SpaceX’s Starship: Transportation System for the Moon and Mars

Miami Valley Astronomical Society | Jerry Black | April 10, 2026

Revolutionizing Space Transportation

- Taking space transportation to a whole new level
- First fully reusable orbital launch vehicle
- Largest and most powerful by far
- Most versatile – 2nd stage can land people or cargo or the Earth, Moon, or Mars
- Will enable cities on the Moon and on Mars

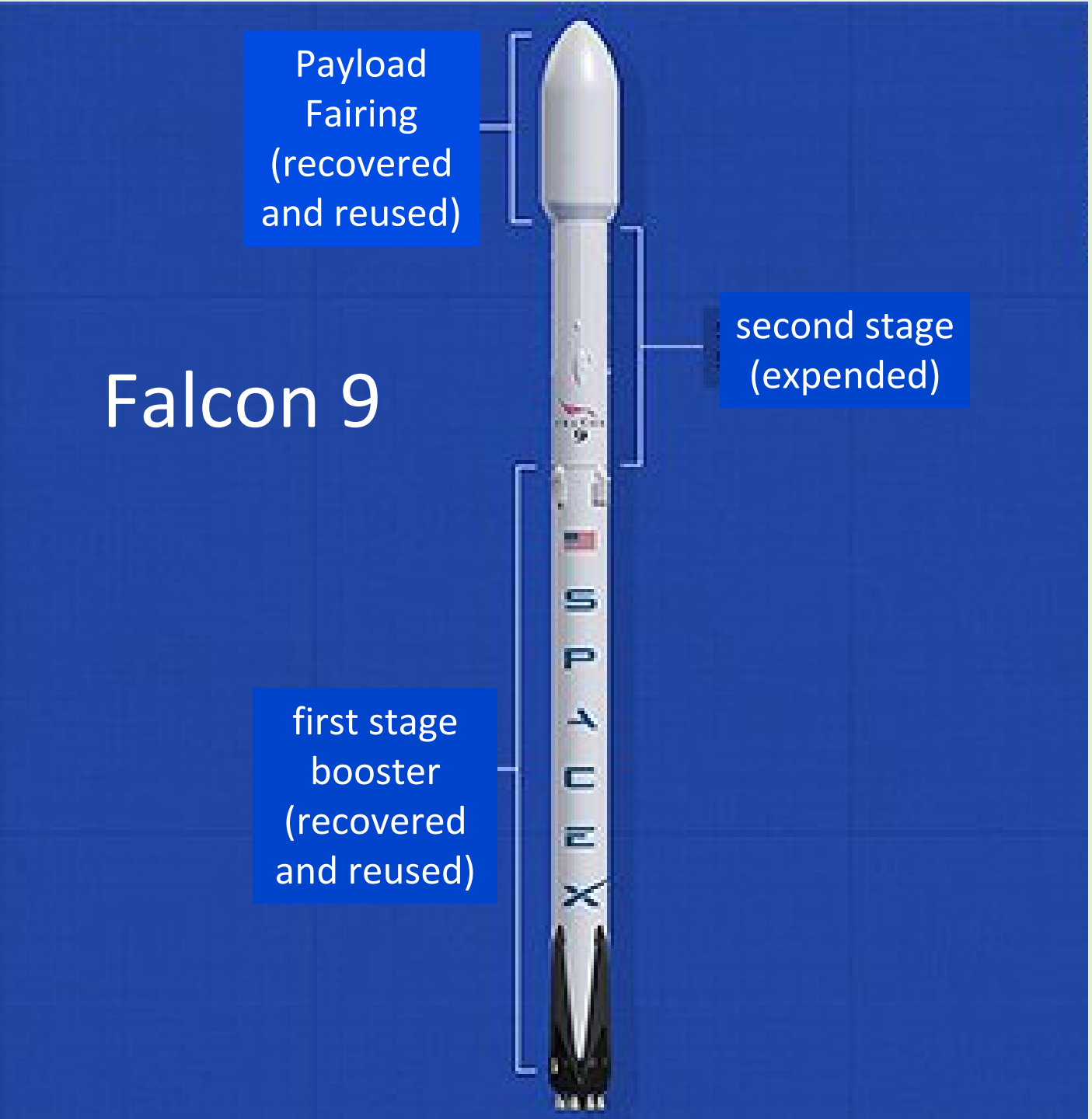
Elon Musk

- Billionaire, inventor, innovator, engineer
- Polarizing figure
  - Purchased Twitter, then renamed it to X
  - 237 million followers on X
  - Helped elect Trump
- Immigrant - born and grew up in South Africa
- Brilliant and visionary entrepreneur
- Tesla and SpaceX have been hugely successful
- Thomas Edison of our time

