Dark and Quiet Skies for Science and Society

Defining and Regulating the Orbital Environment of Earth

Charles Lee Mudd Jr.

October 6, 2021

MUDD LAW
SPACE | INTERNET | CREATIVES | IP | STARTUPS

DARK & QUIET SKIES

What is the Earth's Environment?

The term is most often applied to the Earth or some parts of Earth. This environment **encompasses the interaction of all living species, climate, weather and natural resources that affect human survival and economic activity**.

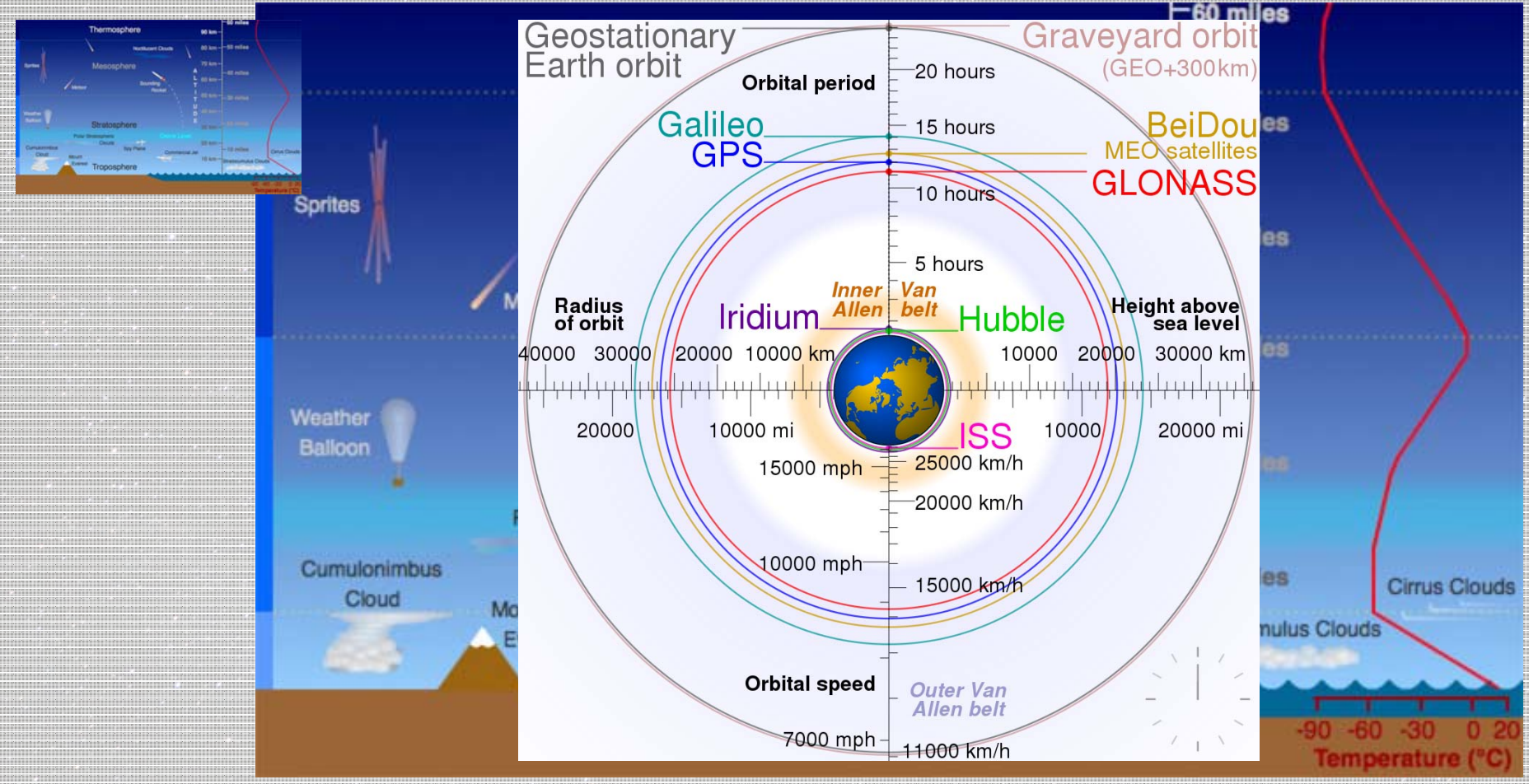
https://en.wikipedia.org › wiki › Natural_environment

Natural environment - Wikipedia

What is the Earth's Environment?

(1) This necessarily means that the environment includes the effects of humans and their activities on fellow humans, *their* activities (natural, economic, or otherwise), other species, other species' activities, and natural resources.

What is the Earth's Environment?



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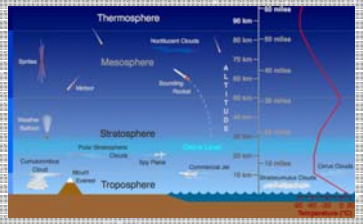

