



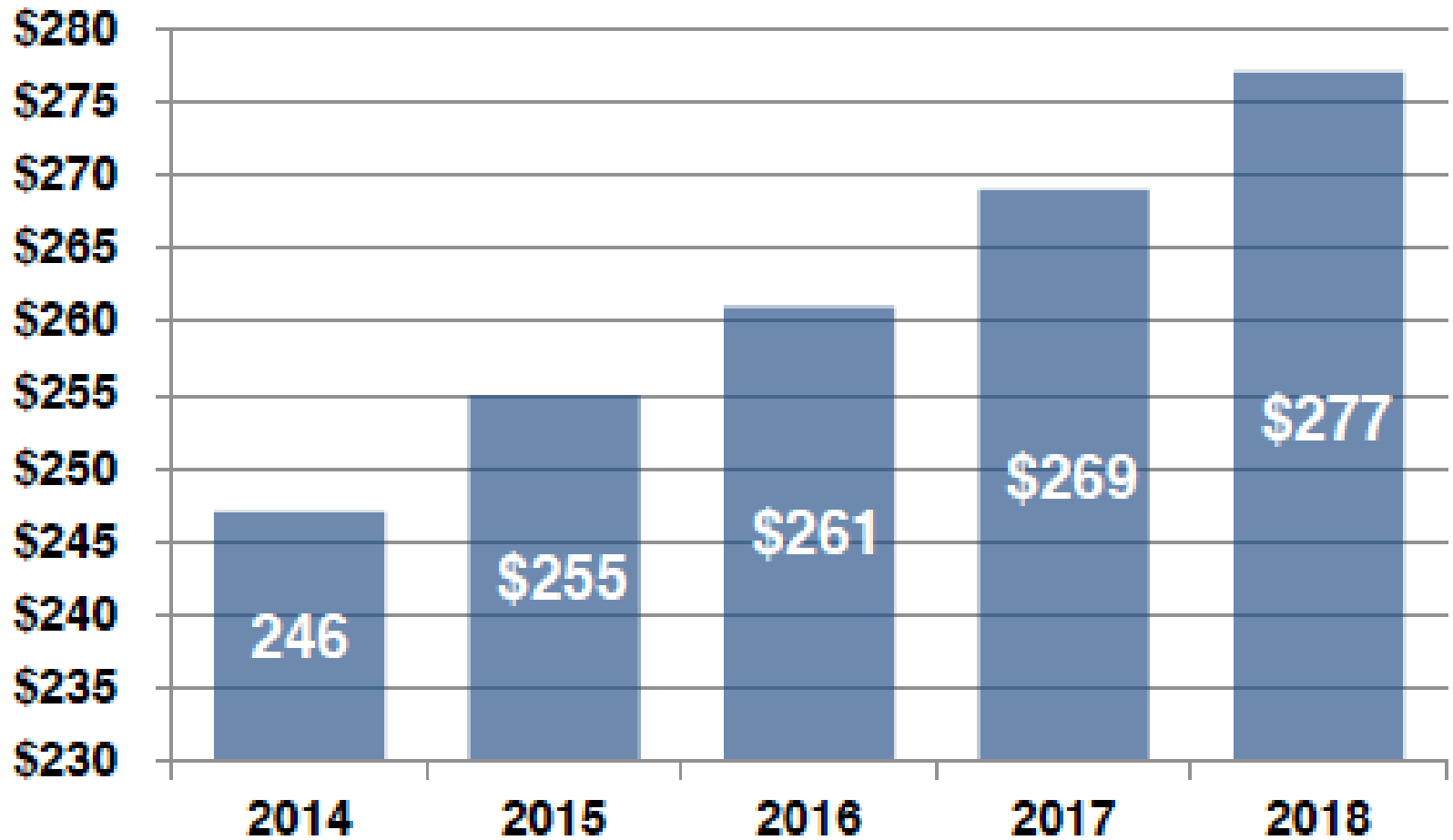
Private Actors in Space

THE FUTURE OF OUTER SPACE SECURITY
2019 GEOPOLITICS AND GLOBAL FUTURES SYMPOSIUM
Geneva Centre for Security Policy

Christopher D. Johnson
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Global Satellite Industry Revenues

