

# Introduction to Small Satellite and Their Applications

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American University of Phnom Penh

# Warming-up Questions

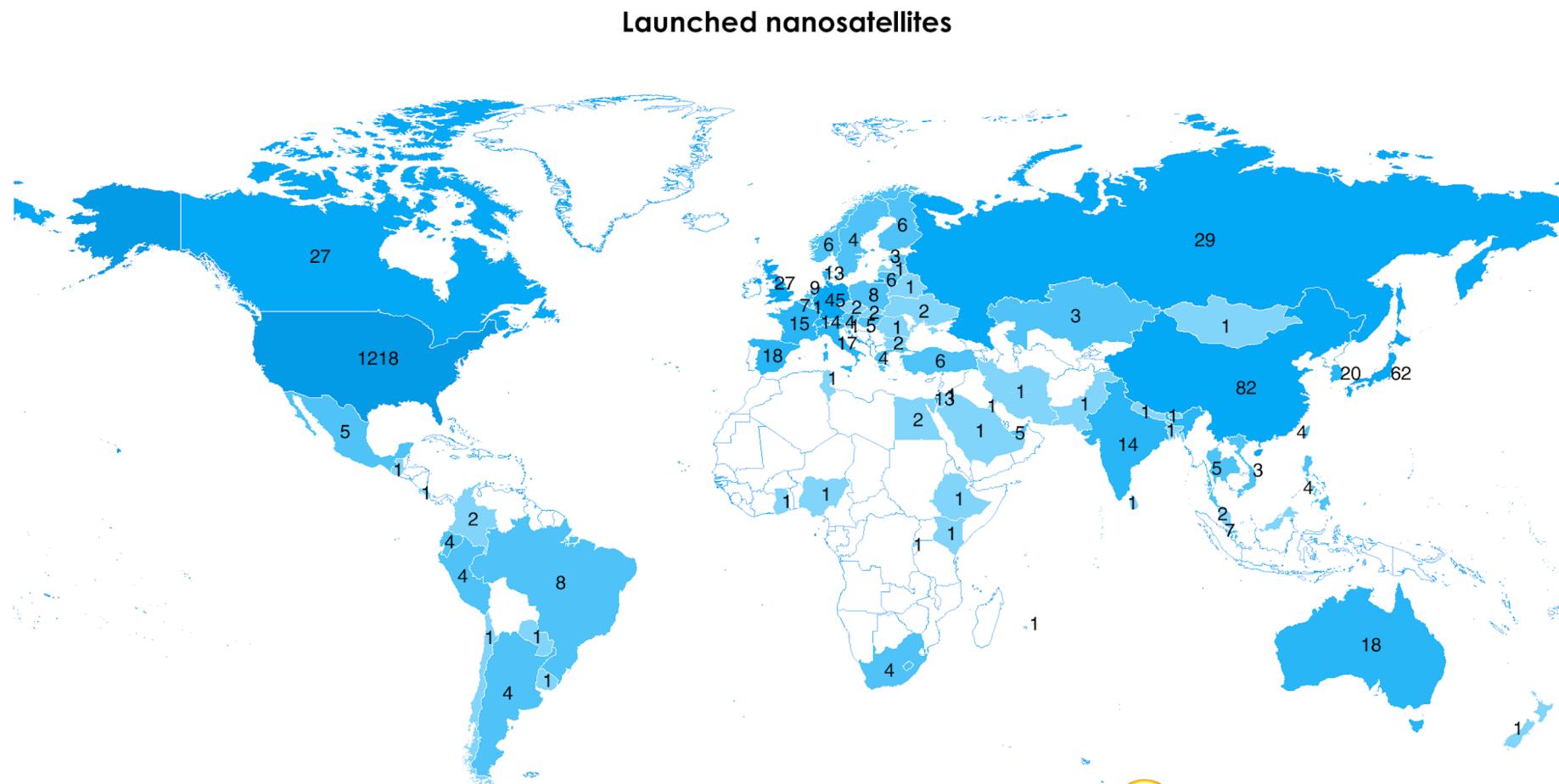




# Space for Everyone

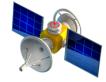
**Accessing to space** is no longer limited to wealthy and well-developed countries.

- Before 2000, about **30 countries** own satellites
  - As of February 2022, over **80 countries** own satellites



# What is happening now? 🤔





# Starlink's Role in Russia-Ukraine Conflict

One day later ...



**Mykhailo Fedorov** @FedorovMykhailo · 12h

@elonmusk, while you try to colonize Mars — Russia try to occupy Ukraine! While your rockets successfully land from space — Russian rockets attack Ukrainian civil people! We ask you to provide Ukraine with Starlink stations and to address sane Russians to stand.

1,486

11.8K

67.3K



...



**Elon Musk**

@elonmusk

Replying to @FedorovMykhailo

Starlink service is now active in Ukraine. More terminals en route.