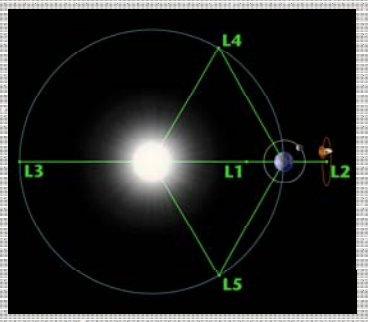

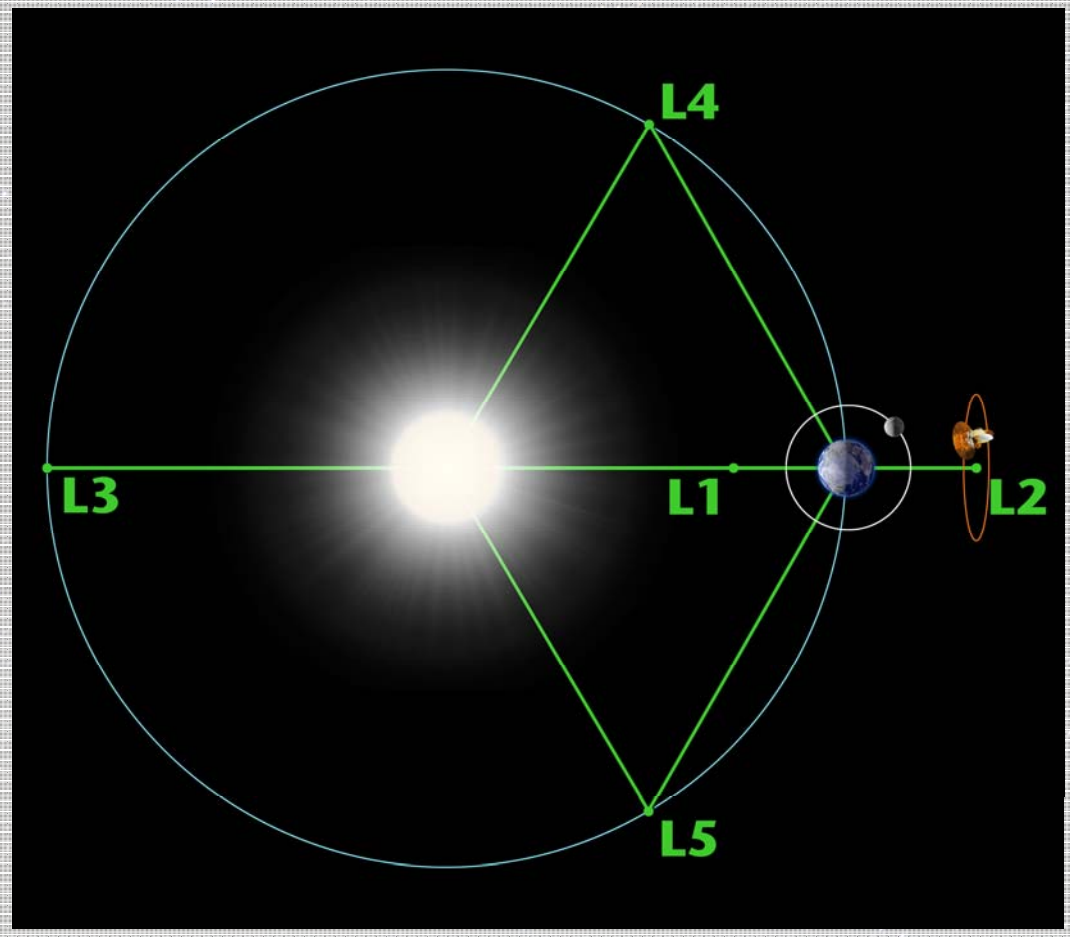

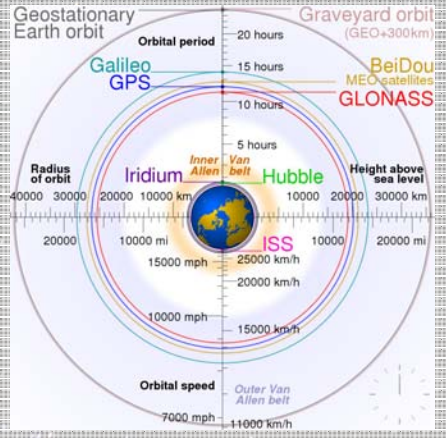

What is the Earth's Environmental Effect on Space?

Planetary Protection

Planetary Protection is the practice of protecting solar system bodies from contamination by Earth life and protecting Earth from possible life forms that may be returned from other solar system bodies.

Image Credit: NASA

https://planetaryprotection.jpl.nasa.gov/

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Image Credit: NASA

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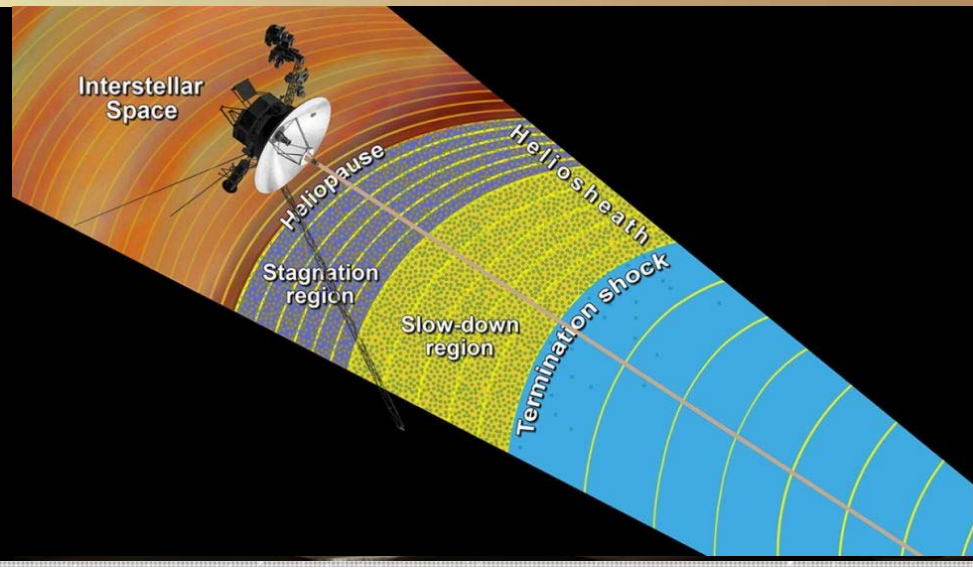

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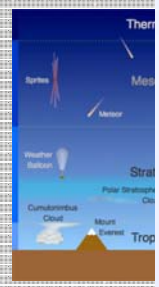