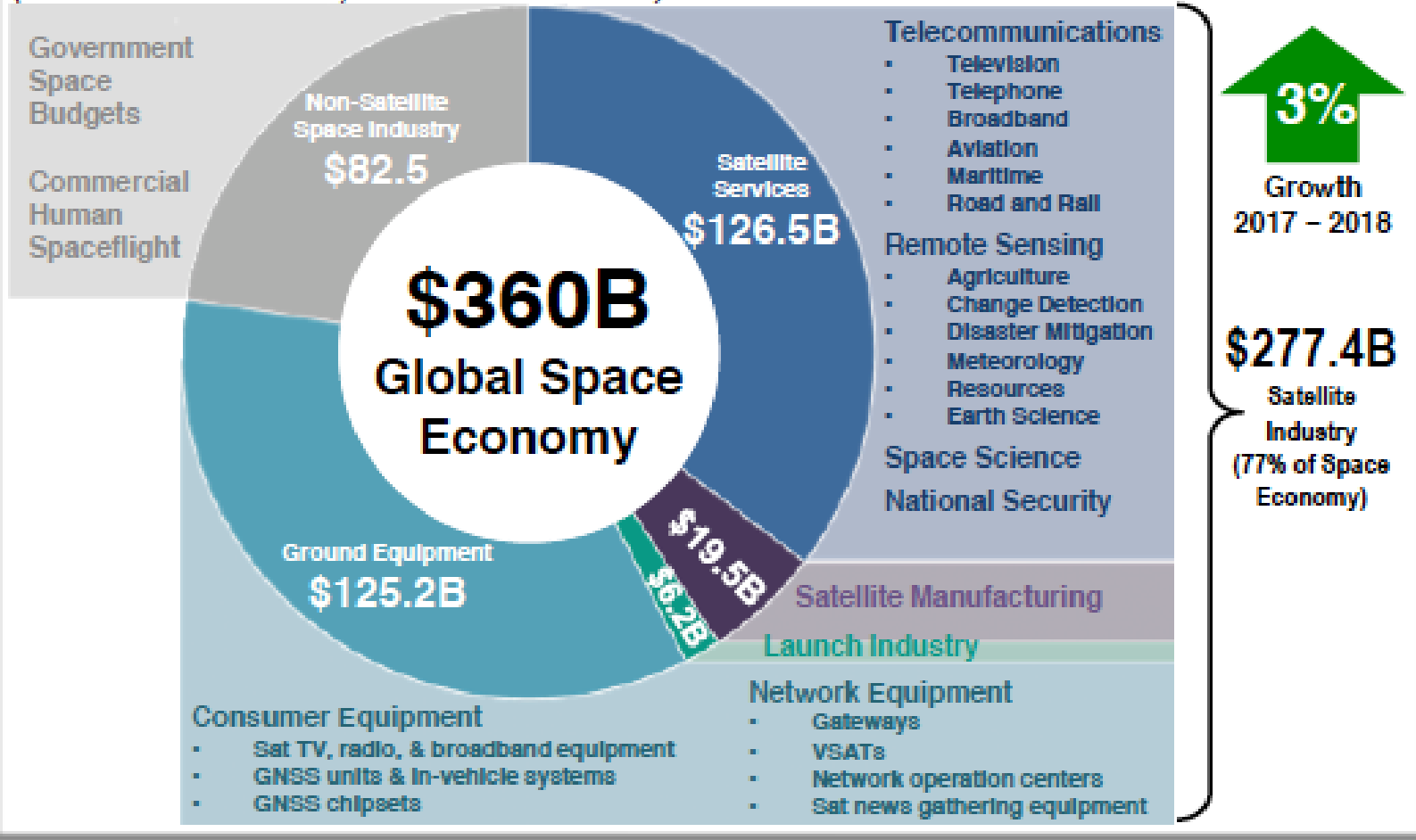
(billions of U.S. dollars)



Source: Bryce Space and Technology, *2019 State of the Satellite Industry Report*

The Satellite Industry in Context

(2018 revenues worldwide, in billions of U.S. dollars)



76% of the global space economy is the satellite industry

Satellite industry (communication services, launch, ground segment) is *the only commercial space market at scale* – few truly commercial markets in other segments.

Source: Bryce Space and Technology, *2019 State of the Satellite Industry Report*

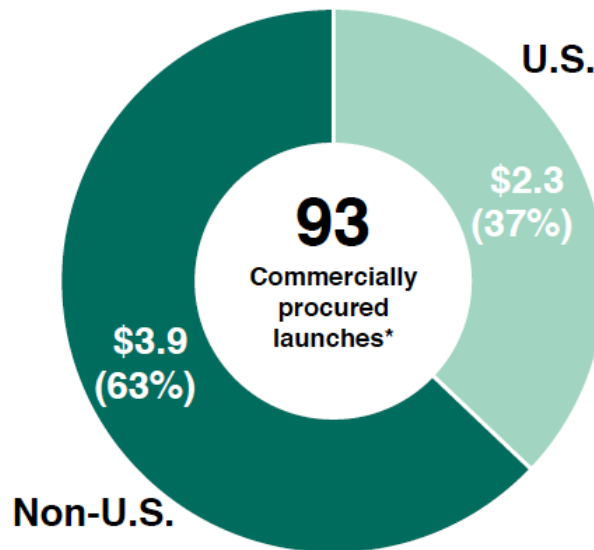


**Launch
Industry**



2018 Revenues

\$6.2B



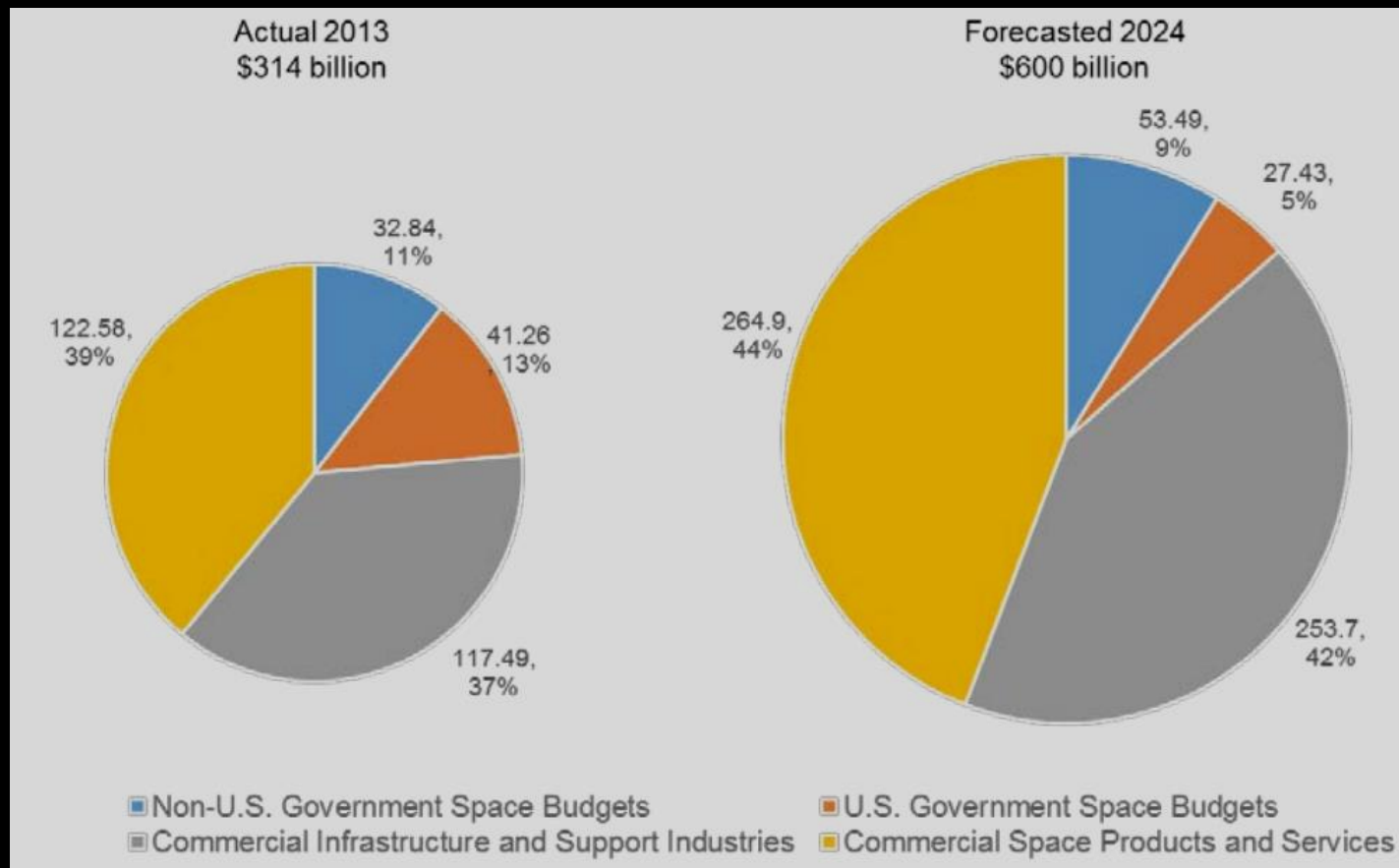
** There were 114 total orbital launches in 2018. Of these, 93 were commercially procured, 15 involved space vehicles, and 6 were not commercially procured*