In Pursuit of Reusability

Falcon 9

- First flown in 2010
- First cost-effective partially reusable orbital launch vehicle
- Much less expensive than any expendable orbital launch vehicle



Reusability Why It Matters

- Propellant cost only .3%
- Remaining cost is almost entirely the launch vehicle
- Discarded after one flight
- First stage most important (70% of the vehicle cost)
- First stage and payload fairing are recovered

Reusability
Why It Matters

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Payload Fairing Recovery

Reusability
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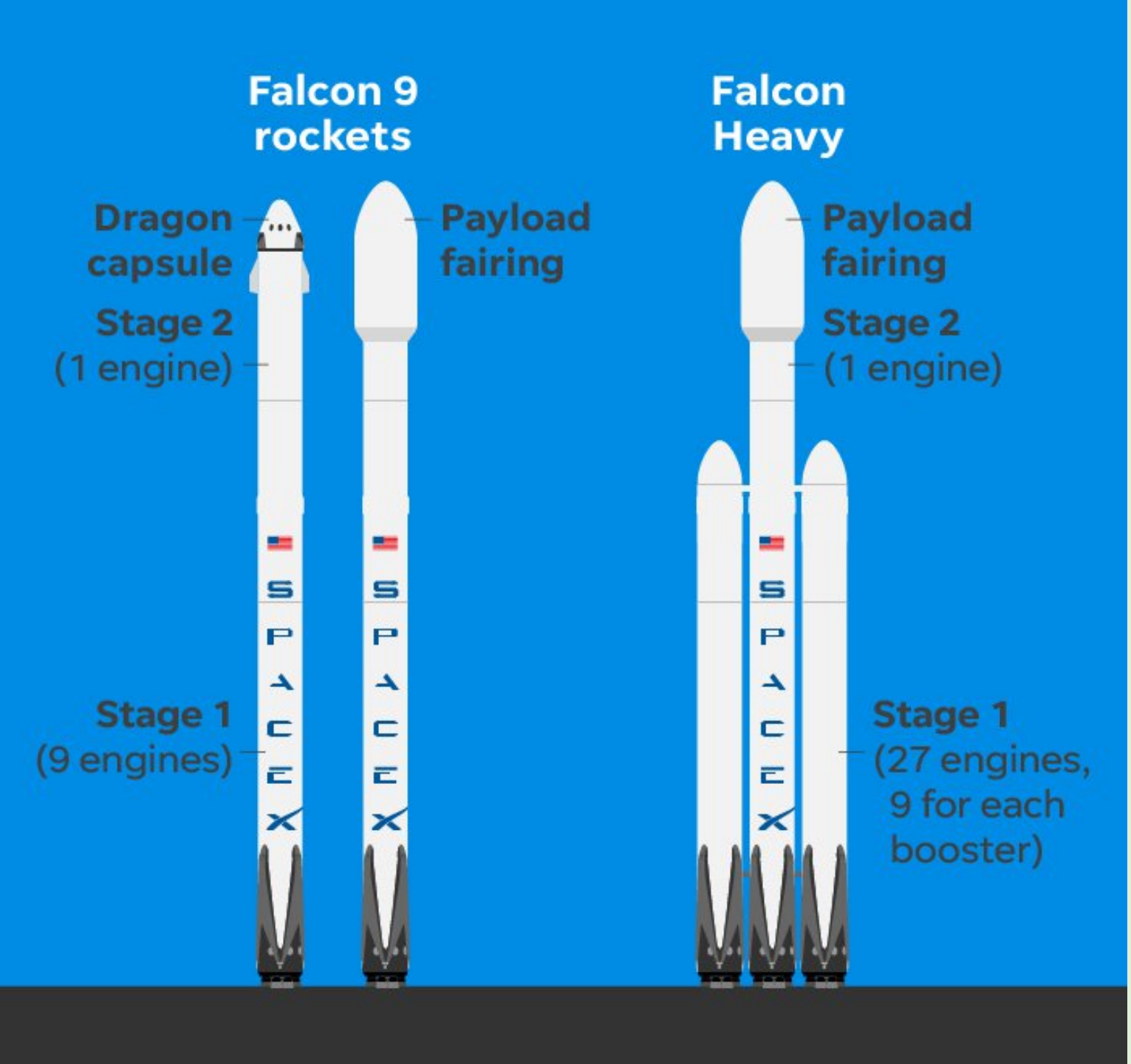
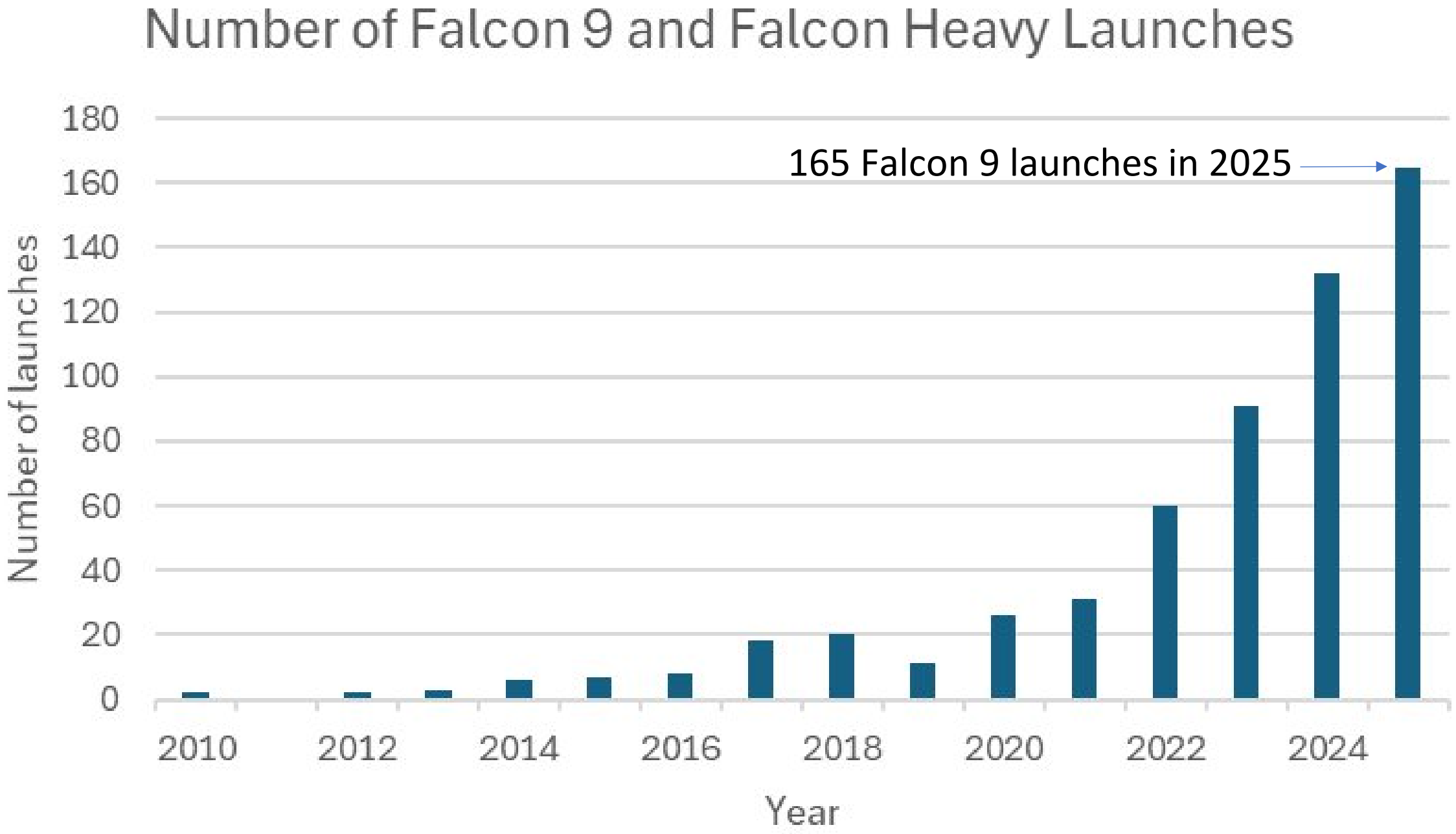
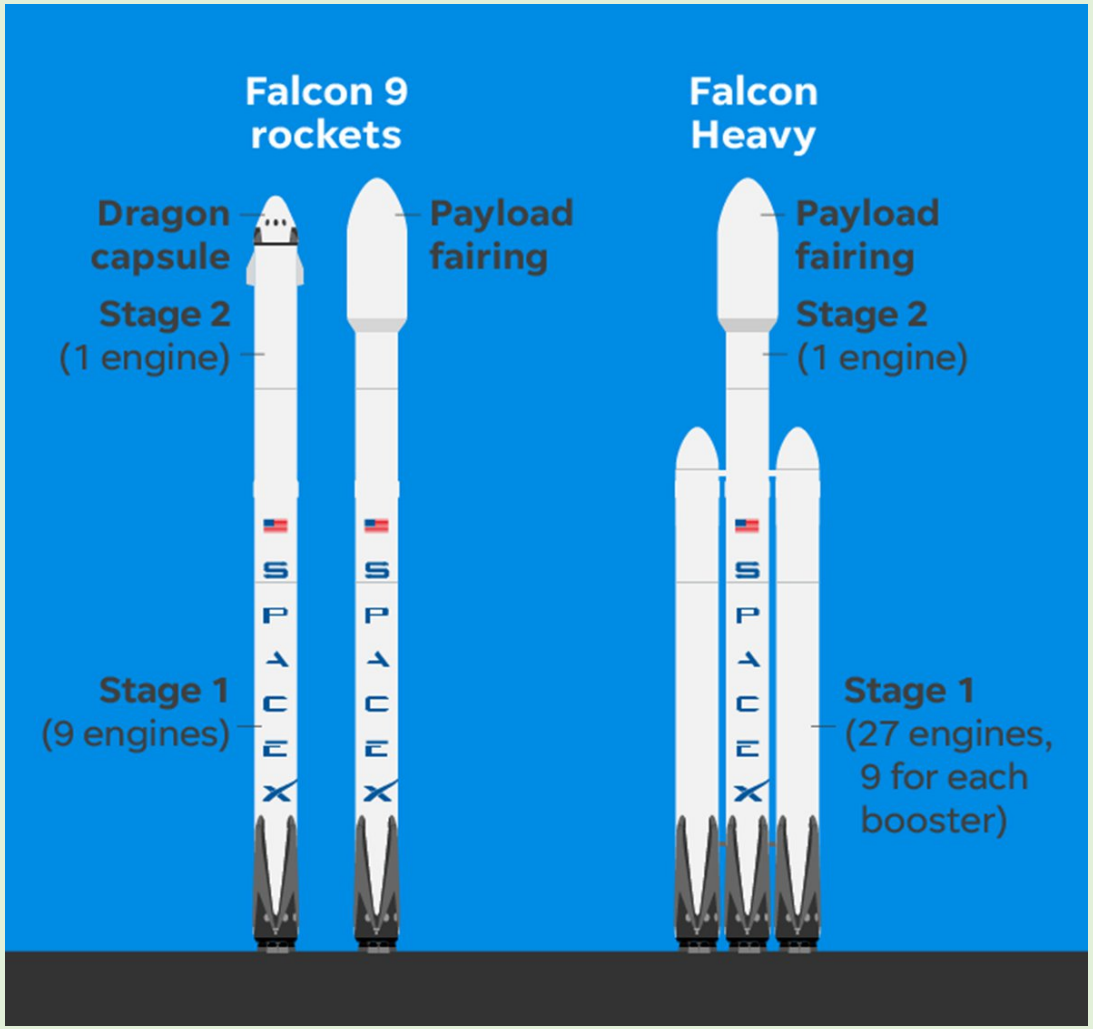