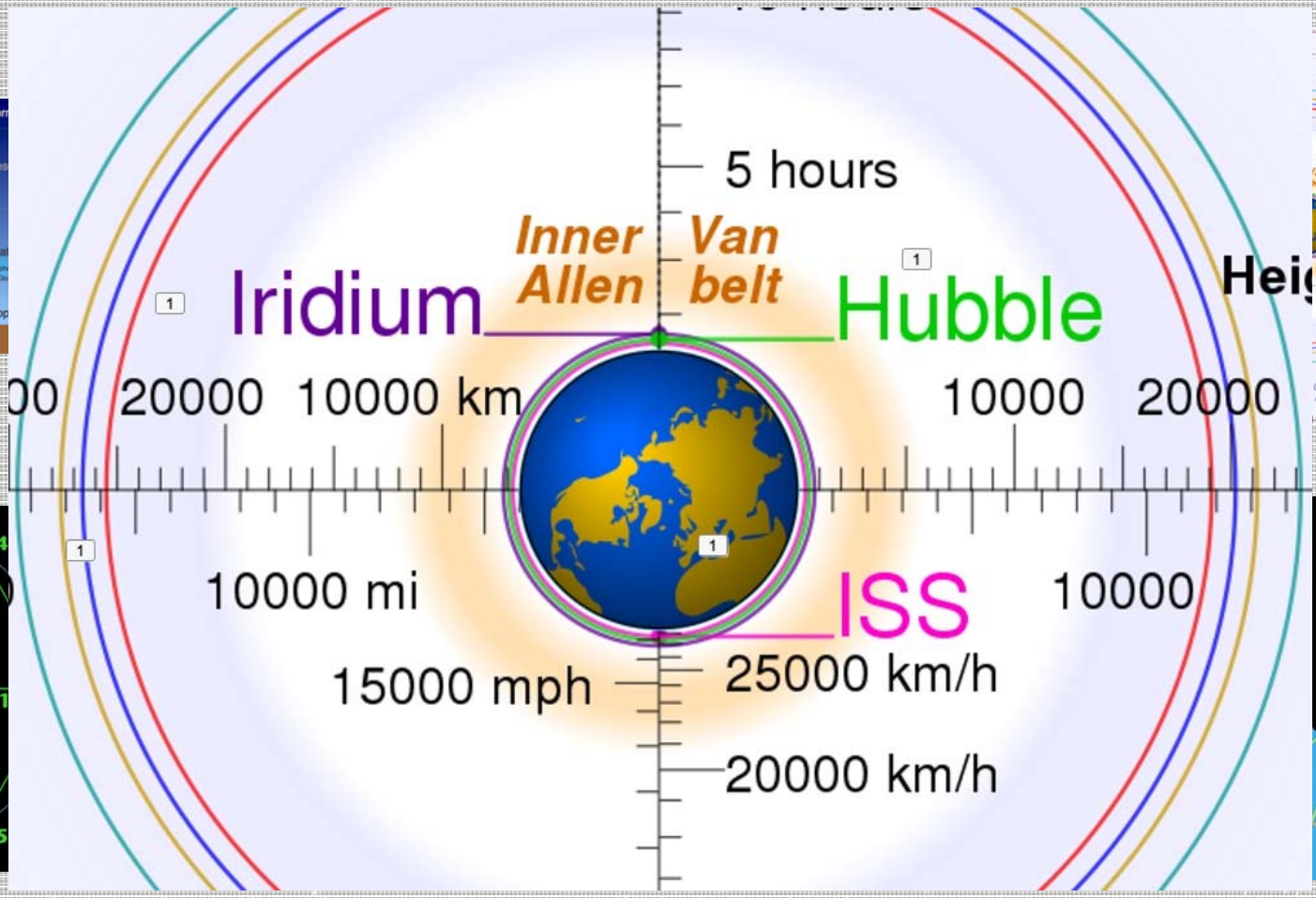

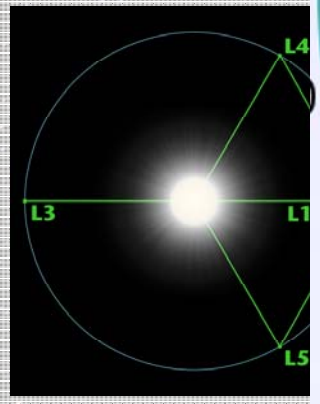

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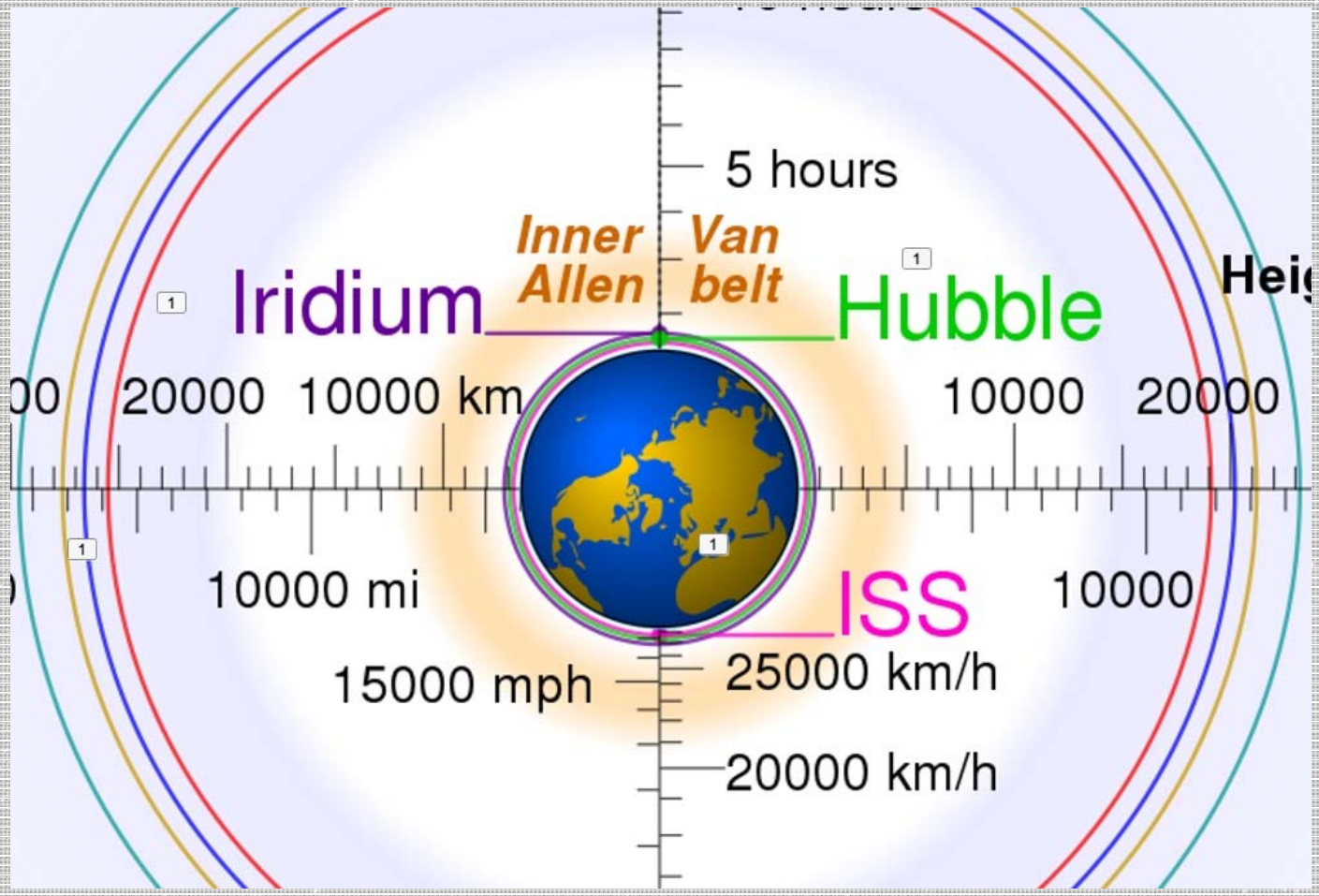