**Commercial Launch Revenues
by Region**

Source: Bryce Space and Technology, *2019 State of the Satellite Industry Report*

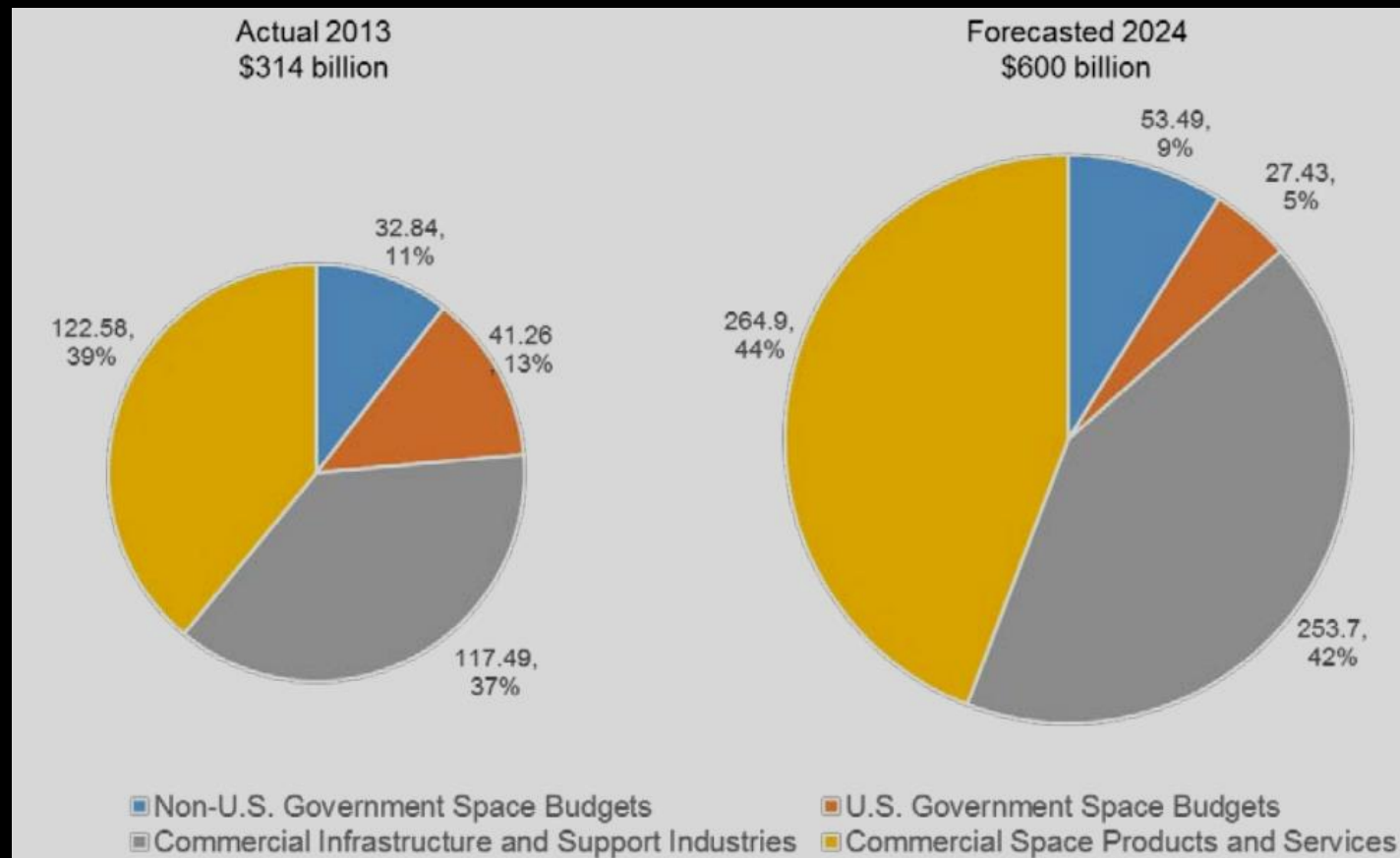
Fifty years ago, the United States and Soviet Union were the only significant national space programs, and only a small number of commercial entities were involved in substantial space activities.

