APNIC Panel
Satellite broadband in the Asia-Pacific: technology and policy

APRICOT 2023

Dan York, Director, Internet Technology
Project Expert, LEO Satellite Systems for Internet Access

February 28, 2023

The Internet is for Everyone

How Do We Connect the Unconnected?

LEOs?

Can LEO Meet the Changing Arctic's Connectivity Needs?

SpaceX's Starlink to exit beta next month

The end of the beta comes as SpaceX preps a new Starli

By Michael Kan for PCMag on September 22, 2021

Technology

Eutelsat to Provide Satelli Access in Spain, Portugal

+Sign Up

2:33 AM EDT

The complicated promise of Amazon's space internet

Project Kuiper, the company's satellite-based broadband service, is finally getting off the ground.

By Adam Clark Estes | @adamclarkestes | ace@recode.net | Nov 3, 2021, 11:20am EDT

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THE I

Amazon to Launch First Two Internet Satellites in 2022

Competing with SpaceX, OneWeb and others, the e-commerce will rely on small rockets to get prototypes of its satellite into space.

QUARTZ

Elon Musk's new satellites could sneak internet past the Taliban

SPACEFLIGH

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BREAKING NEWS > [November 11, 2021] SpaceX test-fires Falcon 9 rocket for Starlink lau

SpaceX launches first full batch of laser-equipped Starlink satellites

September 14, 2021 Stephen Clark

TeleGeography.com Series Topics Search

this World: The International Satellite Broadband Battle Intensifies

TRENDS

By Tom Leins Oct 25, 2021

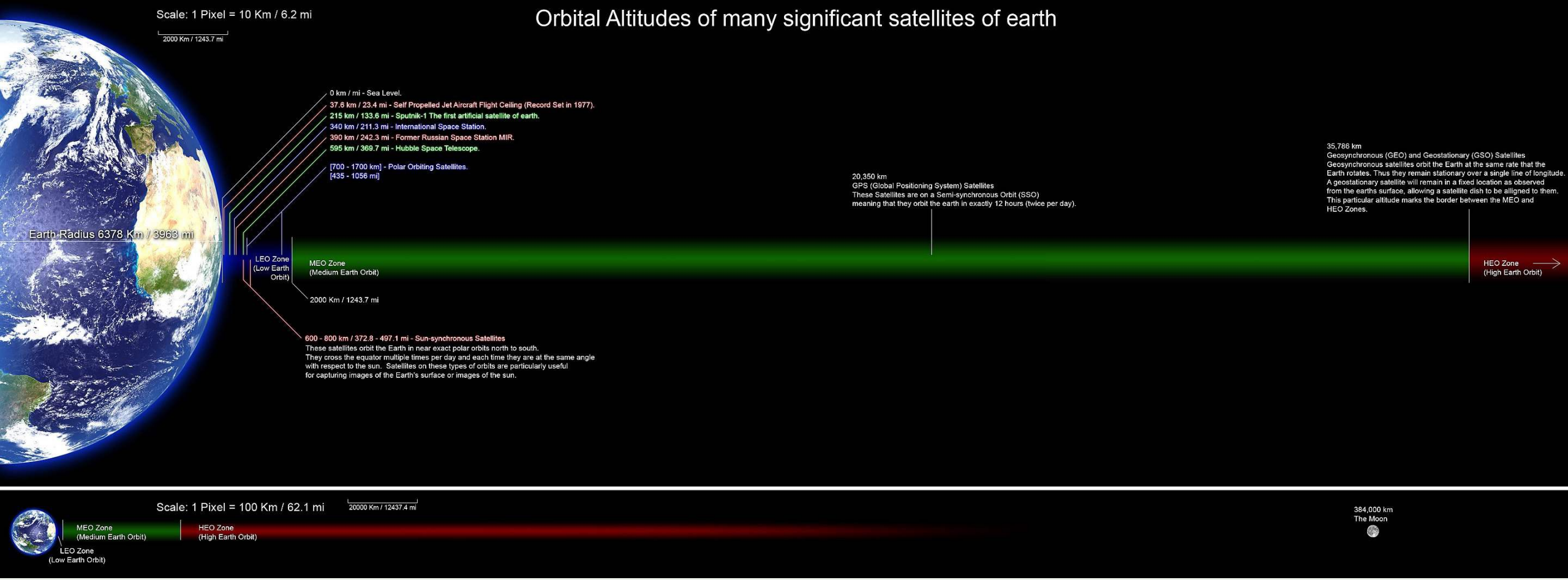
Why the Interest in LEOs?