Defining Earth's Environment

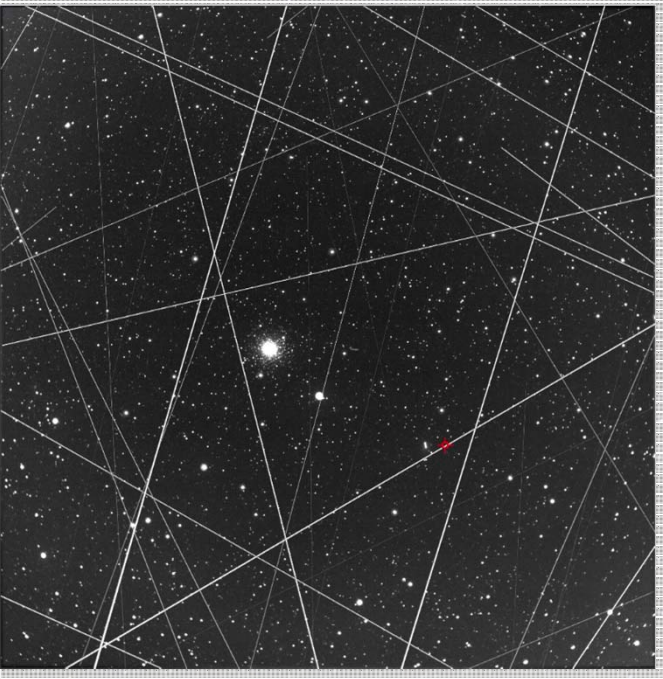
(1) This necessarily means that the environment includes the effects of humans and their activities on fellow humans, *their* activities (natural, economic, or otherwise), other species, other species' activities, and natural resources.

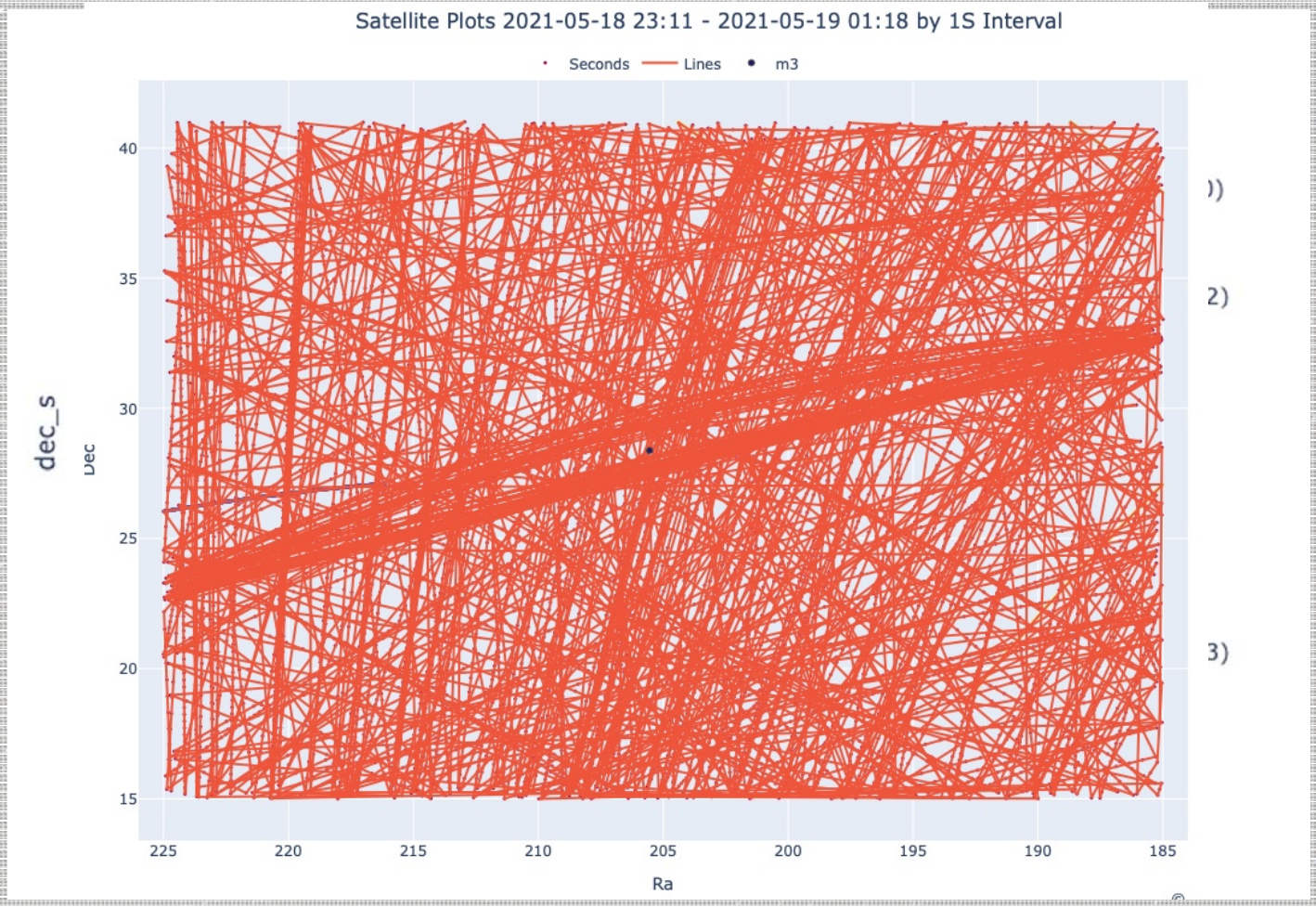
Defining Earth's Environment

- Humans use celestial bodies for navigation
- Non-human species "use stars as a source for directional information"
- Humans use celestial bodies and the dark sky for religious and other cultural purposes
- Humans use the dark skies for astronomy and scientific research…

Defining Earth's Environment

Defining Earth's Environment





Defining Earth's Environment

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    - that includes significant economic activities

Defining Earth's Environment

Astronomy and related fields clearly involve economic activities, with many examples:

- Proposed NASA Budget $24.8 billion, $7.9 billion to Science Division

- James Webb Telescope (estimated cost) $9.7 billion

- Extremely Large Telescope €1.3 billion

- Operations of Observatories (annual)

  -- European Southern Observatory – Member State € 150 million
  -- NRAO ~ $88 million
  -- Rubin Observatory ~ $40.75 million
  -- W.M. Keck ~ $17 million

to name a few.

