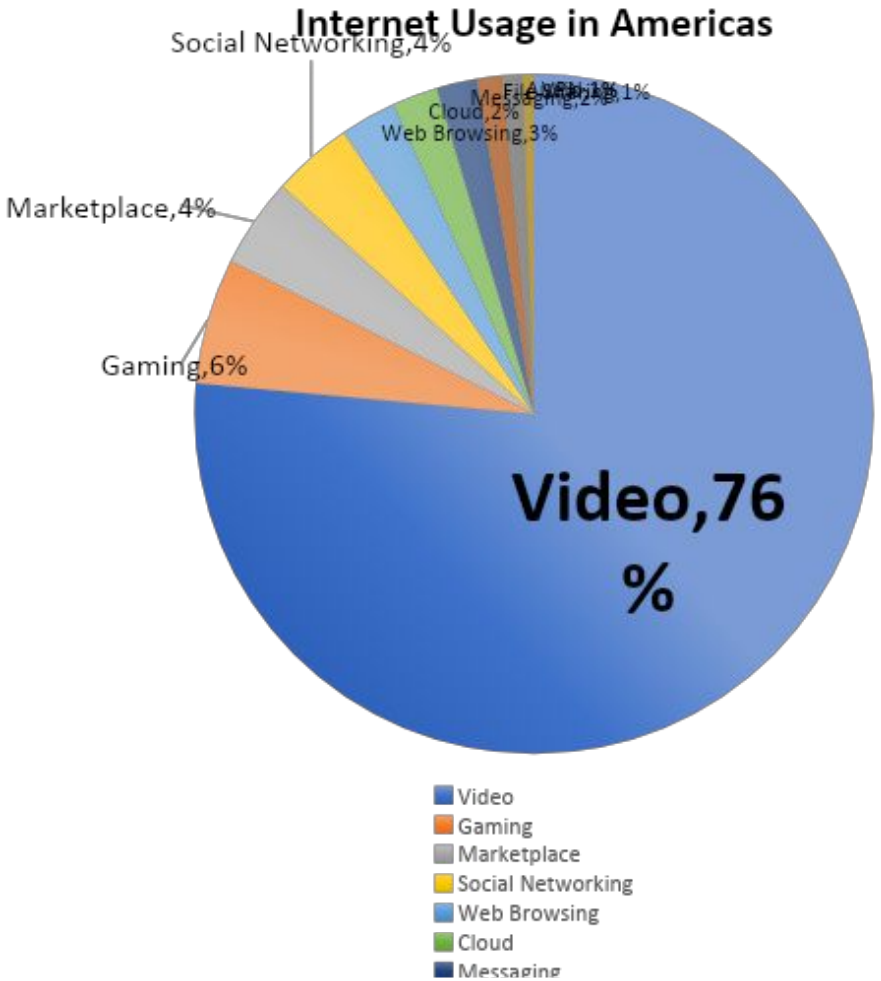
* as of 4 Feb 2022

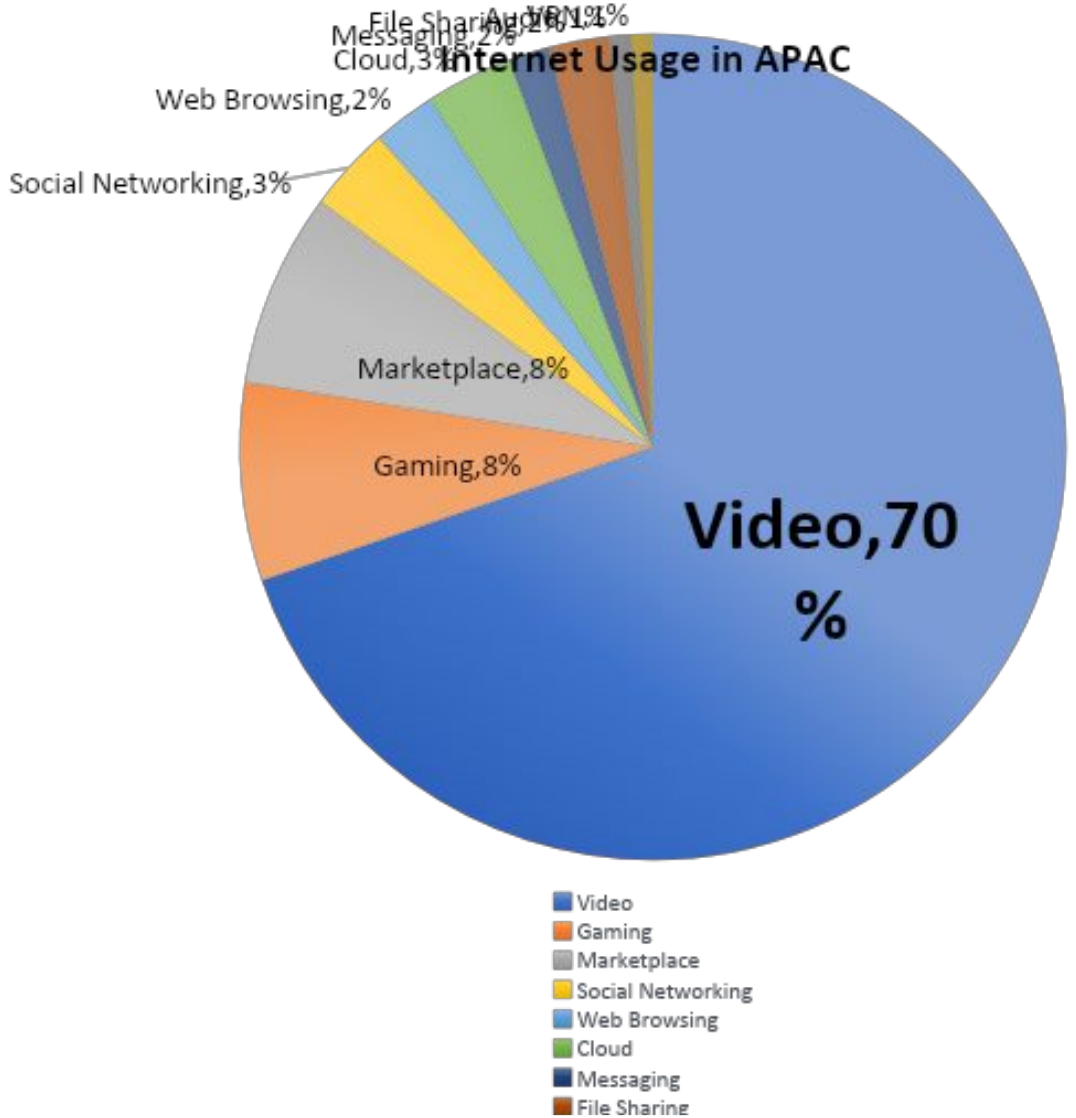
Source: Orbital Debris Quarterly News, NASA

statista

The Global Internet Phenomena Report 2023

(Sandvine)