Today, U.S. Government space programs make up **barely a quarter** of global space budgets.



Source: Published and unpublished data from the Space Foundation.

In the next 10 years, even as **global space spending is expected to double**, government budgets, according to some experts, will make up less than a seventh of the total pie, with the **U.S. Government contributing only 5 percent** of the total.



Source: Published and unpublished data from the Space Foundation.

Private Actors in Space

Who are they?

Manufacturers, launch providers, spacecraft operators, etc., (all along the value chain)

- *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 spacecraft), etc.)

Private Actors in Space

What is the role of the governments in all this? What is their relationship to private actors in space?

Governments are

- Regulators
- Customers
- Partners

As Customers: trend is for governments becoming customers, who will merely buy the end product, and not specify the process (design, details, etc.,)

As a Customer (amongst other customer), governments get what the market offers (with a limited ability to influence demand).

However, new private actors can offer governments resiliency & redundancy (with quick launch times).

"Outstanding." — *FORBES*




ROCKET BILLIONAIRES

ELON MUSK, JEFF BEZOS,
AND THE NEW SPACE RACE

TIM FERNHOLZ

ELON MUSK, JEFF BEZOS,
AND THE QUEST TO
COLONIZE THE
COSMOS

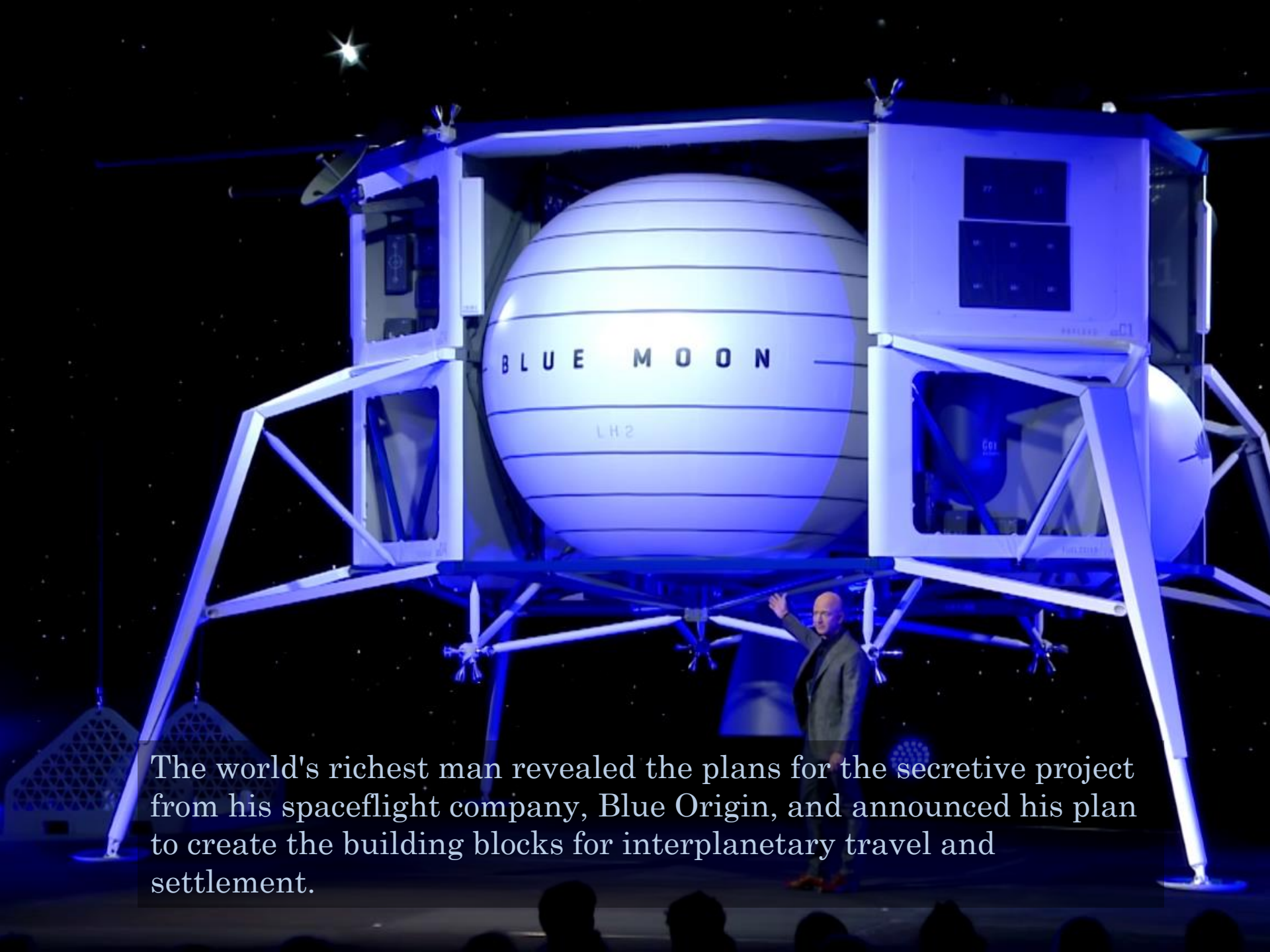


THE SPACE BARONS


CHRISTIAN DAVENPORT







The world's richest man revealed the plans for the secretive project from his spaceflight company, Blue Origin, and announced his plan to create the building blocks for interplanetary travel and settlement.

An aerial photograph of a rocket launch site during sunset. The sky is filled with dramatic, golden clouds. In the foreground, a large, circular concrete pad is visible. To the right of the pad, a tall, white rocket is being mated to a mobile launcher platform (MLP) on a mobile service structure (MSS). Several other MLPs are stacked on the ground nearby. The background shows a vast, flat desert landscape with distant mountains under the twilight sky.