5:33 AM · Feb 27, 2022 · Twitter for iPhone

59.2K Retweets 11.3K Quote Tweets 294.1K Likes



Note: not starlink but the ground receiver for communicating with starlink

Received new replies

**Mykhailo Fedorov** @Fedorov... · 9h ...  
Starlink — here. Thanks, @elonmusk



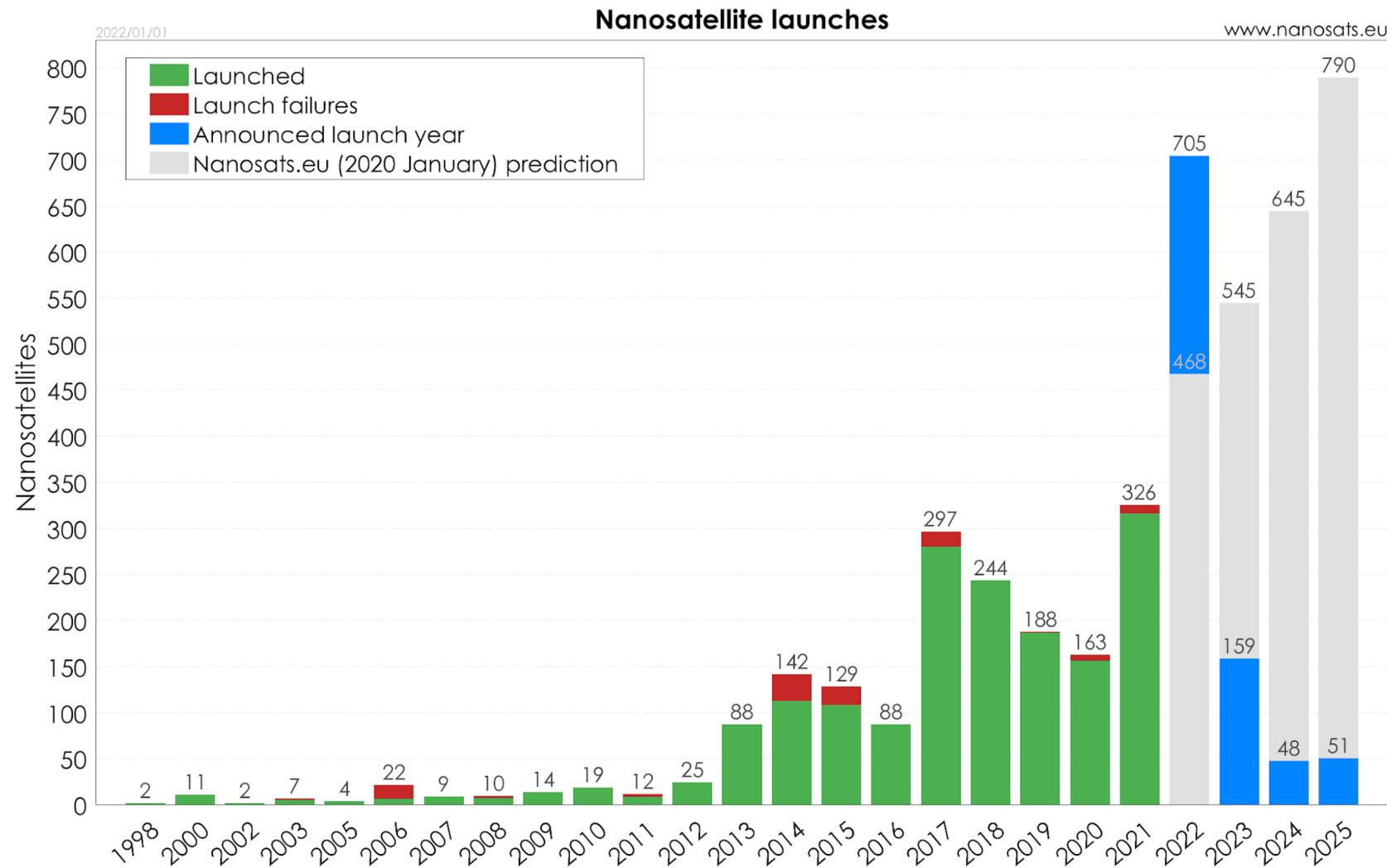
4,317 62.2K 404K

**Elon Musk** @elonmusk · 8h  
You are most welcome

5,596 12.4K 198K

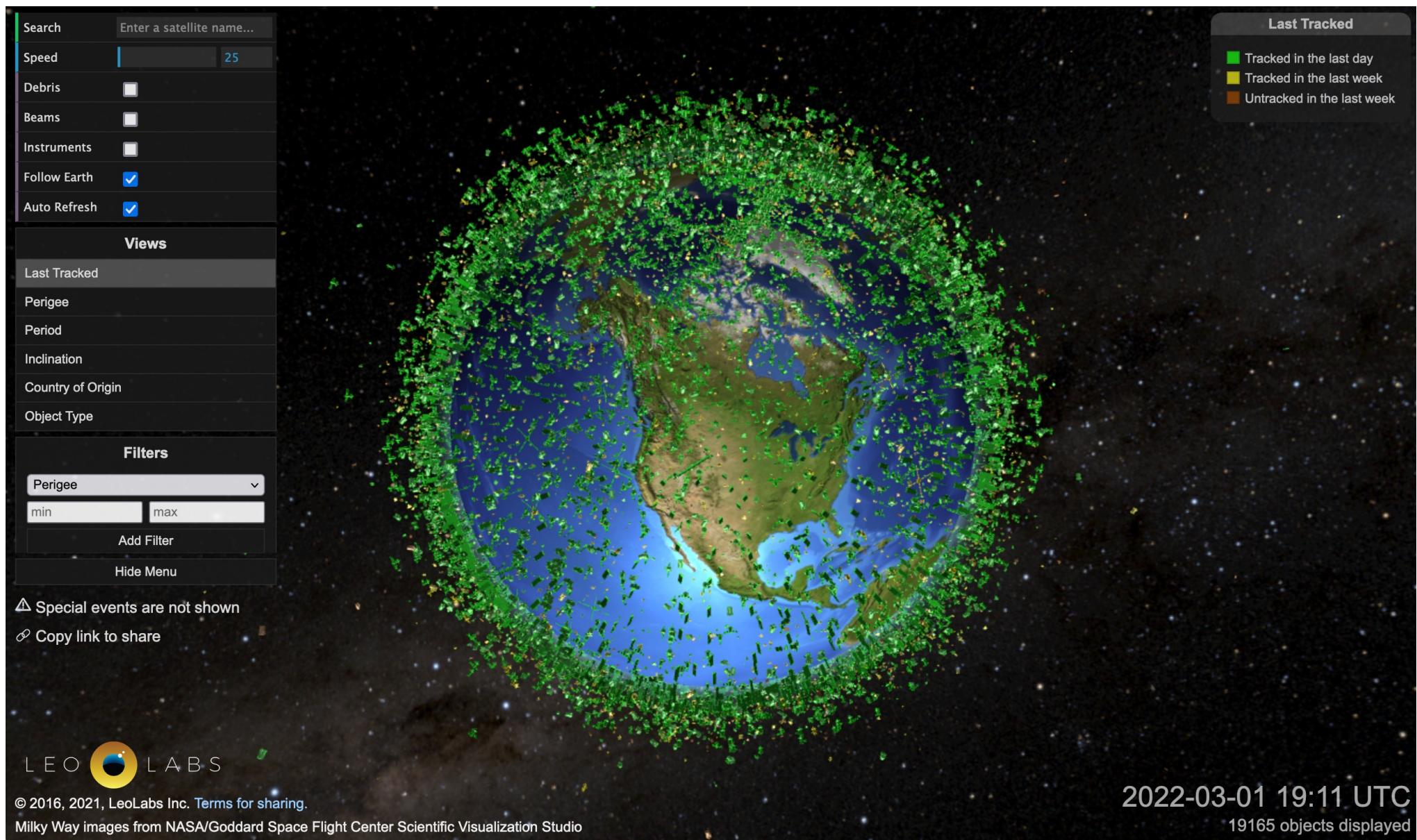


# Space for Everyone



Objects currently in orbit: [Leo Labs](#)

# Objects in Orbit (Leo Labs)





# Agenda

- Introduction to Space
- The Rise of Small Satellite
- Space Projects for Education



# Agenda

- **Introduction to Space**
  - Space Environment
  - Getting into Space
  - Why Space?
  - New Space
- **The Rise of Small Satellite**
- **Space Projects for Education**

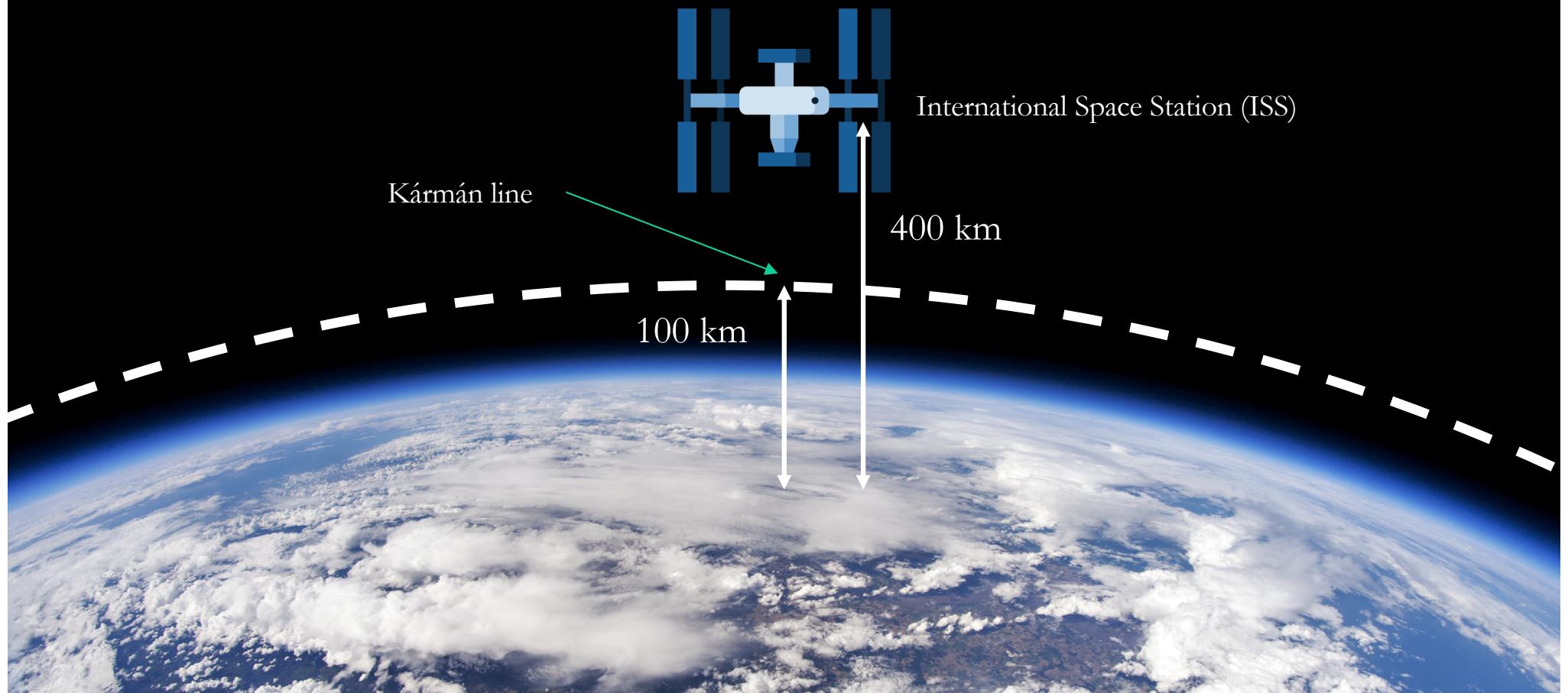


# Space Environment

Space is an extreme environment

- No gravity
- No atmosphere (vacuum)
- Temperature variation (too hot, too cold)
- No geomagnetic protection (malfunction due to radiation)