- **Traditional satellite Internet access provides connectivity, but suffers from long latency and often high cost**

  ("GEO"/"GSO" – geosynchronous orbits)

- **LEOs offer low-latency, high-speed connections that support real-time communication (ex. video calls), gaming, e-sports, virtual worlds / metaverse**

  ("NGSO"/"Non-GSO" – non-geosynchronous orbits – LEO or MEO)

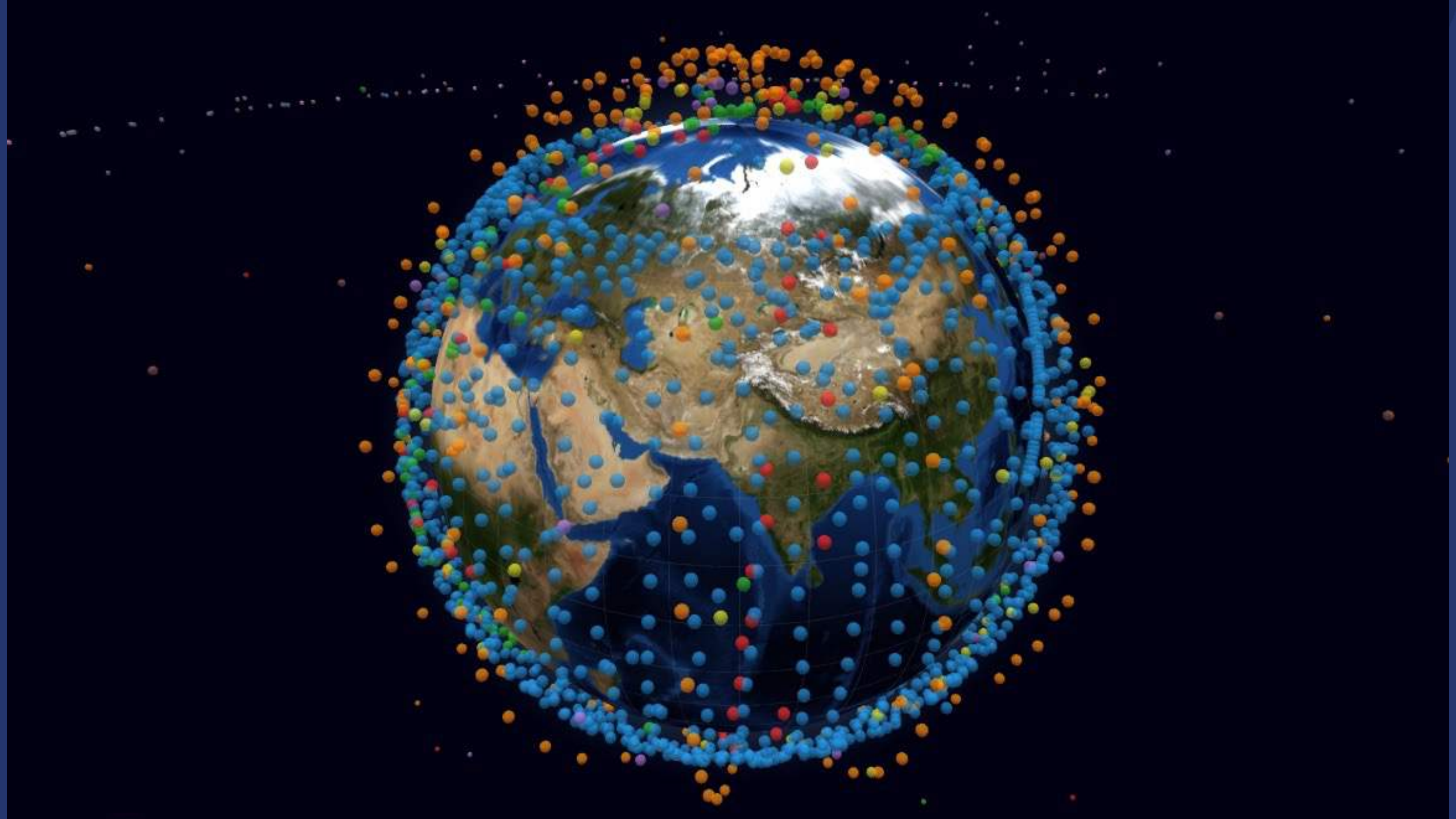


Low Earth Orbit (LEO)
< 2,000 km

Medium Earth Orbit (MEO)
2,000 km – 36,000 km

