



Promoting Cooperative Solutions for Space Sustainability

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Private Actors in Space

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Recent Satellite Frequency Applications in the US

Licensee	Purpose	# of Satellites	Orbits	Earth-Space	Space-Earth	Space-Space	
Audacy	Relay communications	3	MEO	29.5-30.0 GHz	19.2-20.2 GHz	22.55-23.55 GHz	
							24.24-24.75 GHz
							32.3-33.0 GHz
				47.20-50.20 GHz	37.5-42.0 GHz	54.25-56.9 GHz	
				50.5-51.4 GHz		57.0-58.2 GHz	
						65.0-71.0 GHz	
Boeing	Broadband	60	MEO	27.6-29.1 GHz	17.8-19.3 GHz		
				29.5-30.0 GHz	19.3-19.7 GHz		
					19.7-20.2 GHz		
Boeing	Broadband	2956	LEO	47.2-50.2 GHz	37.5-42.5 GHz		
				50.4-52.4 GHz			
Boeing	Broadband	132	LEO	51.15-51.4 GHz	37.5-42.0 GHz	Ka	
		15	HEO				V
Karousel	Broadband	12	IGSO	14.0-14.5 GHz	10.7-12.7 GHz		
				27.5-30.0 GHz	17.8-19.3 GHz		
					19.7-20.2 GHz		
Kepler	Broadband	140	LEO	12.75-13.25 GHz*	10.7-12.7 GHz	25.25-27.5 GHz*	
				14.0-14.5 GHz			



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LeoSat	Broadband	78	LEO	27.5-29.1 GHz	17.8-18.6 GHz	
				29.5-30.0 GHz	18.8-20.3 GHz	
O3b	Broadband	24	MEO	27.5-30.0 GHz	17.7-18.6 GHz	
		16	Inclined MEO		18.8-20.2 GHz	
O3b	Broadband	24	MEO	50.4-51.4 GHz	42.0-42.5 GHz	
OneWeb	Broadband	720	LEO	14.0-14.5 GHz	10.7-12.7 GHz	
				27.5-29.1 GHz	17.8-18.6 GHz	
				29.5-30.0 GHz	18.8-19.3 GHz	
OneWeb	Broadband	720	LEO	42.5-43.5 GHz	37.5-42.5 GHz	
				47.2-50.2 GHz		
				50.4-51.4 GHz		
OneWeb	Broadband	1280	MEO	42.5-43.5 GHz	37.5-42.5 GHz	
				47.2-50.2 GHz		
				50.4-51.4 GHz		
SpaceX	Broadband	4425	LEO	14.0-14.5 GHz	10.7-12.7 GHz	
				13.85-14.0 GHz	12.15-12.25 GHz	
				27.5-29.1 GHz	17.8-18.6 GHz	
				29.5-30.0 GHz	18.8-19.3 GHz	
				47.2-52.4 GHz	37.5-42.5 GHz	
SpaceX	Broadband	7518	VLEO	47.2-52.4 GHz	37.5-42.5 GHz	



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Recent Satellite Frequency Applications in the US

18,595 new spacecraft

Licensee	Purpose	# of Satellites	Orbits	Earth-Space	Space-Earth	Space-Space
Telesat	Broadband	117	LEO	27.5-29.1 GHz	17.8-18.6 GHz	
				29.5-30.0 GHz	18.8-19.3 GHz	
					19.7-20.2 GHz	
Telesat	Broadband	117	LEO	47.2-50.2 GHz 50.4-51.4 GHz	37.5-42.4 GHz	Optical
ViaSat	Broadband	24	MEO	27.5-29.1 GHz	17.8-19.3 GHz	
				29.5-30.0 GHz	19.7-20.2 GHz	
Space Norway	Broadband	2	HEO	14.0-14.5 GHz	10.7-12.75 GHz	
				28.0-29.0 GHz	18.2-19.2 GHz	
				29.5-30.0 GHz	19.7-20.2 GHz	
Theia	Multi-spectral imagery	112	LEO	12.75-13.25 GHz	1215.0-1300.0 MHz	
	Hyperspectral imagery					
	L-band Radar imagery					
	Medium-wave Infrared imagery					
	Broadband					
Spire	AIS	100	LEO	156.762-156.788 MHz 156.812-156.838 MHz 161.937- 162.038 MHz 399.9-400.05 MHz 402.0-403.0 MHz 449.75-450.25 MHz 1087.7-1092.3 MHz 1557.52-1611.05 MHz 1166.215-1254.2 MHz	401.0-403.0 MHz 2020.0-2025.0 MHz 2200.0-2290.0 MHz	
	Meteorology					