Engineering Challenges





# Getting Into Space

Currently, **using rocket** is the only available method for human to access to Space



Falcon Heavy Launch



# Why Space?

## Near earth application



## Space exploration



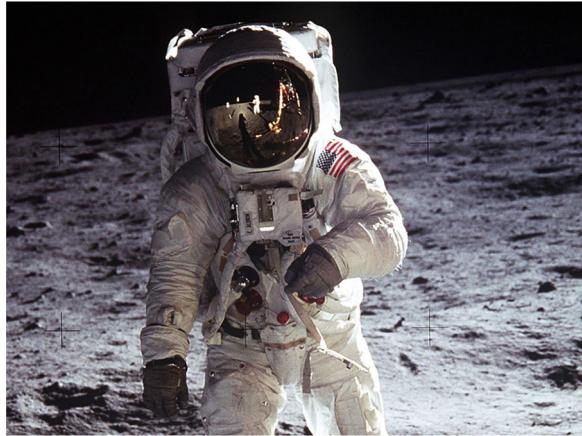
### Support our daily life

- Weather forecasting
- Navigation (Google map...)
- Communication (TV broadcast, telephone service, internet...)
- Remote sensing application (Agriculture, forest management...)

### Answering the fundamental questions

- Are we alone in this universe?
- Where do we come from?

# Space Eras



USA and USSR (Cold War)  
Apollo Era



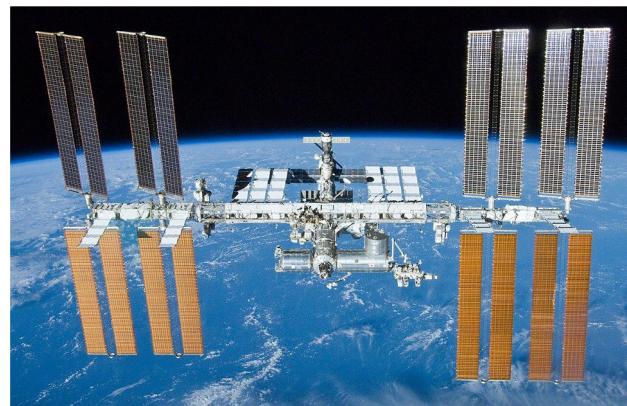
New Space



1950s – 1970s

1980s – 1990s

2000s - Present



International Space Station



# New Space (1 of 2)

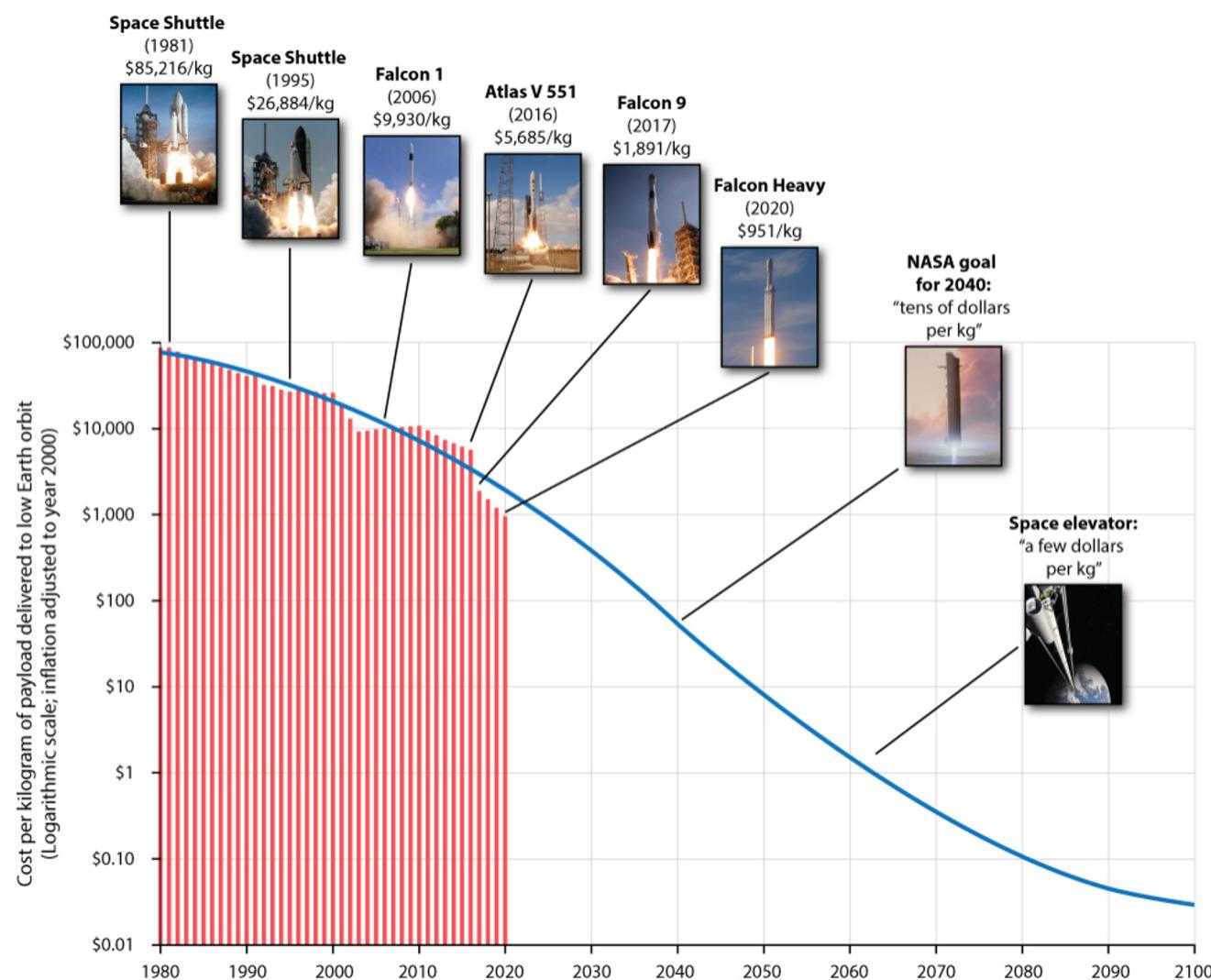
Space has become more accessible due to recent **advancement of technologies**, availability of **low-cost** and **highly reliable** Commercial-Off The Shelf (COTS) component.



Source: Workshop on Space Mission Design by Open Cosmos, SSERD – WSW2020

# New Space (2 of 2)

Space has become within reach due to lower cost launch opportunities offered by the commercial launch service.