Current Operational SpaceX Launch Vehicles

- Falcon 9
  - Cargo or crew to ISS aboard SpaceX's Dragon spacecraft
  - Satellites and science missions
- Falcon Heavy
  - 3 times the payload weight capability of the Falcon 9
  - The two side mounted boosters are reused

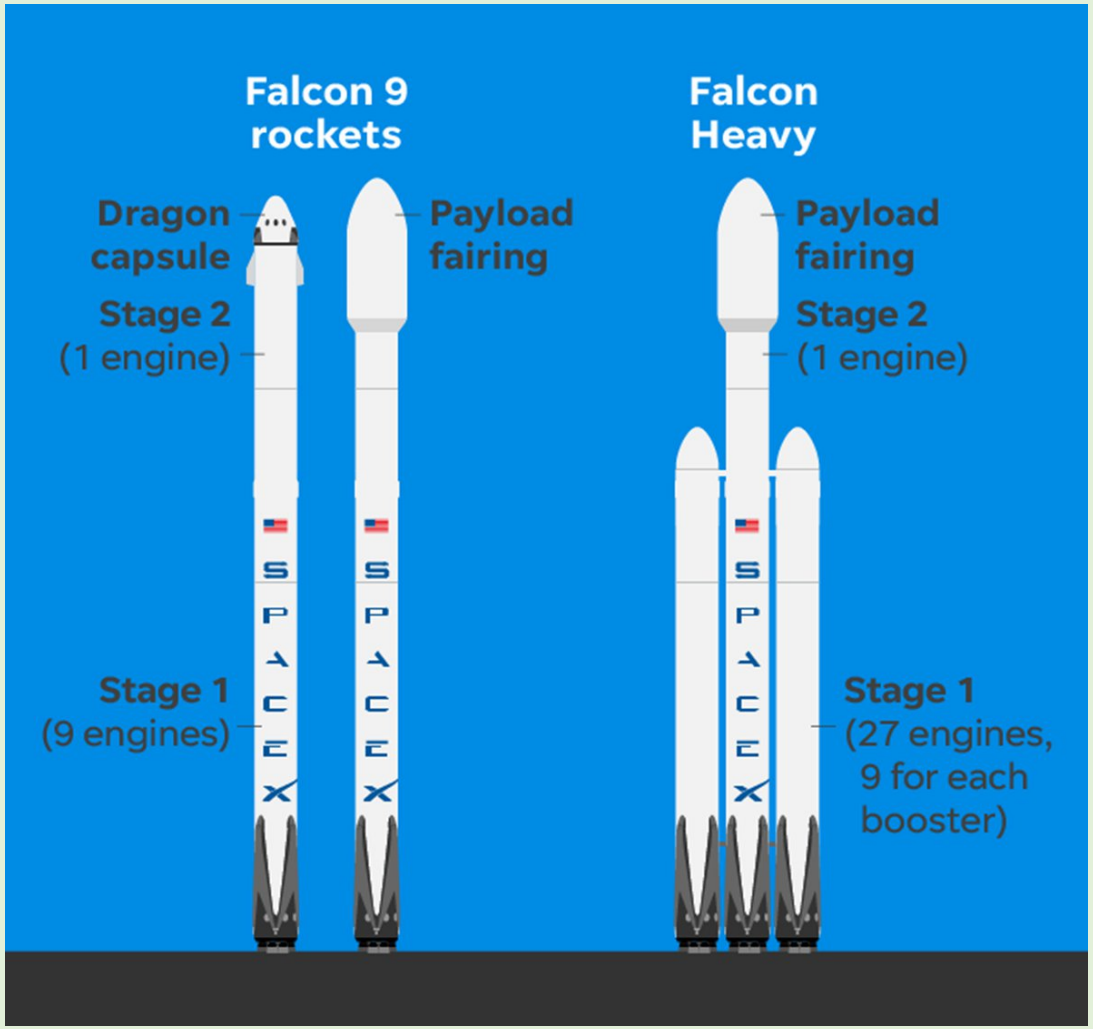

Number of Falcon 9 and Falcon Heavy Launches
165 Falcon 9 launches in 2025
Number of launches
180
160
140
120
100
80
60
40
20
0
2010
2012
2014
2016
2018
2020
2022
2024
Year

The Falcon 9 and Falcon Heavy have been enormously successful



- The Falcon 9 has had over 630 launches to orbit or beyond. Only 3 failed.
- The Falcon 9 achieved 335 consecutive launches without a failure.
- All 11 Falcon Heavy launches successful
- Achieved 267 consecutive landings of F9 or FH boosters without a failure
- In November of 2025 Blue Origin's New Glenn rocket became the only other partially reusable launch vehicle. China may follow soon.