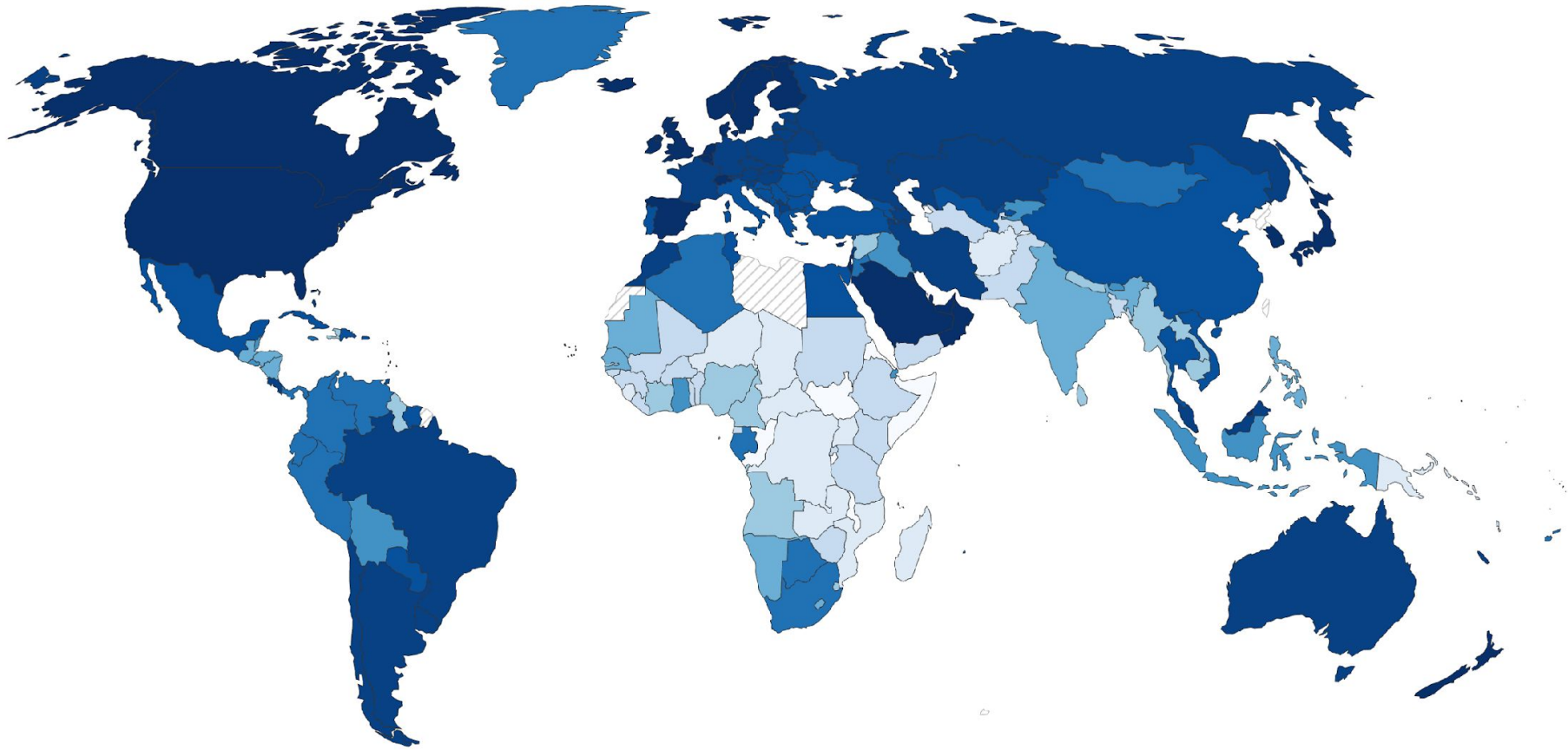


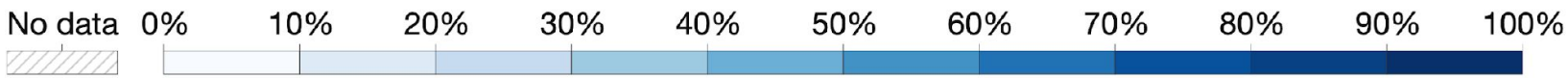


Share of the population using the Internet, 2020

Share of the population who used the Internet[1] in the last three months.