Defining Earth's Environment

- Humans use celestial bodies for navigation
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    - that includes significant economic activities

In each of these circumstances, the diminishment of the dark and quiet skies adversely affects diverse species and their activities.

Defining Earth's Environment

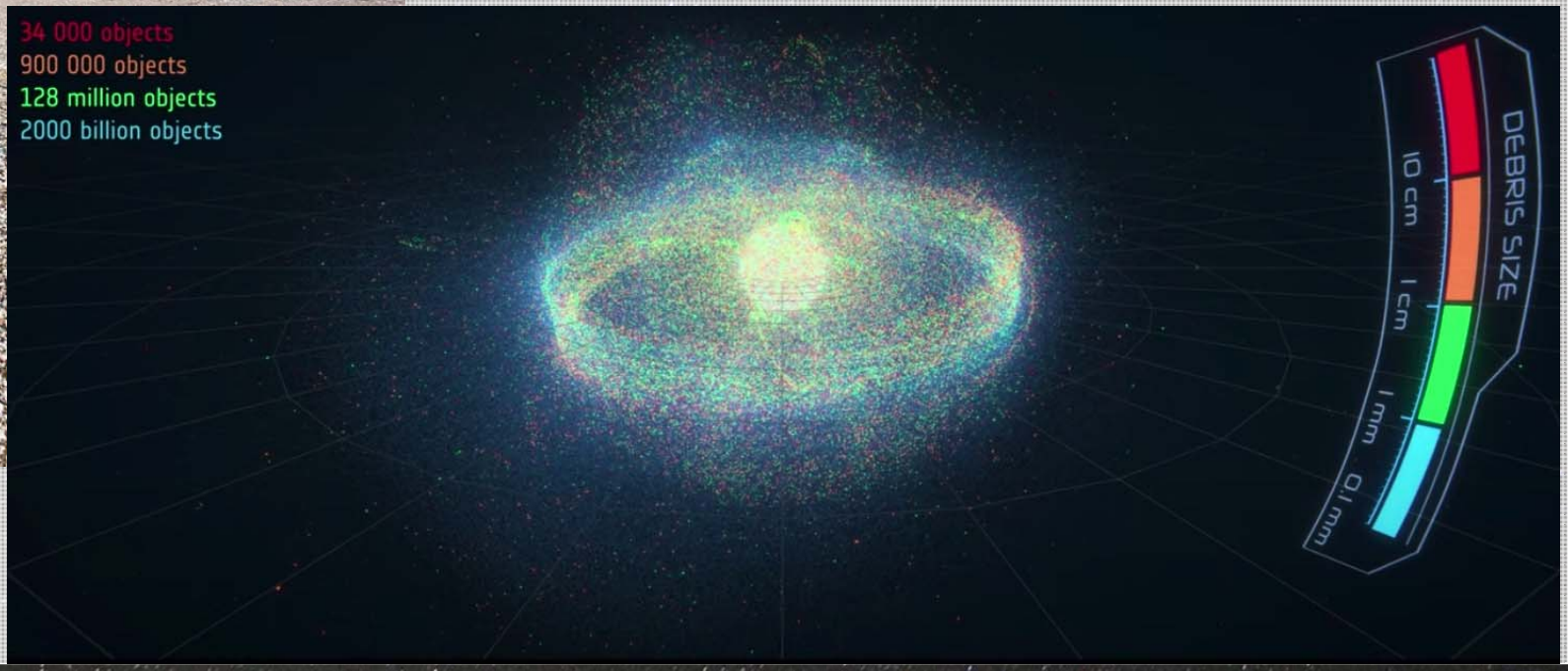
- Satellite re-entry creates aluminum oxide or alumni

  Boley, A.C., Byers, M. Satellite mega-constellations create risks in Low Earth Orbit, the atmosphere and on Earth. *Sci Rep* **11,** 10642 (2021). https://doi.org/10.1038/s41598-021-89909-7

- Satellites reduce overall darkness of night sky, elevating brightness of night sky by at least 10%

  M Kocifaj, F Kundracik, J C Barentine, S Bará, The proliferation of space objects is a rapidly increasing source of artificial night sky brightness, *Monthly Notices of the Royal Astronomical Society: Letters*, Volume 504, Issue 1, June 2021, Pages L40 L44, https://doi.org/10.1093/mnrasl/slab030

Defining Earth's Environment

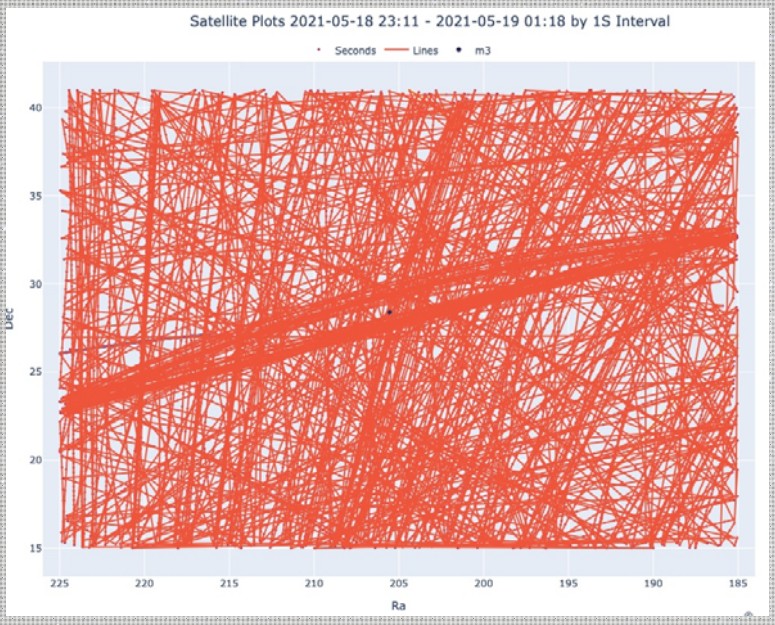


Defining Earth's Environment

(1) This necessarily means that the environment includes the effects of humans and their activities on fellow humans, *their* activities (natural, economic, or otherwise), other species, other species' activities, and natural resources.