Source: <https://www.futuretimeline.net/data-trends/6.htm>

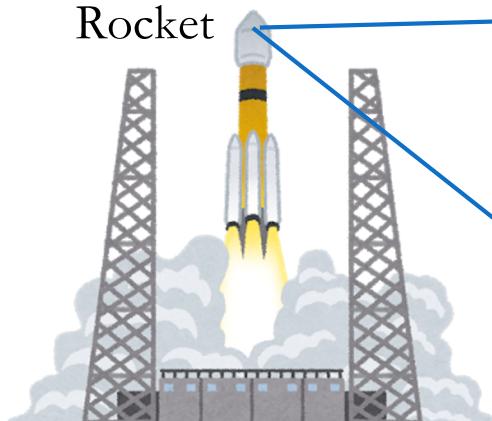


# Launch Services

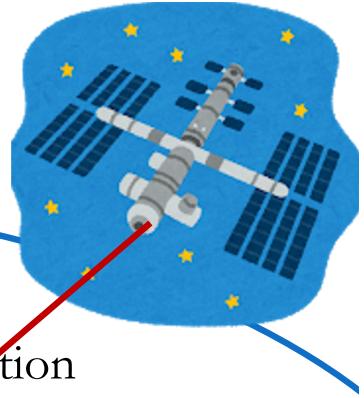
Deploy into orbit



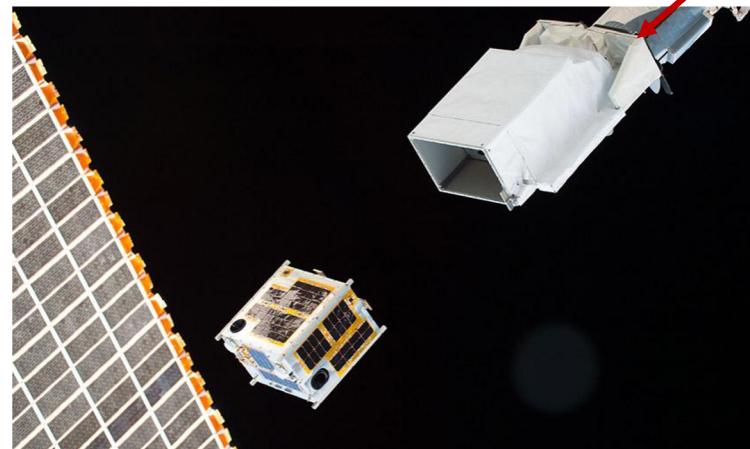
Satellite



International Space Station

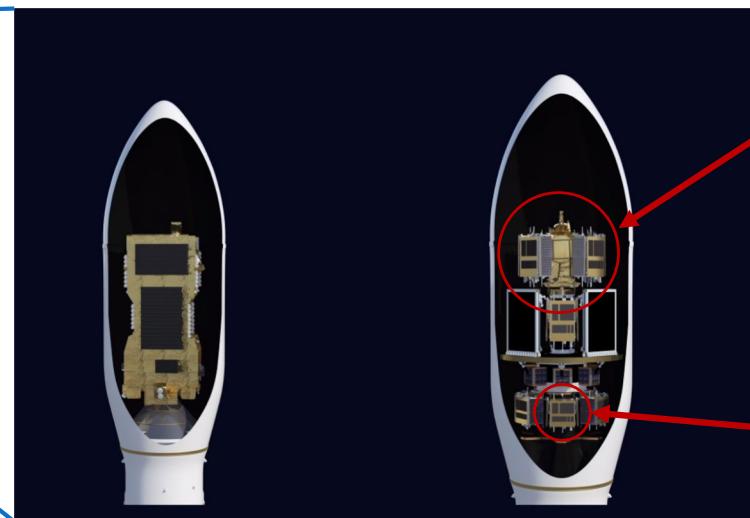


Deploy from International Space Station



Use Rocket Ride-sharing Program

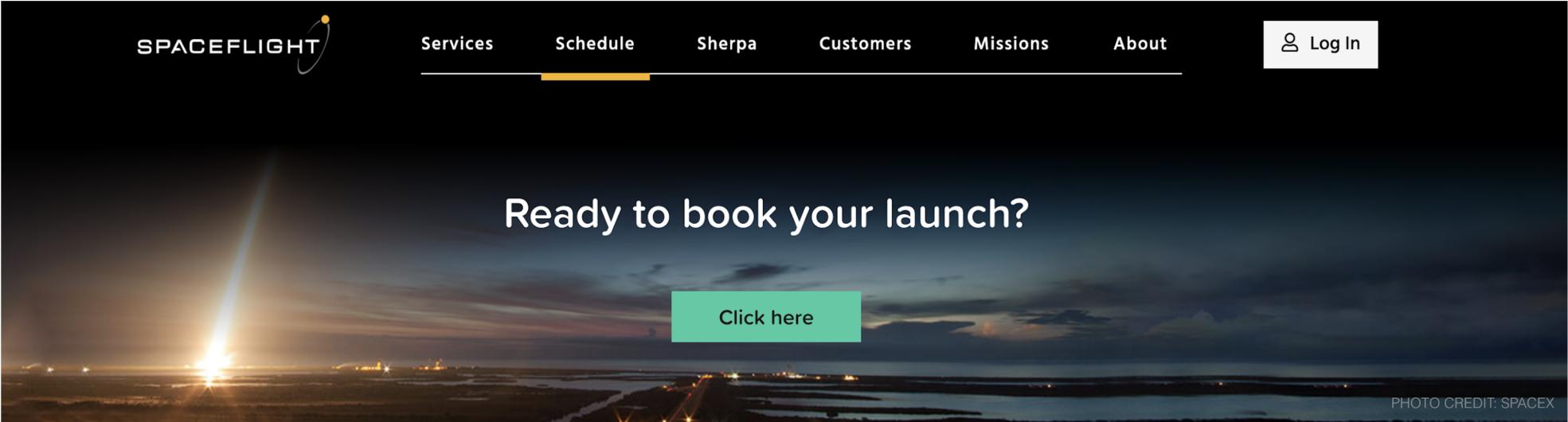
Rocket



Main satellite

Small satellite

# Commercial Launch Service



Ready to book your launch?

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PHOTO CREDIT: SPACEX

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10 of 11 results shown

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**Q1 2023**  
≡ 0% Filled  
U.S. Launch Vehicle

Type: Cubesat & Microsat

Inclination: 51.6°

Altitude: 410km

AVAILABLE NOW ▶

Source: <https://spaceflight.com/#book-my-launch>



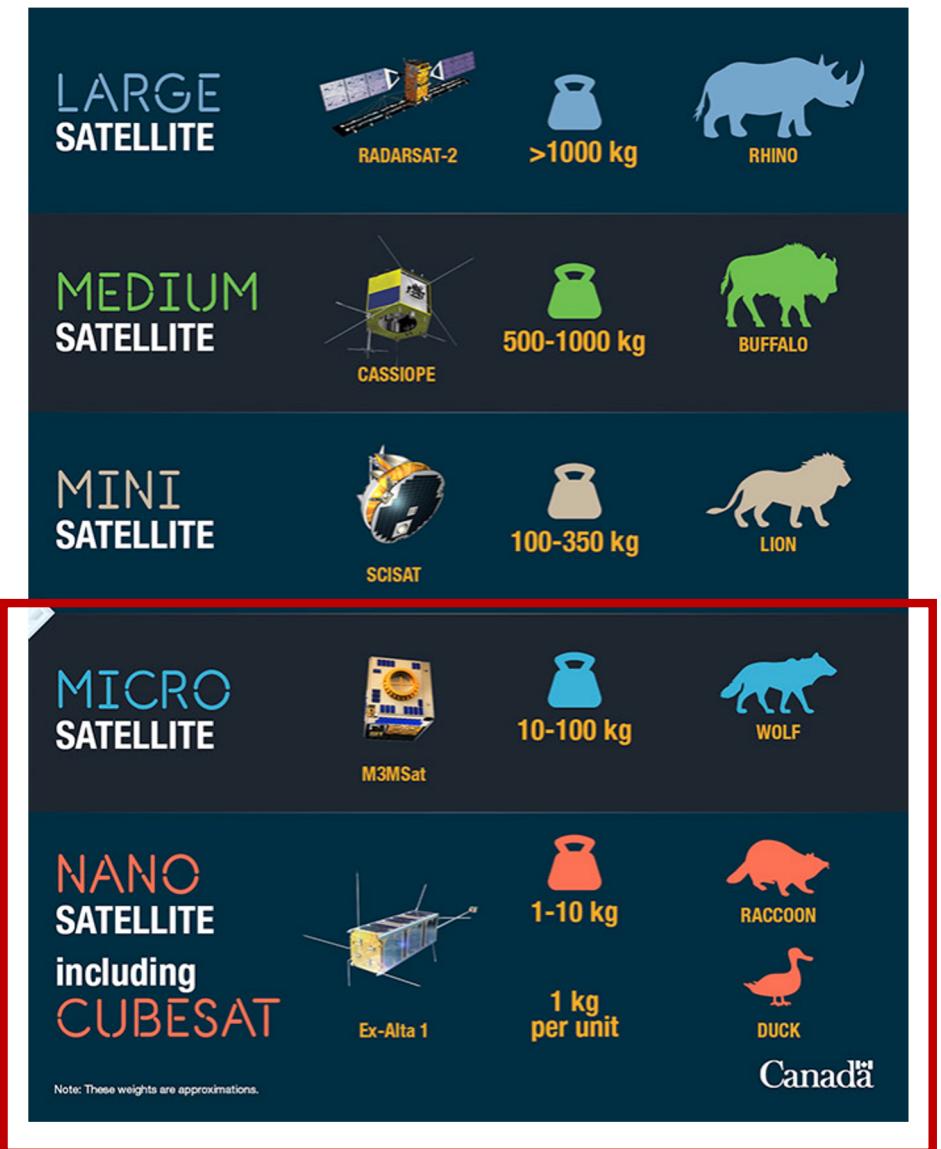
# Agenda

- Introduction to Space
- The Rise of Small Satellite
  - What is Small Satellite?
  - Advantage of Small Satellite
  - Small Satellite Applications
- Space Projects for Education