Geosynchronous Orbit (GEO)
36,000 km

Also “High Earth Orbit” (HEO)
> 36,000 km



Why the Interest in LEOs?

- **Advances in rocket technology now allows less expensive launches**
- **Miniaturization of components allows mass-production of satellites**
- **Rise of companies providing both satellite and launch services**

2023-2027

- **Starlink Gen 1, Gen 2**
- **OneWeb completion**
- **Amazon Project Kuiper**
- **China’s Guowang**
- **EU’s IRIS²**

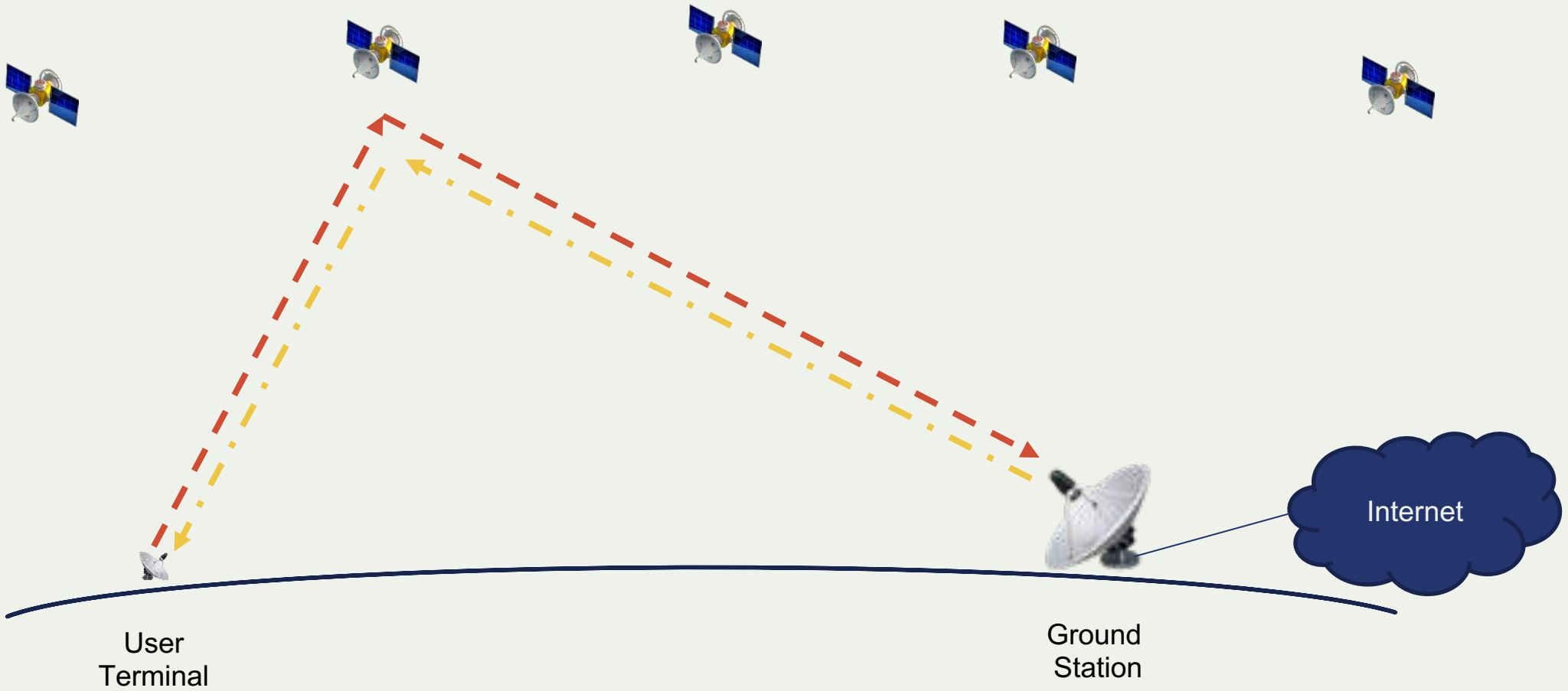
So Many LEO Satellites!