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Space activities – expanding, diversifying

Earth based – LEO labs (startup commercial SSA) <http://www.leolabs.space/>

LEO, MEO and HEO

- Small sat revolution (Megaconstellations, swarms, and clusters, COTS technology) - internet, Earth Observation, weather data, Maritime Domain Awareness, B2B asset tracking, etc.,
- RocketLabs, SpaceX, Blue Origin, Virgin Galactic (SpaceShipTwo) & Virgin Orbit
- Space debris – capture, salvage, graveyard orbits
- Commercial space station(s) (ISS successor, Axiom, Bigelow)

GEO/GSO – Satellite servicing (Darpa, OrbitalATK)

Moon + Lagrange points = Moon Express, JWST, ESA's Moon Village, US back to the Moon?

Mars - SpaceX, MarsOne, China, UAE, USA

Et cetera – Breakthrough Starshot Initiative, Asgardia (173k+ citizens), Planetary Resources, Deep Space Industries

<https://breakthroughinitiatives.org/Concept/3>

<https://asgardia.space/en/#>

New Actors in Space

Who are they? And, is the existing law sufficient?

New Private Actors - Manufacturers, launch providers, spacecraft operators

Governments are reaching out to private industry. Why? Private industry:

- Innovates faster, and is faster to market
 - Carries the risk
 - Is motivated to succeed (if you don't perform, you are gone)
-
- Manufacturers (rockets engines, smaller satellites, spacecraft components, etc.)
 - Launch providers (including small satellite launch providers, new rocket companies, etc.)
 - Spacecraft operators (remote sensing companies, telecommunications (voice & data), maritime domain awareness, mixed payloads (shared gov./private S/C), etc.)



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Attitudes towards governance:

LEGAL ADVISE OR LOOPHOLES NEEDED FOR MANNED SPACE PROGRAM

- Wired, Kristian Von Bengtson

“A DIY space program like Copenhagen Suborbitals is kept alive by keeping total independence, cutting the red tape and simply just doing it all in a garage. We basically try to stay below the radar at all times and are reluctant about engagements leading to signing papers or doing things (too much) by the books.

Our biggest advance is the absence of requirements for a homemade space rocket in the law. At least in Denmark they forgot to write about this and we have more or less free hands – which does give us a certain responsibility for the future.

The law of the land stops 12 nautical miles from any coast, and out there you can pretty much do whatever you want. By doing so, we simply morph a legal issues into a technical problem that we can solve by ourselves. However, we do cooperate with both Danish and Swedish authorities for these launches. We ask politely about using the test range areas and skies and they smile back and everyone is having fun.”

<https://www.wired.com/2013/10/legal-advice-and-loop-holes-needed-for-manned-space-program/>

OUTER SPACE TREATY ART. VI

States Parties to the Treaty shall bear **international responsibility** for national activities in outer space, including the Moon and other celestial bodies, **whether such activities are carried on by governmental agencies or by non-governmental entities**, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty.

The activities of non-governmental entities in outer space, including the Moon and other celestial bodies, **shall require authorization and continuing supervision by the appropriate State Party to the Treaty**. When activities are carried on in outer space, including the Moon and other celestial bodies, by an international organization, responsibility for compliance with this Treaty shall be borne both by the international organization and by the States Parties to the Treaty participating in such organization.

What is the role of the governments in all this? What is their relationship to new actors in space? Governments are

- *Customers/Consumers*
- *Partners*
- *Regulators*

As **Customers:** Trend is for governments as *consumers*, who will buy the end product and not specify the process (design, details, etc.) As a consumer (amongst other consumers), governments get what the market offers (with a limited ability to influence demand).