(2) Earth's orbital space constitutes a natural resource.

Defining Earth's Finite Environment



Earth's Orbital Space is Finite

Precious, and should be

Treated as such.

Regulating Earth's Orbital Space as its Environment

Earth's Environment includes its Orbital Space;

Earth's Orbital Space is an integral part of Earth's Environment,

should be discussed as such,

…and should be regulated as such.

Regulating Earth's Orbital Space as its Environment

Planetary Protection

Planetary Protection is the practice of protecting **celestial** bodies from contamination by Earth life and protecting Earth from possible life forms that may be returned from other solar system bodies.

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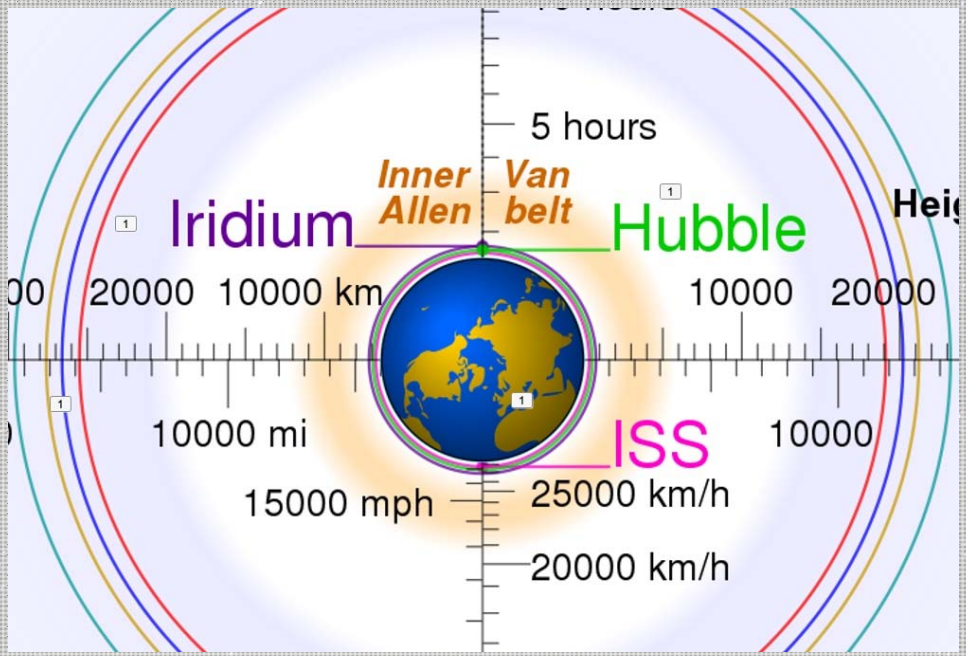
Regulating Earth's Orbital Space as its Environment

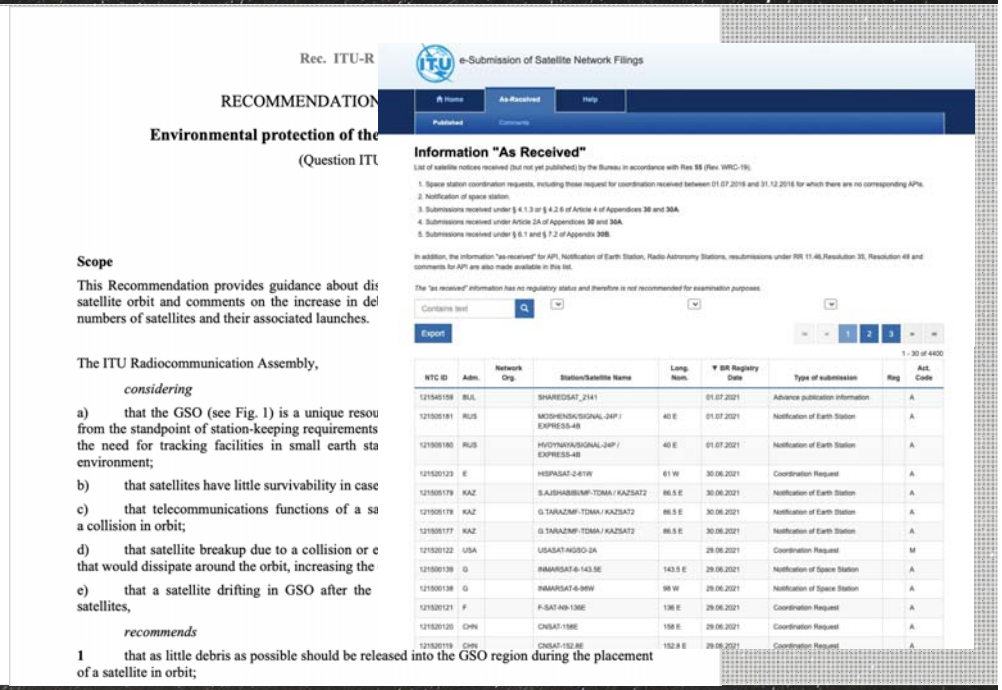


Regulating Earth's Orbital Space as its Environment

Consistent Definition of Environment

International Treaties and Guidelines
(eg UNOOSA, IADC;
SATCON, D&QS -> Formal)

International (ITU)



Rec. ITU-R

RECOMMENDATION

Environmental protection of the

(Question ITU

Scope

This Recommendation provides guidance about dis
satellite orbit and comments on the increase in del
numbers of satellites and their associated launches.