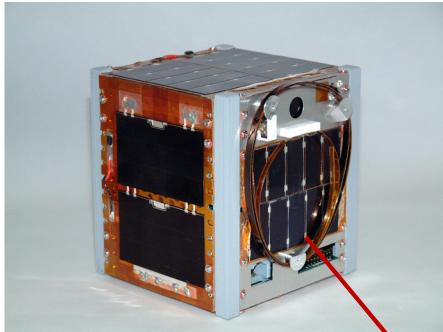
# The Rise of Small Satellite

- Refer to the type of spacecraft weight less than 100 kg
- Small and inexpensive to build and launch
- Revolutionize access to space



Source: <https://www.asc-csa.gc.ca/eng/satellites/cubesat/what-is-a-cubesat.asp>

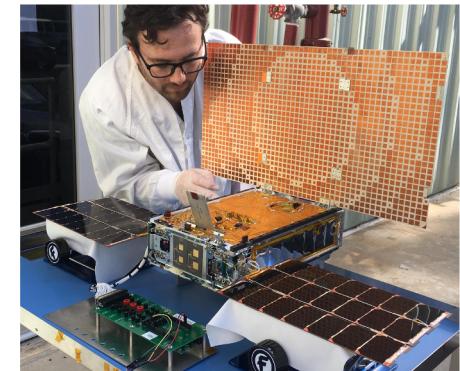
# History



XI-IV (Utokyo)



Planet's Dove (2014)

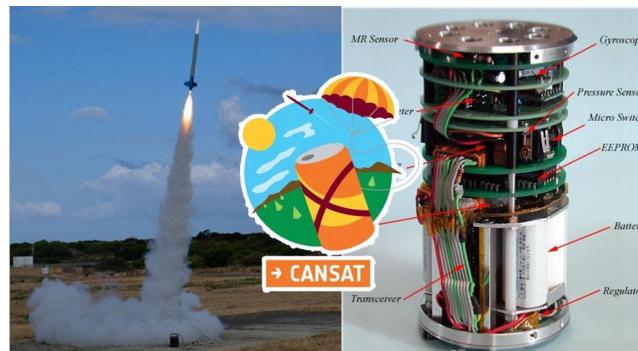


MarCo (2018)

1999 - Education



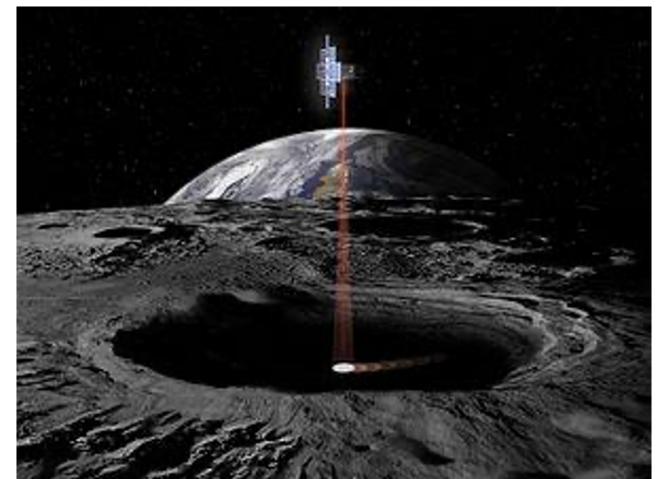
2003 – First CubeSat



2010s - Commercialization



Present – Space exploration  
many other applications



LunarFlashlight (2022)



# Advantages of Small Satellite

## Conventional Satellite



### ALOS-2

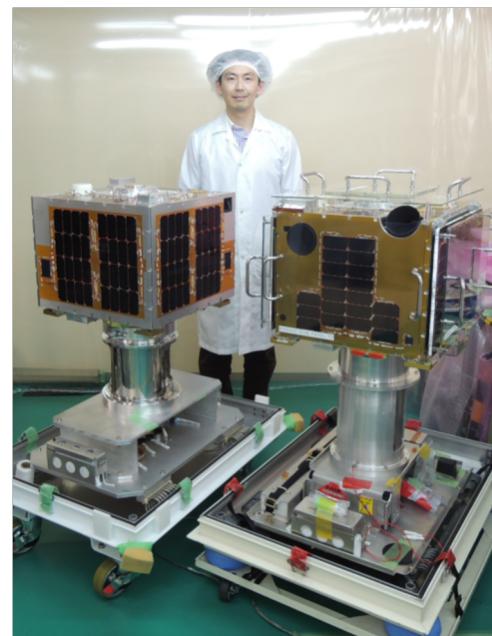
Mass:  
2.1 ton

Cost:  
380 millions

User:  
Government/  
Enterprise

High performance, high cost  
Lengthy development time (10 years)

## Microsatellite



Mass:  
Roughly 50kg

Cost:  
~ 3 millions

User:  
University/Start-up  
Company

Small form-factor, low cost  
Short development time (2-3 years)

### Small satellite advantage:

- Chance for University/start-up company to **create new space business**
- Tackling challenging mission, **demonstrating next generation space system technology**