Also, new private actors can offer resilience and redundancy (quick launch times for new sats.)

Governments are

- *Customers/Consumers*

As **Customers:** the trend is for governments:

- Not the *primary* customer (“Not Very High Resolution” EO data); thus, govts. Not driving requirements
- Not the *only* customer (Launch?); thus govts. don’t have to pay for “Mission Assurance”), or
- *Not customers at all* (small satellite launch market, space mineral resources).

To get private funding from investors (in some markets (EO)), new actors might not advertise that their primary customer is a government (they don’t want to be seen as government-reliant).

Private actors might see governments as bad customers (red tape, long wait times, difficult to deal with, want to own all the data). They might rather serve private sector customers only.

Governments are

- *Customers/Consumers*

Overall, the trend is from **Privatization** to **Commercialization**

- **Privatization** - the government contracting with a private company to build something under a government contract, instead of the government building it itself.
- **Commercialization** - A market where there are multiple sellers and the government is just one of multiple buyers.
 - This changes the economics (from states of):
 - *oligopoly* - a state of limited competition, in which a market is shared by a small number of producers or sellers, and
 - *oligopsony* - a small number of buyers exists for a product.

As **partners**, government can be a source of investment

- Non-dilutive financing
 - Governments don't want to be shareholders, or not allowed to be shareholders.
- Research and Development funding
 - To help technology past low Technology Readiness Levels (TRLs less than 5)
- Why are governments funding this? Economic benefits
 - Jobs
 - Domestic STEM capacity
 - Domestic industrial capabilities (so that Govs. can be customers in the future)

As **partners**, governments can help coordinate customers, and foster emerging companies and markets (flight opportunities with new companies, coordinated by the government)

*As **Regulators**, governments want their domestic space industry to develop. When to regulate? How much regulation? How to balance private profit and public spending?*

- New actors want licensing for a class of activity (same class of launch vehicle; megaconstellations) rather than each individual activity; licenses on a yearly basis.
 - For experimental activity, they don't want to re-certify each new change they make (that's burdensome, and reduces innovation).
- New actors face a challenge in devoting time/resources to compliance (too much burden threatens their viability). They would prefer:
 - A conversation with regulators on rule-making and regulatory regimes,
 - A “presumptive approval”, rather than a “presumptive denial”
 - Classes of permitted activity, with listed prohibitions (blacklist); **rather than** classes of prohibited activity, with a few allowable exemptions (whitelist)
 - Chances to amend their filings, rather than costly & lengthy re-submissions.

*As **Regulators**, governments want their domestic space industry to develop. When to regulate? How much regulation? How to balance private profit and public spending?*

- **New Actors** want certainty, clarity, consistency, predictability in the rules.

Are governments ready?

- Do regulators have the capacity for emerging space activities like mega-constellations, reusable rockets, advanced remote-sensing, etc.,?
- If the regulatory structure is in place, balanced, clear, and is the agency sufficiently funded and staffed?
- Can it respond to new actors in a timely fashion?

New Actors understand that there are areas where the industry will sort out the rules by themselves.

The question for governments -

Your citizens want to do these space activities: Establish new space companies, rocket companies, spacecraft design and manufacture, spacecraft operation, selling services, performing science. Will you let them? Can you help them?

Rationale: Article VI and VIII of the Outer Space Treaty; national space legislation & national registries.

- National Space Legislation: 22+ States
- States Parties to the REG: 62 ratifications
 - Established their national registry of space objects & notified OOSA: 29 States



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SWF's upcoming publication: *Handbook for New Actors in Space* (2017; 150+ pages; hard copies and .pdf online; no cost)

<http://swfound.org/handbook>

Intended to reach two categories of new actors in space:

- **States developing national space policies and regulations; and**
- **Start-up companies, universities, and other non-governmental entities** beginning their first foray into space activities.

The goal of the Handbook is to provide both groups with a broad overview of the fundamental principles, laws, norms, and best practices for peaceful, safe, and responsible activities in space.



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Thank you!

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