SpaceX Starlink Gen 1	4,408
SpaceX Starlink Gen 2	29,988
OneWeb, Phase 1	718
OneWeb, Phase 2	6,372
Amazon Project Kuiper	7,774
China Guowang	12,992
Astra	13,620
Boeing	5,842
Globalstar	3,080
Lynk	2,000
Telesat Lightspeed	1,969
Spin Launch	1,190
TOTAL	**89,953**
E-Space	337,323

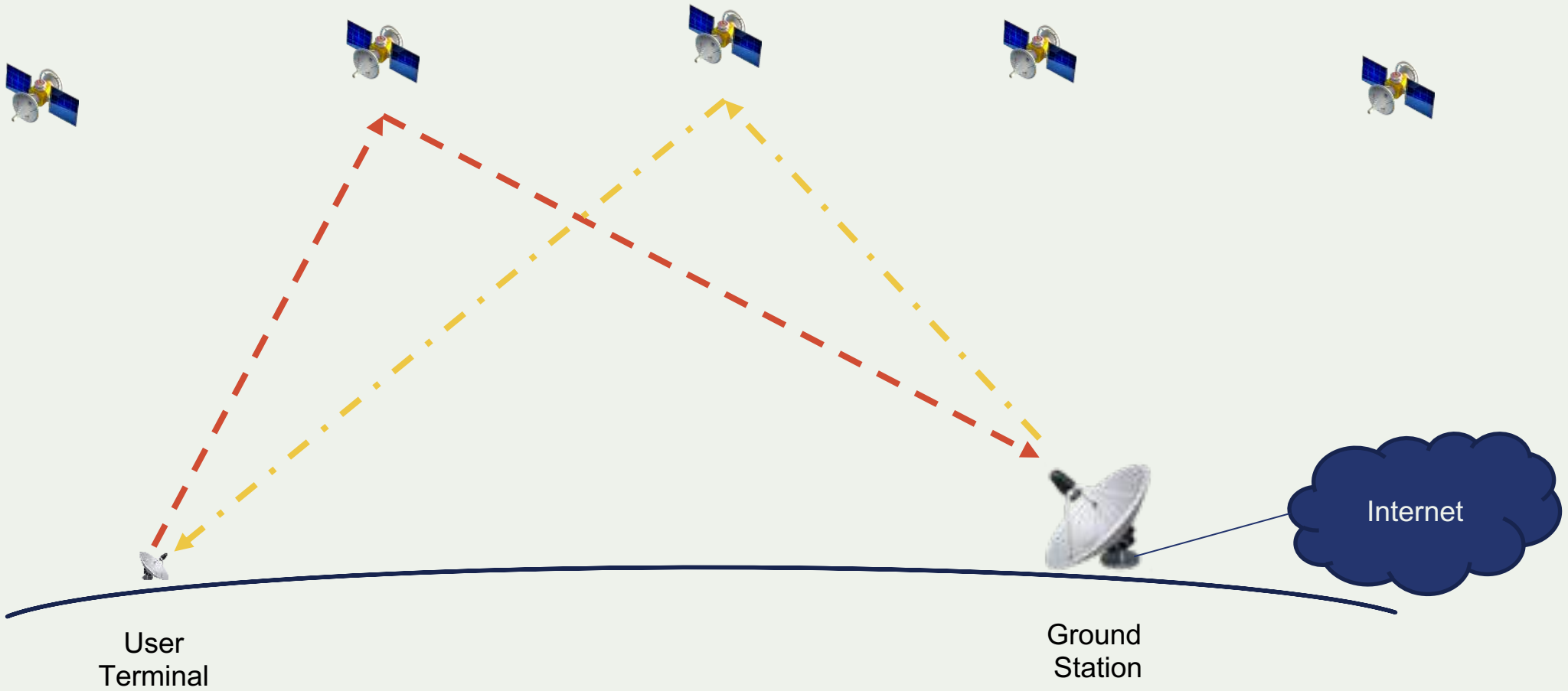
LEO System Components

- Satellite constellation
  - The hundreds or thousands of satellites that are launched into orbit and typically arranged into different “shells” at different altitudes
- User terminal
  - Also sometimes called a ground terminal or simply an antenna or dish, this is how the users receive data from and transmit data to the satellites. The antennas are “electronically steerable” (they do not have to physically move) and track multiple satellites. LEO companies selling direct to consumers may also package additional equipment with the terminal such as a Wi-Fi router.
- Ground stations
  - Also sometimes called gateways, these are the large antennas and facilities that connect the satellites to the rest of the Internet.