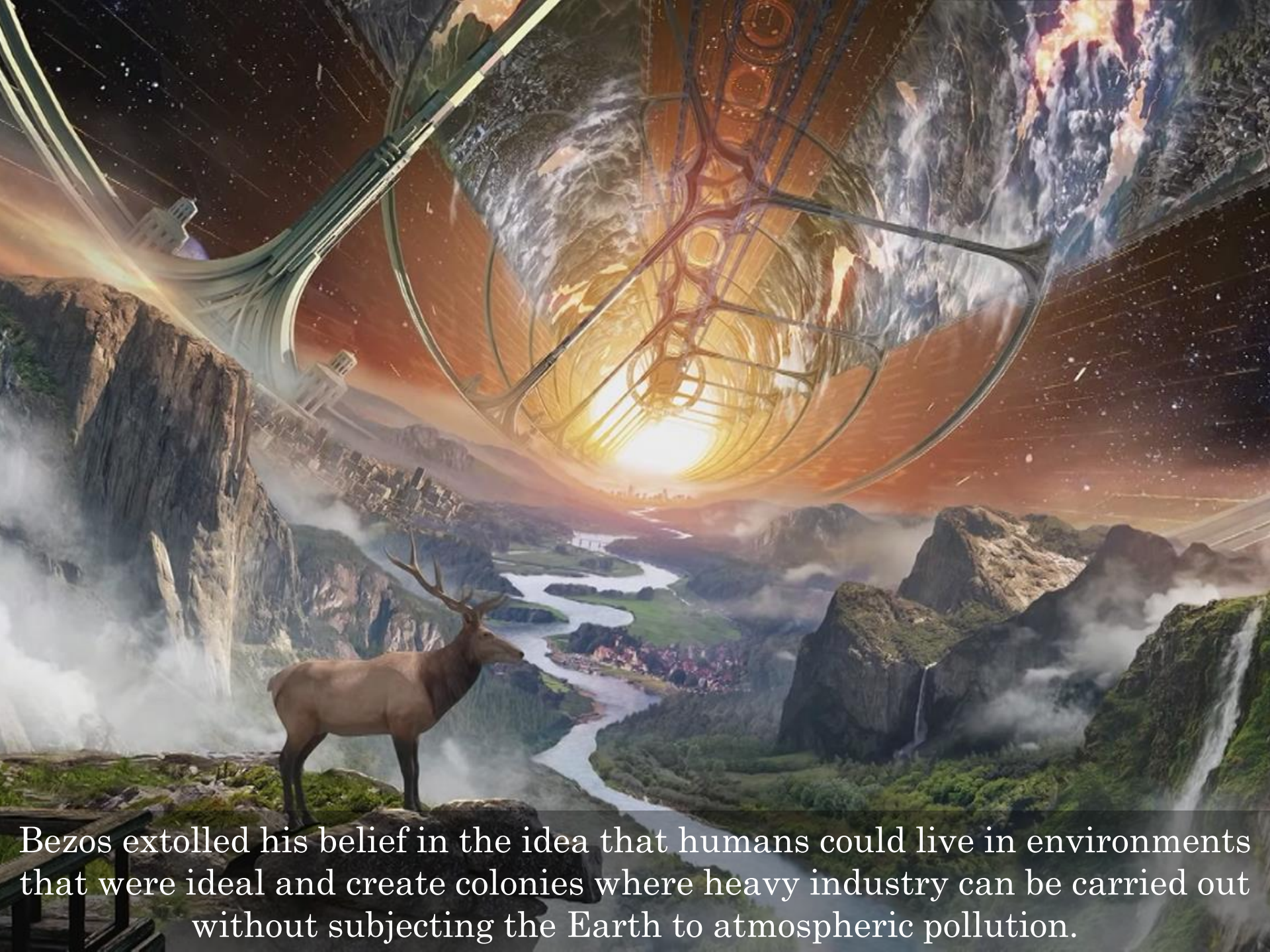
The Amazon founder identified two initial goals that Blue Origin would focus on: a radical reduction in launch costs and establishing resources for space.

Like Elon Musk's SpaceX, Blue Origin has focused on reusable rockets.

Blue Origin would begin by sending humans into space in 2019 on *New Shepard*, a suborbital vehicle designed for space tourism, which uses liquid hydrogen, an incredibly efficient fuel source.

“We’re going to be flying humans in New Shepherd this year,” Bezos said.





Bezos extolled his belief in the idea that humans could live in environments that were ideal and create colonies where heavy industry can be carried out without subjecting the Earth to atmospheric pollution.

Outer Space Treaty

Article 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.

Outer Space Treaty

Article VI

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.

Legally speaking,

All activities in outer space are **national** activities.

Legally speaking,

All activities in outer space are **national** activities.

Whatever a private actor does, at least one (1) government is international responsible for; and possibly more than one government.

Internationally responsible and potentially internationally liable.

Outer Space Treaty

Article VII

Each State Party to the Treaty that *launches or procures the launching of an object* into outer space, including the Moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, **is internationally liable for damage** to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the Moon and other celestial bodies.

So, if you have the money & tech, can you do
whatever you want in outer space?



QUARTZ

WHODUNIT?