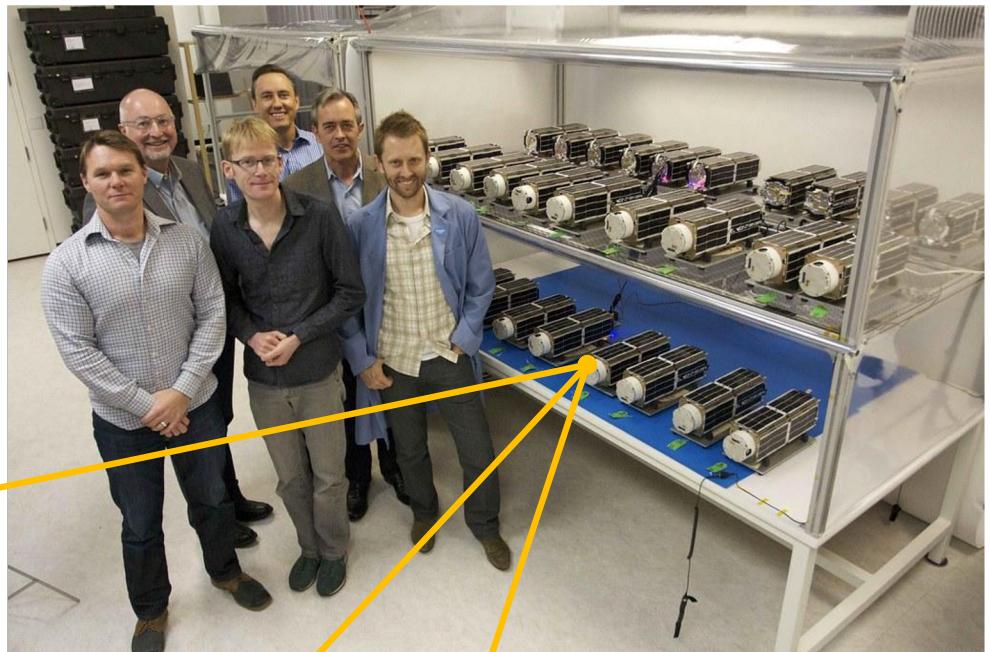
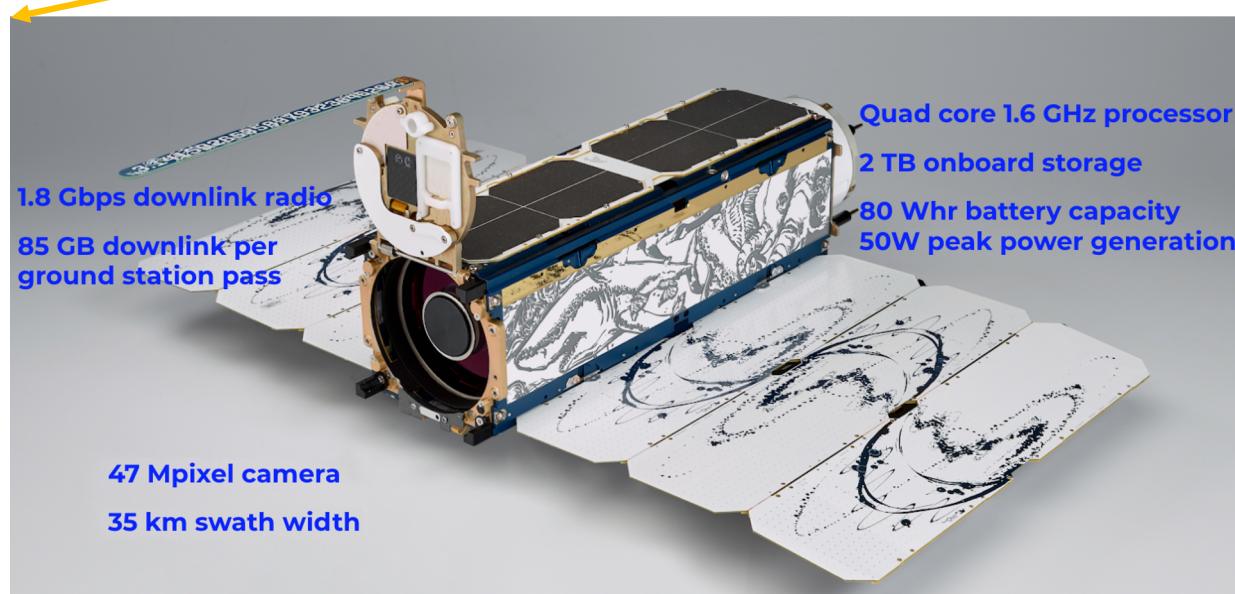
Opportunity for developing countries such as Cambodia to initiate space research and development activities



# Planet's Satellite Constellation - Earth Observation

Goal: to image the entirety of the Earth daily to monitor changes and pinpoint trends

Learn more: <https://www.planet.com/>





## Agriculture

Monitor fields, manage crops, improve yields

[Learn More](#)

## Defense & Intelligence

Understand events, anticipate impacts, respond immediately

[Learn More](#)

## Drought Response

Guide decision-makers for more effective drought preparation and response

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## Government

Map land use, manage resources, monitor urbanization

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## Mapping and GIS

Update GIS data, visualize topographies, enhance UX

[Learn More](#)

## Maritime

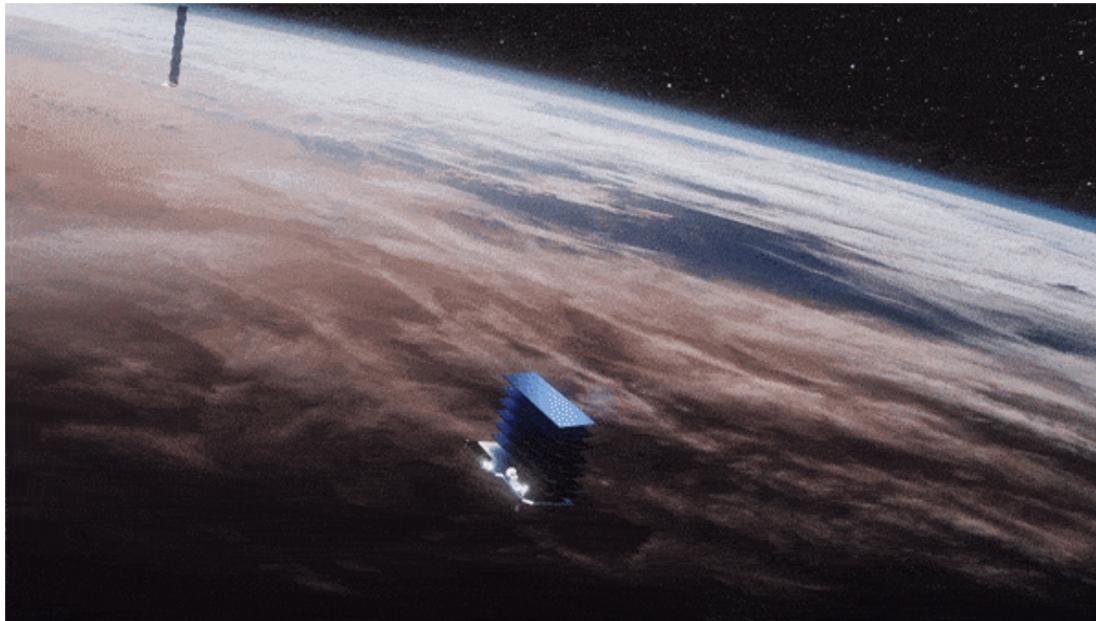
Survey waters, detect vessels, track activity

[Learn More](#)



# SpaceX's Starlink - Connectivity

- Constellation of satellite for providing internet access to places where ground internet infrastructure is not available



# How Starlink works?

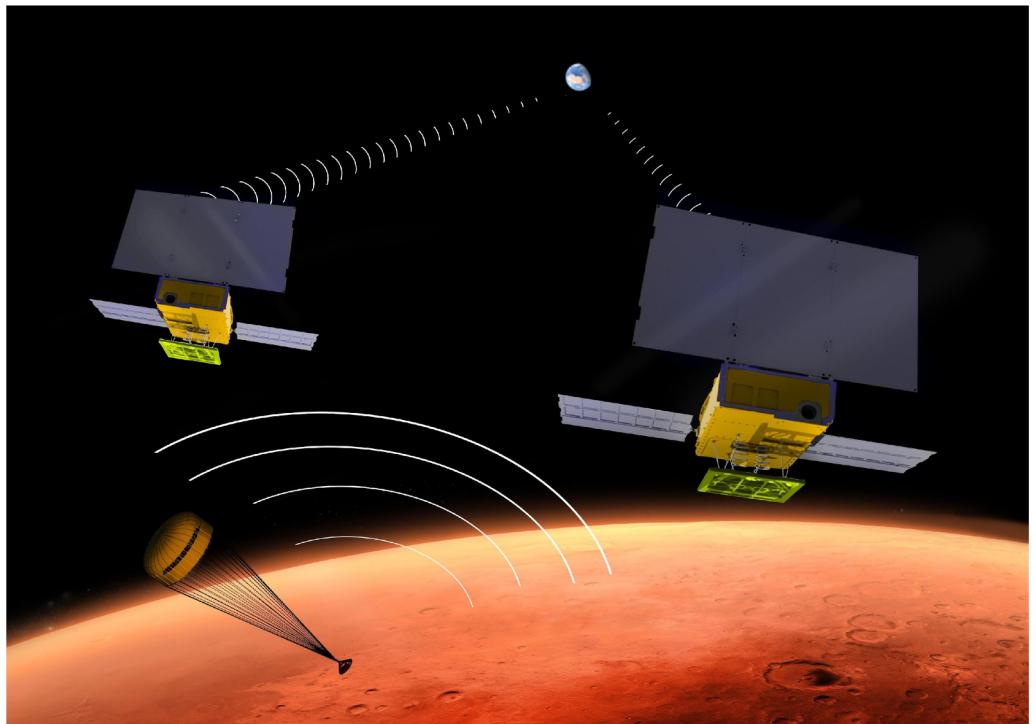
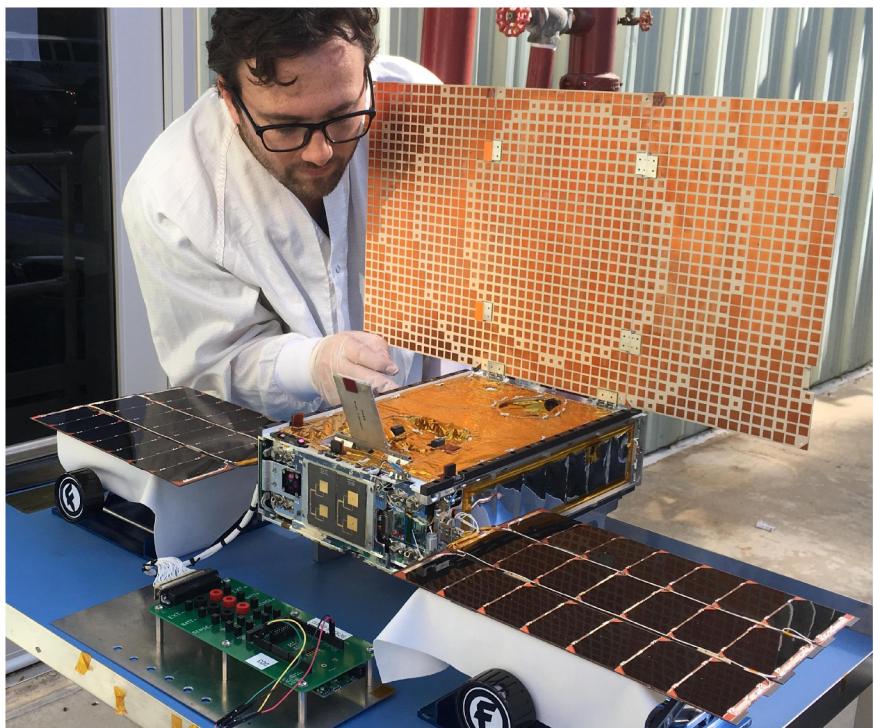