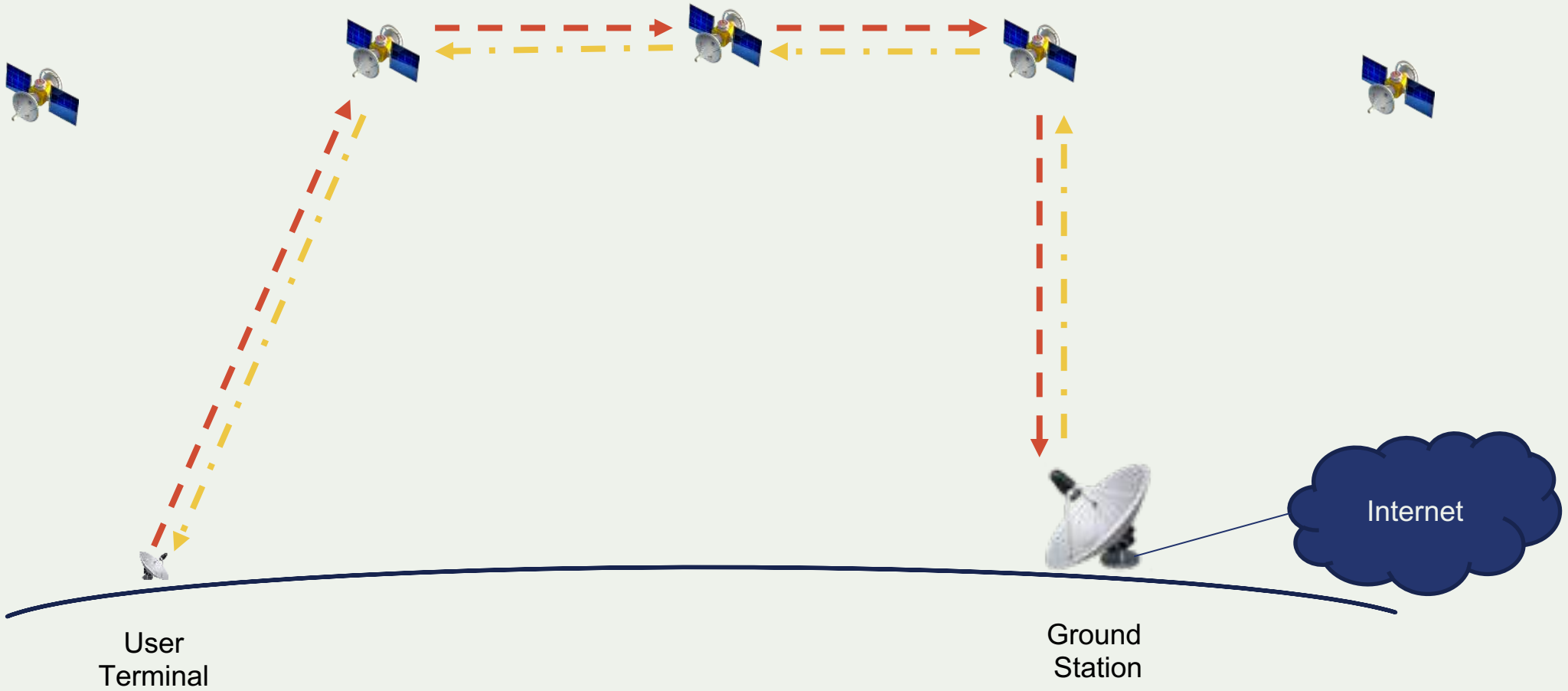
LEO System Operation

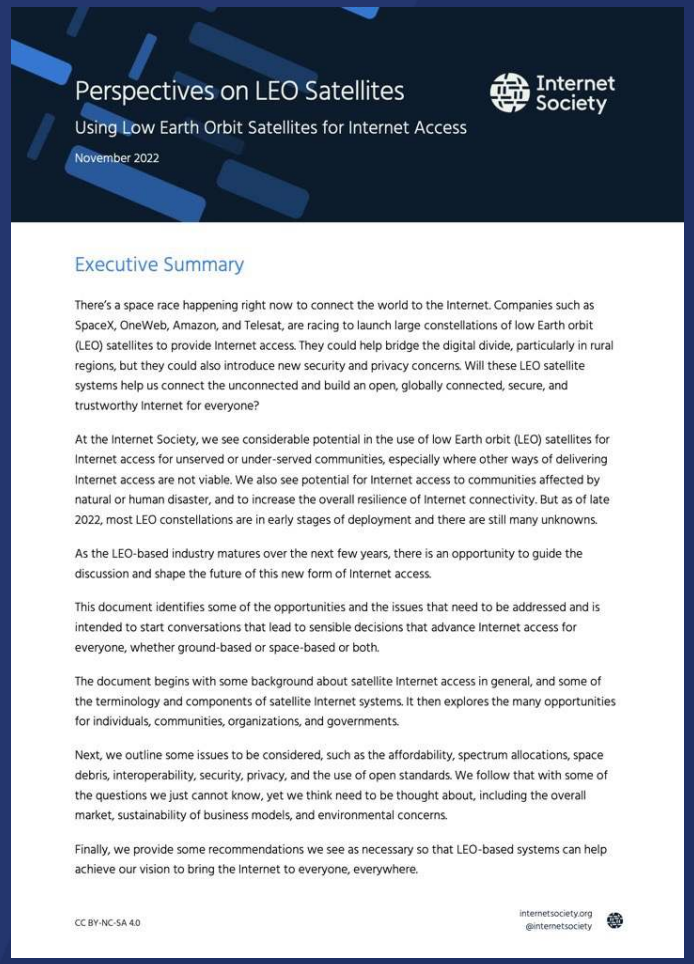


LEO System Operation – using multiple satellites



LEO System Operation – using Inter-Satellite Links (ISLs)