The US government said no. Swarm Technologies launched its satellites anyway

By [Tim Fernholz](#) · March 20, 2018

SPACE

FCC Fines Swarm Technologies \$900,000 for Launching Illegal Satellites Into Orbit



Catie Keck

12/20/18 8:15pm · Filed to: SWARM TECHNOLOGIES ▾



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2



After satellite flap, Swarm Technologies raises \$25M for space-based IoT network

BY ALAN BOYLE on January 26, 2019 at 10:57 am

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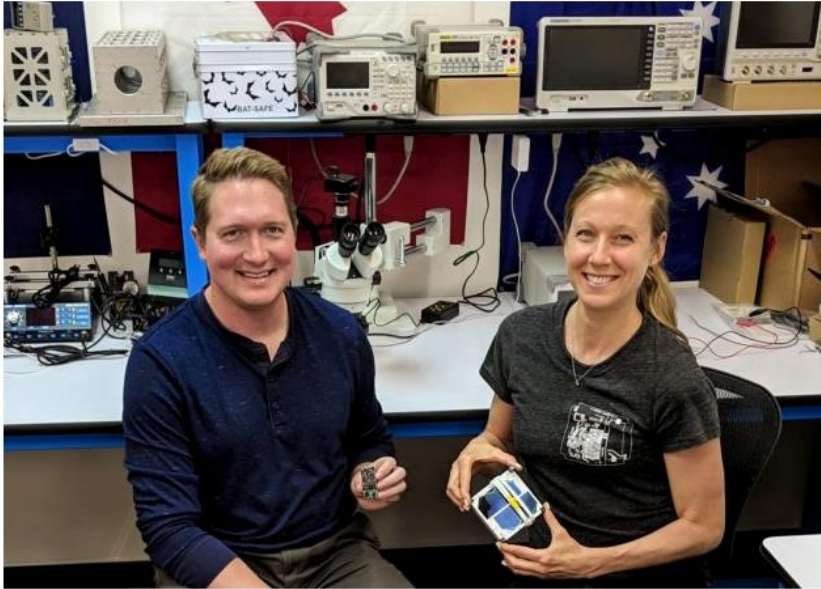
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GeekWire Cloud Summit: FAQ



Swarm Technologies was founded by chief technology officer Ben Longmier and CEO Sara Spangelo, who is holding one of the company's super-miniaturized SpaceBEE satellites. (Swarm Technologies Photo)

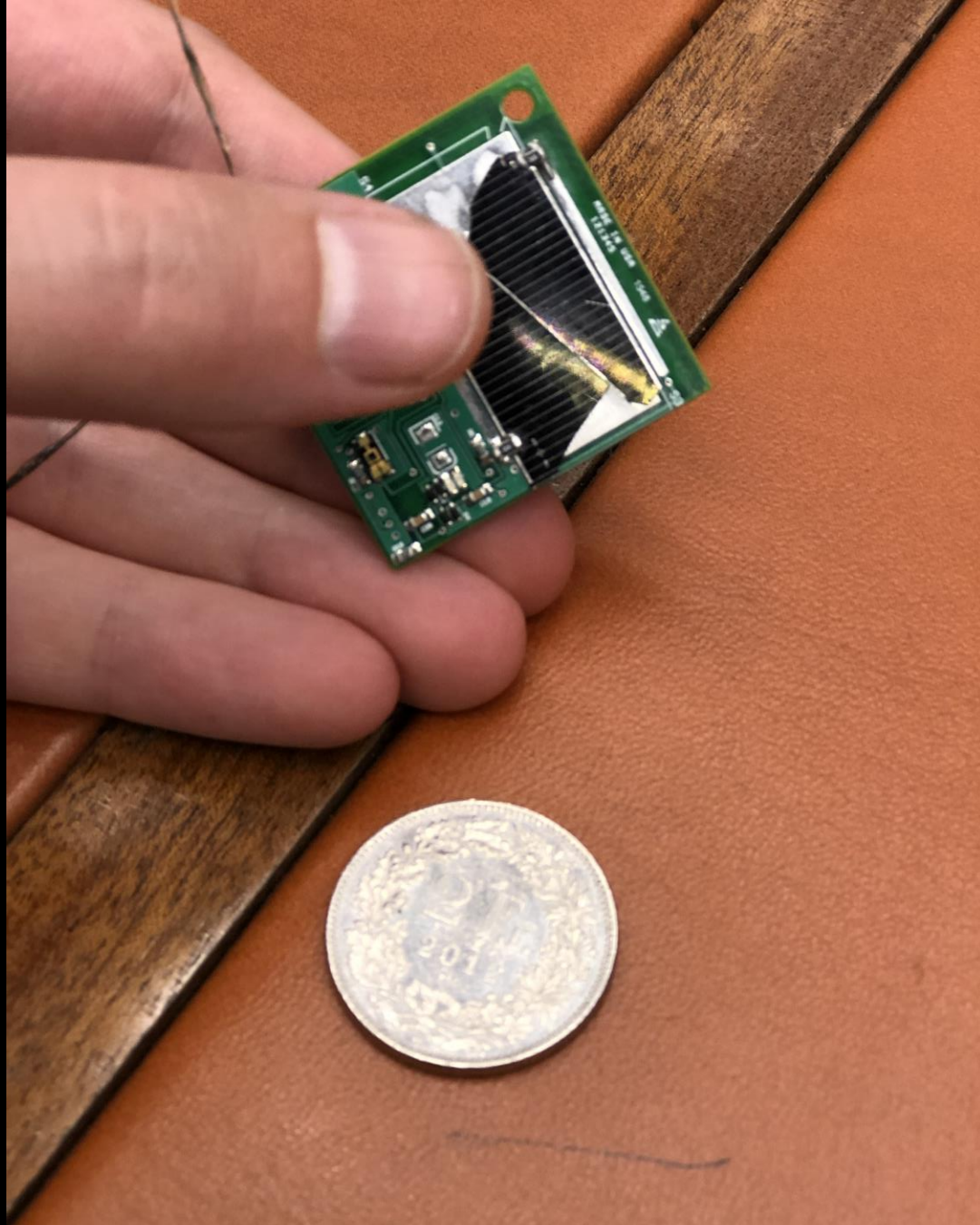
A year after making a \$900,000 mistake, Swarm Technologies is raking in \$25 million in a funding round aimed at getting a constellation of sandwich-sized satellites up and running for the Internet of Things.

Getting the constellation in orbit could open up a big frontier for tiny satellites within the next year and a half.

"We're just excited to get launched and get our network up there and start offering global, affordable internet," said Swarm CEO Sara Spangelo, a veteran of NASA's Jet Propulsion Laboratory and Alphabet's X "moonshot factory."