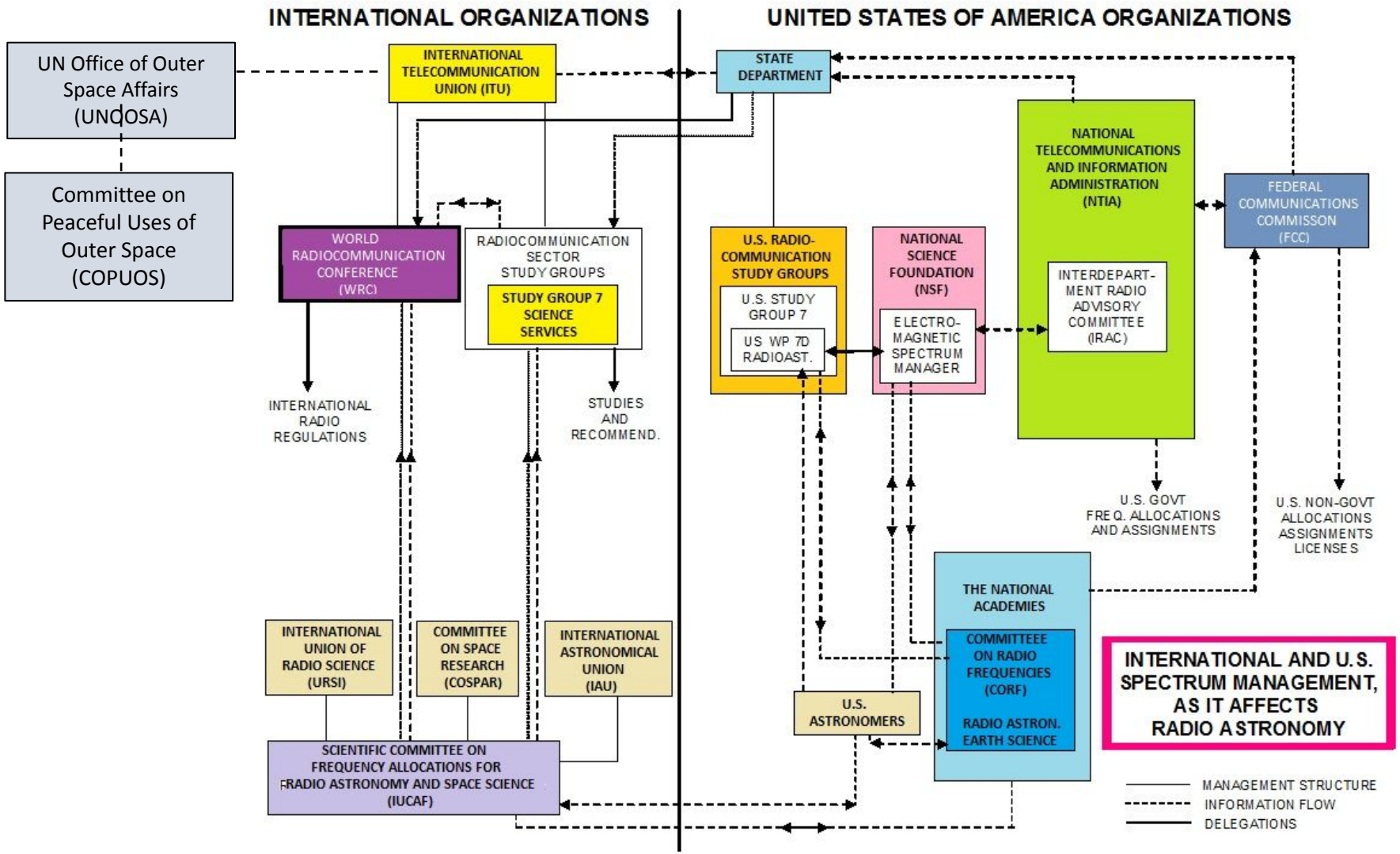
Our World in Data





Source: International Telecommunication Union (via World Bank)

OurWorldInData.org/internet • CC BY


INTERNATIONAL ORGANIZATIONS
UNITED STATES OF AMERICA ORGANIZATIONS
UN Office of Outer Space Affairs (UNOOSA)
Committee on Peaceful Uses of Outer Space (COPUOS)
INTERNATIONAL TELECOMMUNICATION UNION (ITU)
STATE DEPARTMENT
WORLD RADIOCOMMUNICATION CONFERENCE (WRC)
RADIOCOMMUNICATION SECTOR STUDY GROUPS
STUDY GROUP 7 SCIENCE SERVICES
INTERNATIONAL RADIO REGULATIONS
STUDIES AND RECOMMEND.
U.S. RADIO-COMMUNICATION STUDY GROUPS
U.S. STUDY GROUP 7
US WP 7D RADIOAST.
NATIONAL SCIENCE FOUNDATION (NSF)
ELECTRO-MAGNETIC SPECTRUM MANAGER
NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION (NTIA)
INTERDEPART-MENT RADIO ADVISORY COMMITTEE (IRAC)
FEDERAL COMMUNICATIONS COMMISSON (FCC)
U.S. GOVT FREQ. ALLOCATIONS AND ASSIGNMENTS
U.S. NON-GOVT ALLOCATIONS ASSIGNMENTS LICENSES
INTERNATIONAL UNION OF RADIO SCIENCE (URSI)
COMMITTEE ON SPACE RESEARCH (COSPAR)
INTERNATIONAL ASTRONOMICAL UNION (IAU)
SCIENTIFIC COMMITTEE ON FREQUENCY ALLOCATIONS FOR RADIO ASTRONOMY AND SPACE SCIENCE (IUCAF)
U.S. ASTRONOMERS
THE NATIONAL ACADEMIES
COMMITTEEE ON RADIO FREQUENCIES (CORF)
RADIO ASTRON. EARTH SCIENCE
INTERNATIONAL AND U.S. SPECTRUM MANAGEMENT, AS IT AFFECTS RADIO ASTRONOMY
MANAGEMENT STRUCTURE
INFORMATION FLOW
DELEGATIONS