The ITU Radiocommunication Assembly,

considering

a) that the GSO (see Fig. 1) is a unique resou
from the standpoint of station-keeping requirements
the need for tracking facilities in small earth sta
environment;

b) that satellites have little survivability in case

c) that telecommunications functions of a sa
a collision in orbit;

d) that satellite breakup due to a collision or e
that would dissipate around the orbit, increasing the

e) that a satellite drifting in GSO after the
satellites,

recommends

1 that as little debris as possible should be released into the GSO region during the placement of a satellite in orbit;

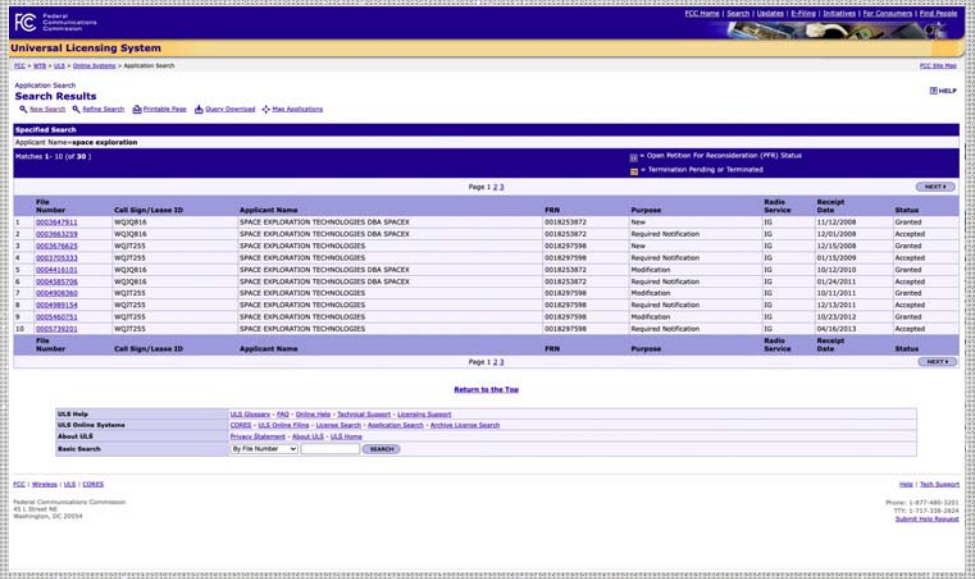
Regulating Earth's Orbital Space as its Environment

Consistent Definition of Environment

International Treaties and Guidelines
(eg UNOOSA, IADC;
SATCON, D&QS -> Formal)

International (ITU)

National | Domestic
Laws and Regulations



Universal Licensing System

Search Results

Specified Search

Applicant Name=space exploration

Matches 1- 10 (of 30)

	File Number	Call Sign/Lease ID	Applicant Name	FRN	Purpose	Radio Service	Receipt Date	Status
1	0003647911	WQJQ816	SPACE EXPLORATION TECHNOLOGIES DBA SPACEX	0018253872	New	IG	11/12/2008	Granted
2	0003663259	WQJQ816	SPACE EXPLORATION TECHNOLOGIES DBA SPACEX	0018253872	Required Notification	IG	12/01/2008	Accepted
3	0003676625	WQJT255	SPACE EXPLORATION TECHNOLOGIES	0018297598	New	IG	12/15/2008	Granted
4	0003705333	WQJT255	SPACE EXPLORATION TECHNOLOGIES	0018297598	Required Notification	IG	01/15/2009	Accepted
5	0004416101	WQJQ816	SPACE EXPLORATION TECHNOLOGIES DBA SPACEX	0018253872	Modification	IG	10/12/2010	Granted
6	0004585706	WQJQ816	SPACE EXPLORATION TECHNOLOGIES DBA SPACEX	0018253872	Required Notification	IG	01/24/2011	Accepted
7	0004908360	WQJT255	SPACE EXPLORATION TECHNOLOGIES	0018297598	Modification	IG	10/11/2011	Granted
8	0004989154	WQJT255	SPACE EXPLORATION TECHNOLOGIES	0018297598	Required Notification	IG	12/13/2011	Accepted
9	0005460731	WQJT255	SPACE EXPLORATION TECHNOLOGIES	0018297598	Modification	IG	10/23/2012	Granted
10	0005739201	WQJT255	SPACE EXPLORATION TECHNOLOGIES	0018297598	Required Notification	IG	04/16/2013	Accepted

Regulating Earth's Orbital Space as its Environment

Viasat v. FCC

Pre-May 2021	-	FCC Proceeding
May 26, 2021	-	Filed in United States District Court
July 20, 2021	-	Court denies Viasat Motion to Stay (all SpaceX launches)
August 6, 2021	-	Viasat | DISH Network files appeal in US Court of Appeals District Columbia Circuit
August 13, 2021	-	Professor Andy Lawrence files supporting Amicus Brief in conjunction with others
September 21, 2021	-	FCC and United States file Appellee Briefs
October 26, 2021	-	All final briefs due

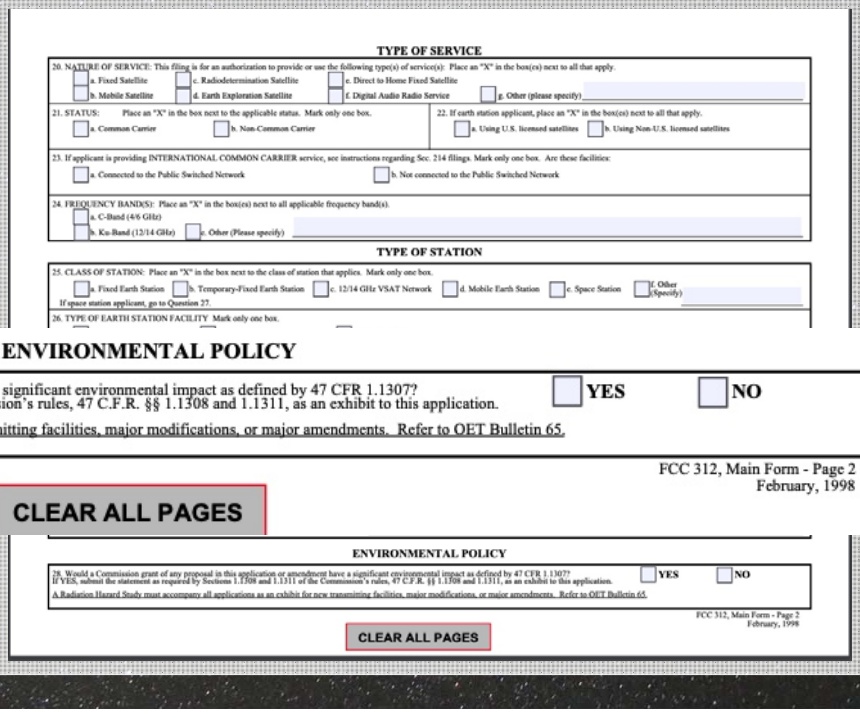
Regulating Earth's Orbital Space as its Environment

Viasat v. FCC

Form 312

47 CFR 1.1307

FCC Interpretation of NEPA



TYPE OF SERVICE

20. NATURE OF SERVICE: This filing is for an authorization to provide or use the following type(s) of service(s): Place an "X" in the box(es) next to all that apply.