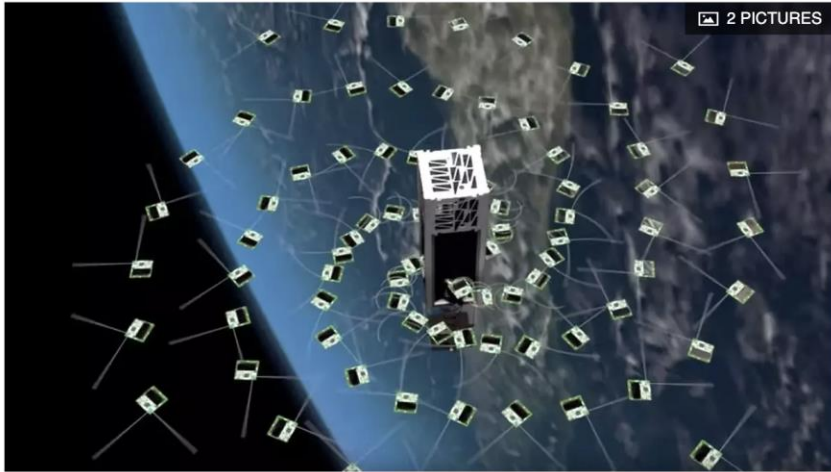




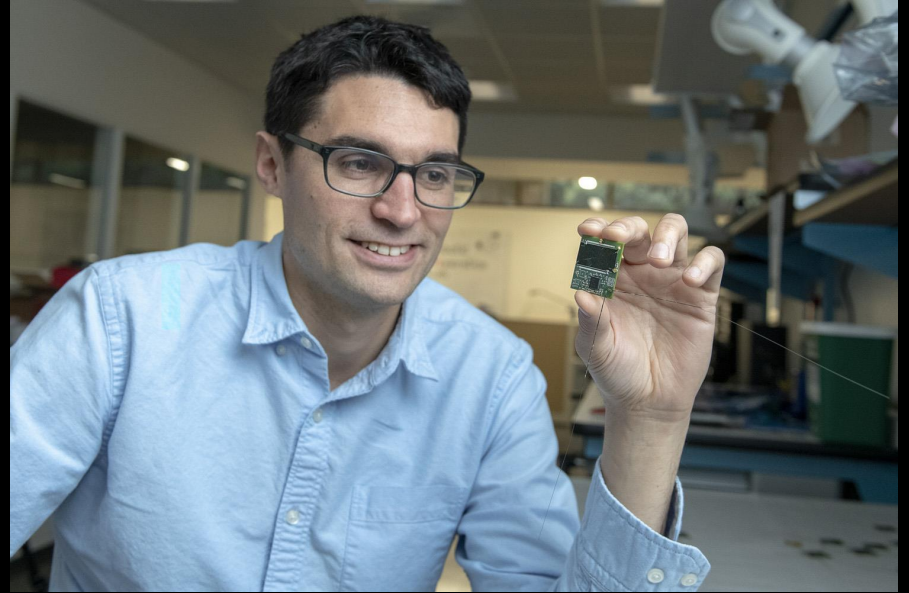
Swarm of 105 tiny Sprite ChipSats successfully deployed



David Szondy | June 6th, 2019



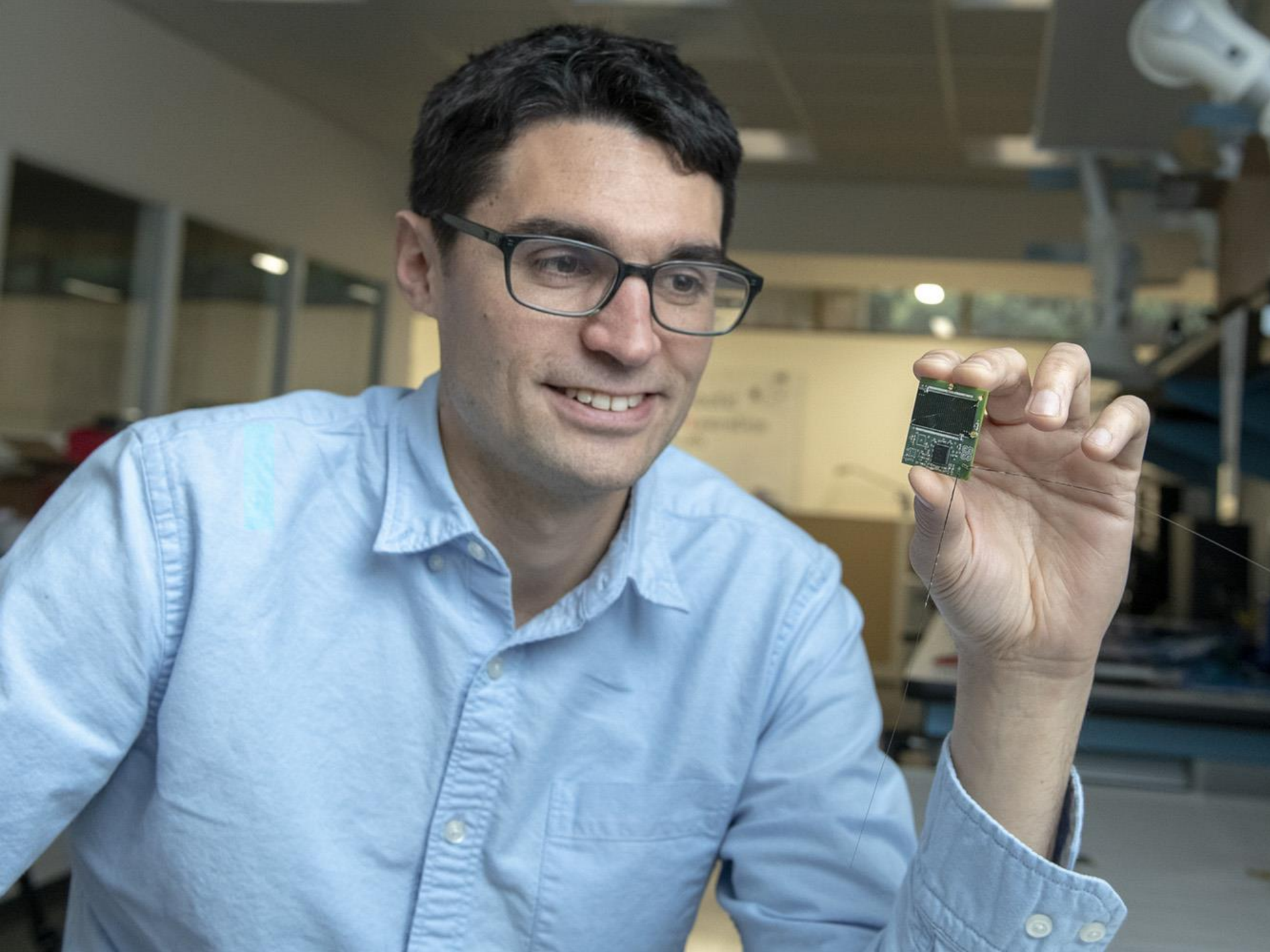
An artist's rendering of the deployment of ChipSats from a shoebox-sized CubeSat (Credit: Cornell University)