Source: <https://www.youtube.com/watch?v=m05abdGSOxY>



# NASA's MarCO - Space Exploration

Used for testing and demonstration new technology for Space exploration



Learn more: <https://www.jpl.nasa.gov/topics/cubesats>



# National Space Program

Small satellite projects were used to kick-start the space research & development activities in ASEAN

Countries	Small Satellites	Space Agency
Vietnam	PicoDragon, NanoDragon, Microdragon, etc	VNSC (2018)
Philippines	Diwata-I, Diwata-II	PhilSA (2019)



**Diwata-I (2016)**



**PicoDragon (2013)**



**MicroDragon (2019)**



**Diwata-II (2019)**

# Buying a CubeSat

The screenshot shows a dark-themed website for EnduroSat. On the left, a vertical sidebar lists icons for various services: EO, RF, Optical, Thermal Control, Power, Avionics, Structure, Navigation, and Propulsion. The main content area features a large image of a CubeSat module with solar panels. To the right, the text "OUR PRODUCTS" is followed by "CubeSat Modules". Below this, the "CubeSat Platforms" section is shown with three options: "12U CubeSat Platform", "6U CubeSat Platform", and "3U CubeSat Platform", each with its price range. A "CONFIGURE CUBESAT" button is located in the top right corner.

OUR PRODUCTS

## CubeSat Modules

## CubeSat Platforms

Remarkable satellites

12U CubeSat Platform	GET A QUOTE
6U CubeSat Platform	\$ 140,000 – \$ 260,000
3U CubeSat Platform	\$ 95,000 – \$ 170,000

CONFIGURE CUBESAT

Source: <https://www.endurosat.com/cubesat-store/cubesat-platforms/>



# Agenda

- Introduction to Space
- The Rise of Small Satellite
- **Space Projects for Education**
  - CanSat, SatNOGS, CubeSat Training Kit



# Space Projects for Education

Although the access to space become easier, it is still expensive for many countries.

Where shall we start? 🤔

We shall start from **promoting space education** with simple space project and keep the momentum.



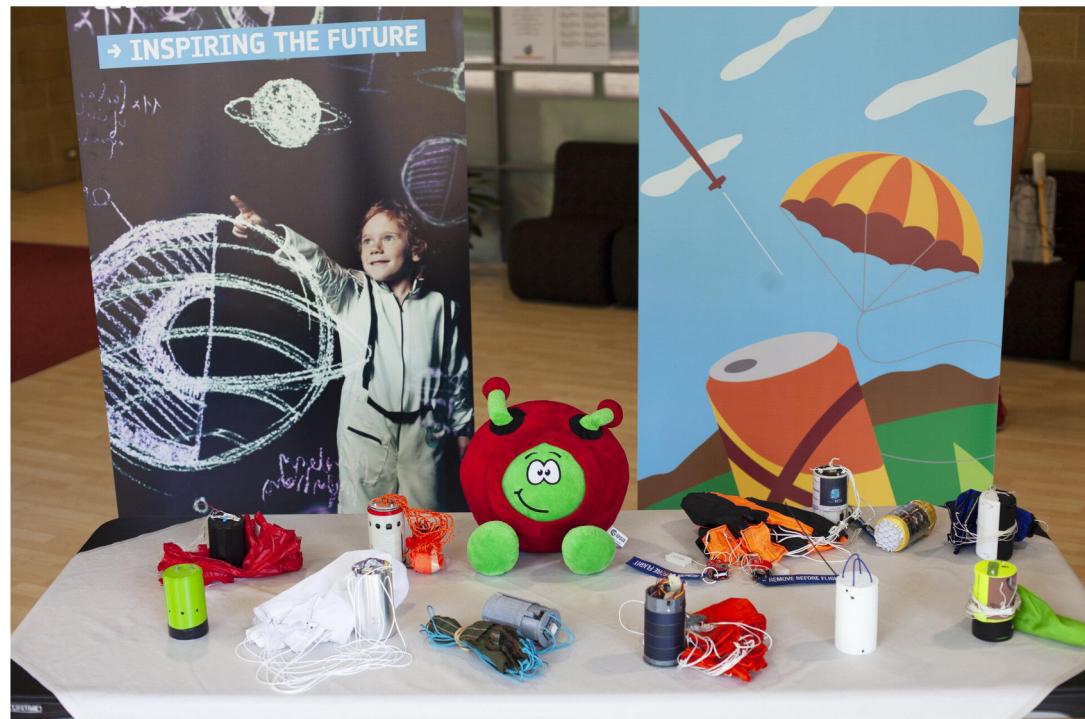


# CanSat

A simulation of a real satellite, integrated within the volume and shape of a soft-drink can.

It is launched to an altitude of a few hundred meters by a rocket or dropped from a platform or captive balloon.

- Level of difficulty: 
- Budget: < 500 USD
- Time spent: < 2 months



Source: [https://www.esa.int/Education/CanSat/What\\_is\\_a\\_CanSat](https://www.esa.int/Education/CanSat/What_is_a_CanSat)