☐ a. Fixed Satellite ☐ c. Radiodetermination Satellite ☐ e. Direct to Home Fixed Satellite
☐ b. Mobile Satellite ☐ d. Earth Exploration Satellite ☐ f. Digital Audio Radio Service ☐ g. Other (please specify)

21. STATUS: Place an "X" in the box next to the applicable status. Mark only one box.
☐ a. Common Carrier ☐ b. Non-Common Carrier

22. If earth station applicant, place an "X" in the box(es) next to all that apply.
☐ a. Using U.S. licensed satellites ☐ b. Using Non-U.S. licensed satellites

23. If applicant is providing INTERNATIONAL COMMON CARRIER service, see instructions regarding Sec. 214 filings. Mark only one box. Are these facilities:
☐ a. Connected to the Public Switched Network ☐ b. Not connected to the Public Switched Network

24. FREQUENCY BAND(S): Place an "X" in the box(es) next to all applicable frequency band(s).
☐ a. C-Band (4/6 GHz)
☐ b. Ku-Band (12/14 GHz) ☐ c. Other (Please specify)

TYPE OF STATION

25. CLASS OF STATION: Place an "X" in the box next to the class of station that applies. Mark only one box.
☐ a. Fixed Earth Station ☐ b. Temporary-Fixed Earth Station ☐ c. 12/14 GHz VSAT Network ☐ d. Mobile Earth Station ☐ e. Space Station ☐ f. Other (Specify)
If space station applicant, go to Question 27.

26. TYPE OF EARTH STATION FACILITY Mark only one box.

ENVIRONMENTAL POLICY

28. Would a Commission grant of any proposal in this application or amendment have a significant environmental impact as defined by 47 CFR 1.1307? ☐ YES ☐ NO
If YES, submit the statement as required by Sections 1.1308 and 1.1311 of the Commission's rules, 47 C.F.R. §§ 1.1308 and 1.1311, as an exhibit to this application.
A Radiation Hazard Study must accompany all applications as an exhibit for new transmitting facilities, major modifications, or major amendments. Refer to OET Bulletin 65.

FCC 312, Main Form - Page 2
February, 1998

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FCC 312, Main Form - Page 2
February, 1998

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Regulating Earth's Orbital Space as its Environment

Viasat v. FCC

47 CFR 1.1307(c)

§ 1.1307 Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared.

(a) Commission actions with respect to the following types of facilities may significantly affect the environment and thus require the preparation of EAs by the applicant and may require further Commission environmental processing:

are to be located in officially designated wilderness area
are to be located in officially designated wildlife preserve
may affect Indian religious sites
to be located in floodplains
whose construction will significant change in surface features
Antenna towers and/or supporting structures equipped with high intensity white lights

……..

Regulating Earth's Orbital Space as its Environment

Viasat v. FCC

47 CFR 1.1307(c)

§ 1.1307 Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared.

(b) With respect to limits on human exposure to RF….

(c) [Authorizes interested parties to file]

(d) [Bureau can act on its own motion where determines that the proposal may have significant environmental impact]

(e) [Supremacy]

Regulating Earth's Orbital Space as its Environment

Viasat v. FCC

47 CFR 1.1307

Terrestrial Concerns

Regulating Earth's Orbital Space as its Environment

Conceptual Definitions

Environment – 40 CFR § 1508.1 (m)

(m) ***Human environment*** means comprehensively the natural and physical environment and the relationship of present and future generations of Americans with that environment. (*See also* the definition of "effects" in paragraph (g) of this section.)

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Regulating Earth's Orbital Space as its Environment

Conceptual Definitions

Effects – 40 CFR § 1808.1(g)

(g) ***Effects*** or *impacts* means changes to the human environment from the proposed action or alternatives that are reasonably foreseeable and have a reasonably close causal relationship to the proposed action or alternatives, including those effects that occur at the same time and place as the proposed action or alternatives and may include effects that are later in time or farther removed in distance from the proposed action or alternatives.

(1) Effects include ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic (such as the effects on employment), social, or health effects. Effects may also include those resulting from actions that may have both beneficial and detrimental effects, even if on balance the agency believes that the effect will be beneficial.

Regulating Earth's Orbital Space as its Environment

Conceptual Definitions

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(2) A "but for" causal relationship is insufficient to make an agency responsible for a particular effect under NEPA. Effects should generally not be considered if they are remote in time, geographically remote, or the product of a lengthy causal chain. Effects do not include those effects that the agency has no ability to prevent due to its limited statutory authority or would occur regardless of the proposed action.

Regulating Earth's Orbital Space as its Environment

Conceptual Definitions

Effects – 40 CFR § 1808.1(g)

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(3) An agency's analysis of effects shall be consistent with this paragraph (g). Cumulative impact, defined in 40 CFR 1508.7 (1978), is repealed.

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Regulating Earth's Orbital Space as its Environment

Conceptual Definitions

Effects – 40 CFR § 1808.1(g)

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Regulating Earth's Orbital Space as its Environment

Proposed Regulations – Criteria, Information, and Metrics – SATCON and D&QS (examples)

reflected sunlight occurring during normal operations, with reflected sunlight ideally slowly varying with orbital phase as recorded by high etendue (effective area × field of view), large-aperture ground-based telescopes to be fainter than 7.0 Vmag +2.5 × log(rorbit / 550 km), equivalent to 44 × (550 km / rorbit) watts/steradian.

Satellite darkening;

Sun shielding; and,

Avoiding non-rigid specular materials on the nadir face of the satellites to reduce false transients.

Regulating Earth's Orbital Space as its Environment

Consistent Definition of Environment

International Treaties and Guidelines

International (ITU)

National | Domestic

Use Existing Structure

Existing Domestic and International Regulatory Regime

Satellites | Space Debris | Radio Interference

Regulating Earth's Orbital Space as its Environment

Consistent Definition of Environment

International Treaties and Guidelines

International (ITU)

National | Domestic

Use Existing Structure

Industry Engagement

Forward Thinking
(Compliance by Design)

Philosophical Approach

Earth's Orbital Space is of its Environment

Next Steps

Engage, Speak, Write

Lobby, Contribute

Comment

Develop

Participate

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Earth's Orbital Space is of its Environment

Invite Collaboration.

Thank you.

Charles Lee Mudd Jr.

Principal Attorney and Owner

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