JUNE 3, 2019

Stanford and NASA Ames researchers put inexpensive chip-size satellites into orbit

A swarm of 105 tiny satellites the size of computer chips, costing under \$100 each, recently launched into Earth's orbit. Stanford scientist Zac Manchester, who dreamed up the ChipSats, said they pave the way for cheaper and easier space exploration.





Outer Space Treaty

Article IX

In the exploration and use of outer space, including the Moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of cooperation and mutual assistance and **shall conduct all their activities in outer space**, including the Moon and other celestial bodies, *with due regard to the corresponding interests of all other* States Parties to the Treaty.

Outer Space Treaty

Article IX

States Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and ***conduct exploration of them so as to avoid their harmful contamination*** and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose.

“Peaks of Eternal Light”

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The Peaks of Eternal Light: a Near-term Property Issue on the Moon

Martin Elvis, Tony Milligan, Alanna Krolikowski

(Submitted on 2 Aug 2016)

The Outer Space Treaty makes it clear that the Moon is the province of all mankind, with the latter ordinarily understood to exclude state or private appropriation of any portion of its surface. However, there are indeterminacies in the Treaty and in space law generally over the issue of appropriation. These indeterminacies might permit a close approximation to a property claim or some manner of quasi-property. The recently revealed highly inhomogeneous distribution of lunar resources changes the context of these issues. We illustrate this altered situation by considering the Peaks of Eternal Light. They occupy about one square kilometer of the lunar surface. We consider a thought experiment in which a Solar telescope is placed on one of the Peaks of Eternal Light at the lunar South pole for scientific research. Its operation would require nondisturbance, and hence that the Peak remain unvisited by others, effectively establishing a claim of protective exclusion and de facto appropriation. Such a telescope would be relatively easy to emplace with today's technology and so poses a near-term property issue on the Moon. While effective appropriation of a Peak might proceed without raising some of the familiar problems associated with commercial development (especially lunar mining), the possibility of such appropriation nonetheless raises some significant issues concerning justice and the safeguarding of scientific practice on the lunar surface. We consider this issue from scientific, technical, ethical and policy viewpoints.

Comments: 20 pages, 3 figures (color). Space Policy in press

Subjects: **Popular Physics (physics.pop-ph)**; Earth and Planetary Astrophysics (astro-ph.EP); Instrumentation and Methods for Astrophysics (astro-ph.IM)

Cite as: [arXiv:1608.01989](https://arxiv.org/abs/1608.01989) [physics.pop-ph]

(or [arXiv:1608.01989v1](https://arxiv.org/abs/1608.01989v1) [physics.pop-ph] for this version)

New paper
from Dr.
Elvis:

How much of the Solar System should we leave as Wilderness?

Martin Elvis^{a1} and Tony Milligan^b

- a. Center for Astrophysics | Harvard & Smithsonian, 60 Garden St.,
Cambridge MA 02138, USA; melvis@cfa.harvard.edu;
- b. Department of Theology and Religious Studies, King's College London,
Virginia Woolf Building, 22 Kingsway, London WC2B 6NR;
anthony.milligan@kcl.ac.uk

Re-submitted to Acta Astronautica, 2018, November 15.

Emerging Governance Challenges

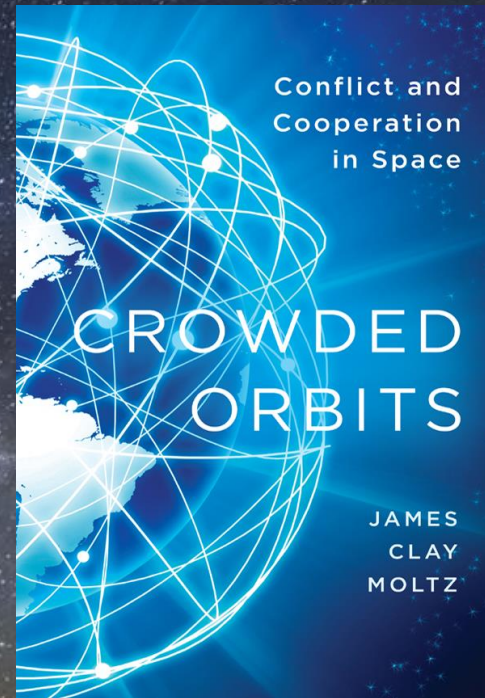
Top-Down or Bottom-Up Approach?
Benefits of both approaches

The concept of 'Subsidiarity'



Recommended Reading

James Clay Moltz, CROWDED ORBITS – CONFLICT AND
COOPERATION IN SPACE





Thank you for your attention

Christopher D. Johnson

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