Perspectives on LEO Satellites

Using Low Earth Orbit Satellites for Internet Access

November 2022

Internet Society

Executive Summary

There's a space race happening right now to connect the world to the Internet. Companies such as SpaceX, OneWeb, Amazon, and Telesat, are racing to launch large constellations of low Earth orbit (LEO) satellites to provide Internet access. They could help bridge the digital divide, particularly in rural regions, but they could also introduce new security and privacy concerns. Will these LEO satellite systems help us connect the unconnected and build an open, globally connected, secure, and trustworthy Internet for everyone?

At the Internet Society, we see considerable potential in the use of low Earth orbit (LEO) satellites for Internet access for unserved or under-served communities, especially where other ways of delivering Internet access are not viable. We also see potential for Internet access to communities affected by natural or human disaster, and to increase the overall resilience of Internet connectivity. But as of late 2022, most LEO constellations are in early stages of deployment and there are still many unknowns.

As the LEO-based industry matures over the next few years, there is an opportunity to guide the discussion and shape the future of this new form of Internet access.

This document identifies some of the opportunities and the issues that need to be addressed and is intended to start conversations that lead to sensible decisions that advance Internet access for everyone, whether ground-based or space-based or both.

The document begins with some background about satellite Internet access in general, and some of the terminology and components of satellite Internet systems. It then explores the many opportunities for individuals, communities, organizations, and governments.

Next, we outline some issues to be considered, such as the affordability, spectrum allocations, space debris, interoperability, security, privacy, and the use of open standards. We follow that with some of the questions we just cannot know, yet we think need to be thought about, including the overall market, sustainability of business models, and environmental concerns.

Finally, we provide some recommendations we see as necessary so that LEO-based systems can help achieve our vision to bring the Internet to everyone, everywhere.

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The LEO industry is only just beginning!

Many questions...

LEO Opportunity Examples

- **Individual users**
  Remote, rural, underserved, mobile
- **Community centers**
  Libraries, schools
- **Community networks**
  “Backhaul”
- **High availability / resilience / disaster response**
  Island connectivity, natural disasters
- **Airplanes, ships, mobile users**

LEO Challenges - Deployment

- **Launch availability!**
- **Satellite constellation**
- **User terminal**
- **Ground stations**
- **Regulatory approvals**