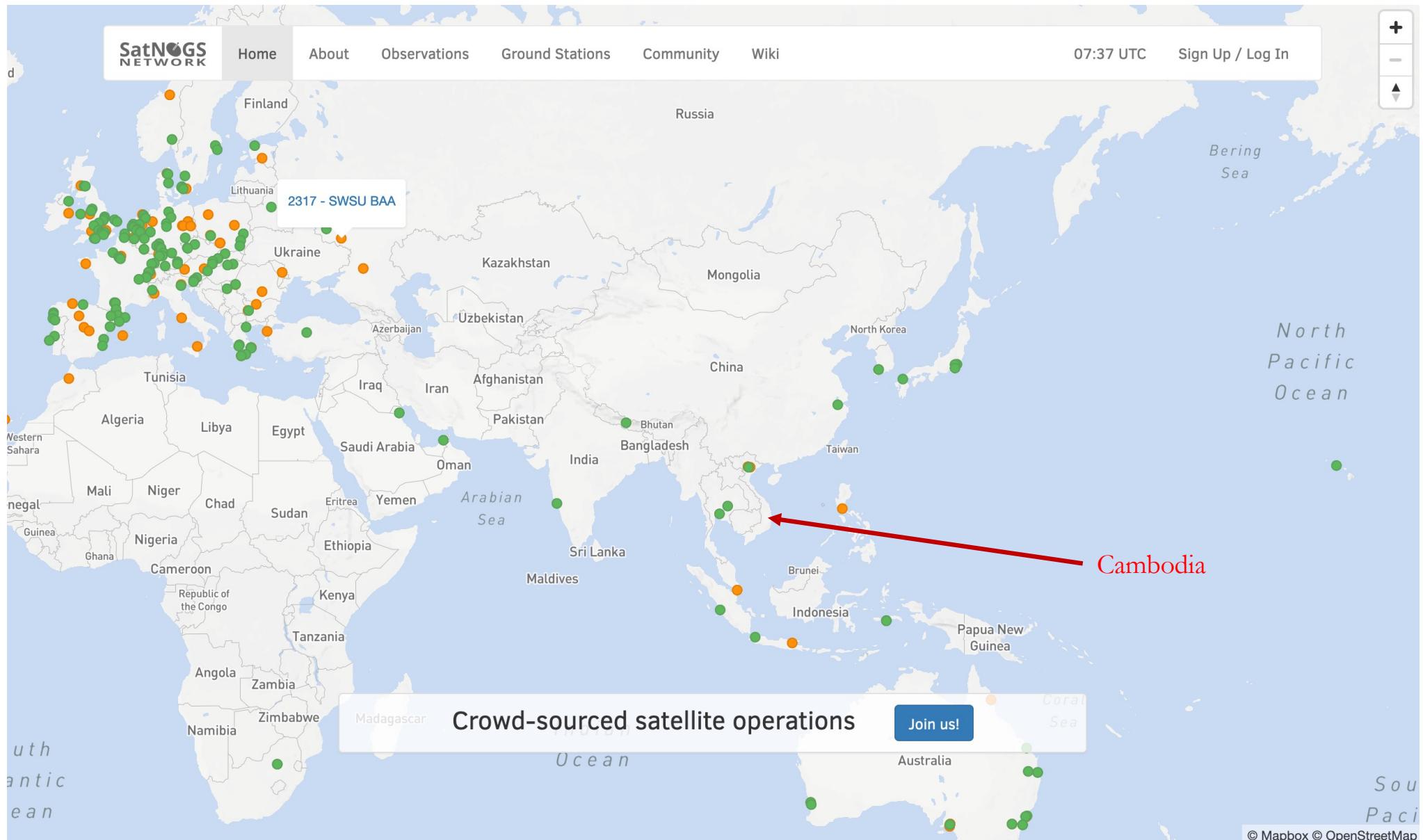


A free software and open-source hardware platform aimed to create a satellite ground station network.

- Level of difficulty: ★★
- Budget: < 2000 USD
- Time spent: 3 - 6 months

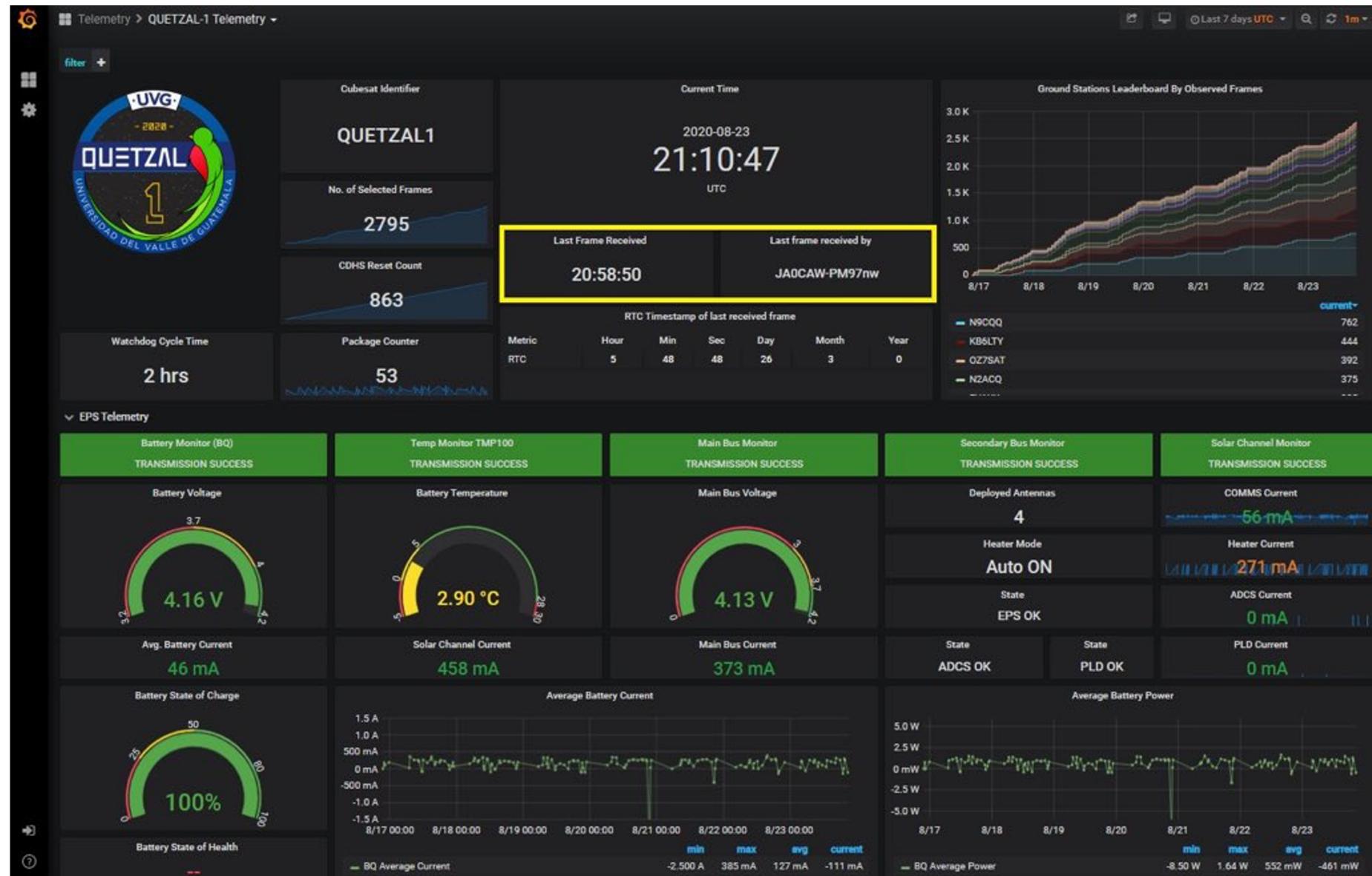


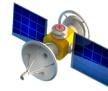
# SatNOGS Network





# SatNOGS Dashboard





# CubeSat Training Kit

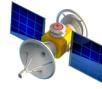
An educational platform with modular subsystem components so student can learn more about CubeSat operations and systems.

It serves to enable training capabilities to the university students.

- Level of difficulty: ★★★
- Budget: < 3,000 USD
- Time spent: 1-2 year



Source: <https://www.polysat.org/projects-1>



# Many others

Ai

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# AiSpace :Challenge™

Advancing Space Exploration with AI

moon camp

AIRBUS FOUNDATION  
In partnership with Autodesk esa

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+ SUBMIT A PROJECT



## Moon Camp Challenge

Moon Camp is an education project run in collaboration between ESA and the Airbus Foundation, in partnership with Autodesk. It uses innovative learning technologies to challenge students to design their own Moon settlement with a 3D modelling tool (Tinkercad or Fusion 360). It features preparatory classroom activities that focus on learning by-design and science experimentation.

SSTL  
Singapore Space & Technology Ltd

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## MISSION ZERO

Young people write a simple program to take a humidity reading onboard the International Space Station and communicate it to the astronauts with a personalised message, which will be displayed for 30 seconds!

1 hour Age 19 and under Suitable for beginners

Mentor sign-up Step-by-step guide





# Conclusion

- **Accessing to space** is no longer limited to wealthy and well-developed countries.
- **Small satellite** revolutionize the access to space and offer opportunity for developing countries such as Cambodia to initiate space research and development activities.
- For promoting space education, space projects like **CanSat**, **SatNOGS**, and **CubeSat Training Kit** is a good starting pointing.

Thank you for your attention.