LEO Challenges - Business

- **Affordability**
- **Capacity**
- **Competition**

starlink.sx

LEO Challenges - Policy

- **Spectrum allocation**
- **Interference**
- **Allocation of orbits**

LEO Challenges - Technology

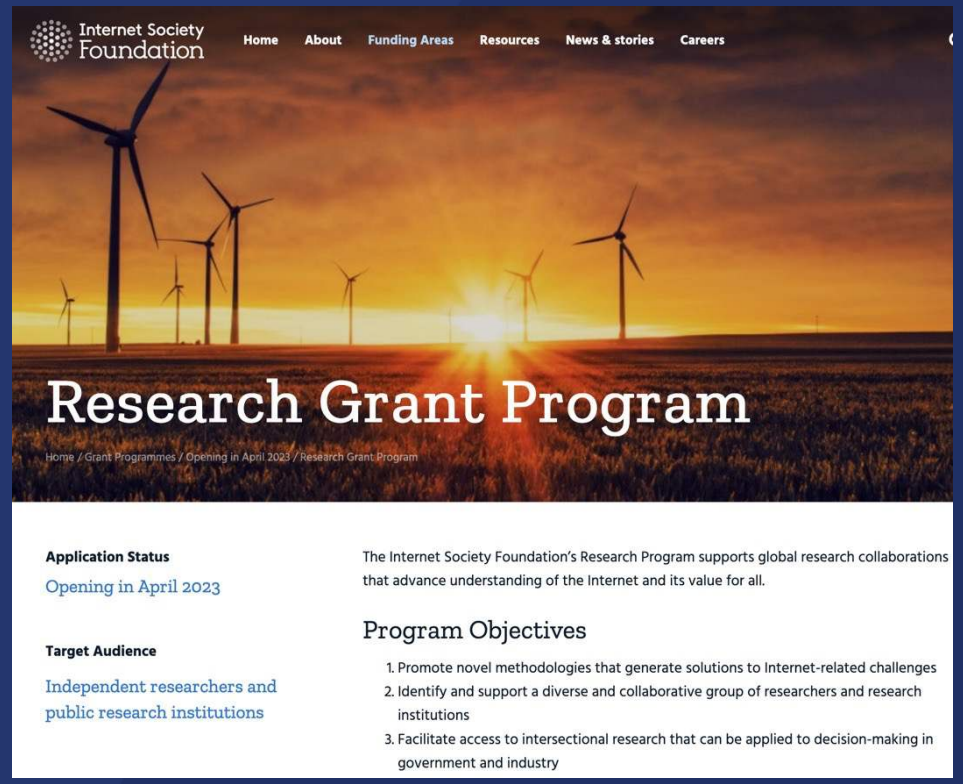
- **Security**
- **Privacy**
- **Open Standards**
- **Interoperability**
- **Space debris**

Questions We Can’t Answer

- **Sustainable business models**
- **Environmental impact**
- **Impact on astronomy**

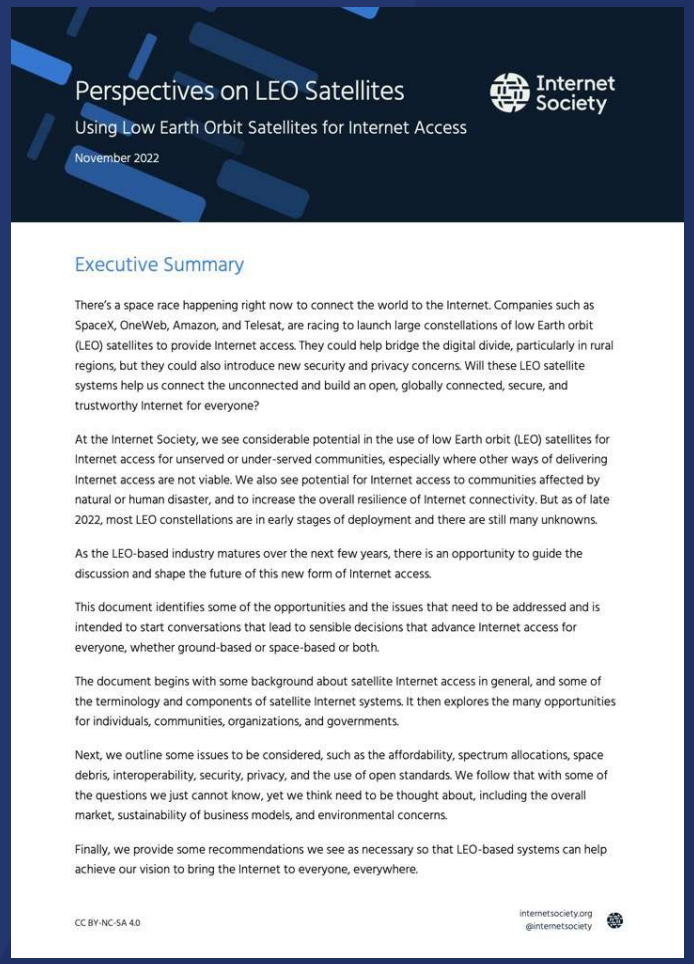
Research Funding

- isocfoundation.org
- April and September 2023



So much potential!

How do we shape the future of LEO Internet access?



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