The Falcon 9 and Falcon Heavy have been enormously successful

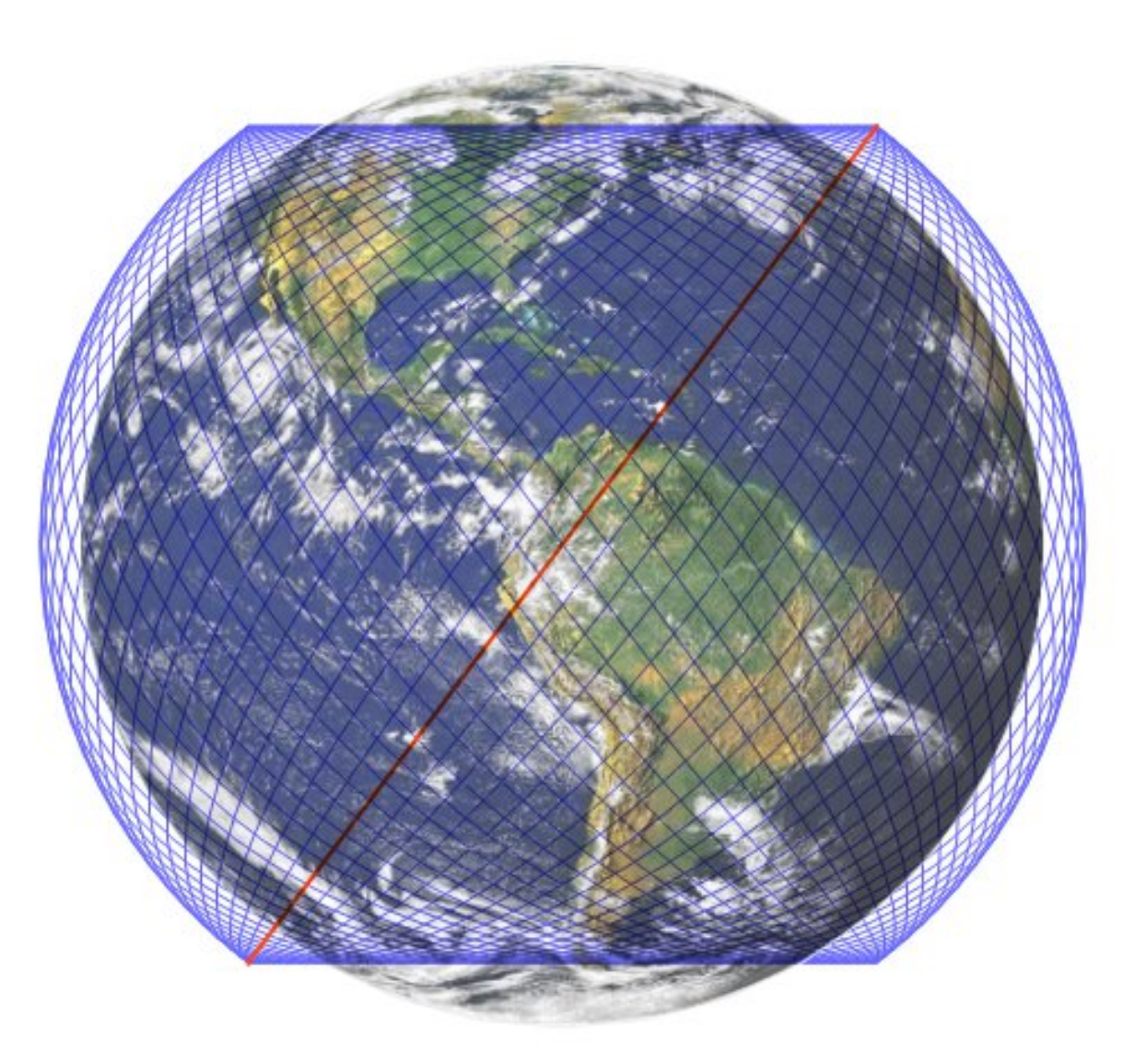


- SpaceX charges the lowest launch prices in the industry
- In the past year SpaceX accounted for more than 80% by weight of all the payloads launched into earth orbit or beyond
- They are winning the lion's share of the worldwide launch market
- Disruptive effect on the launch industry

Starship

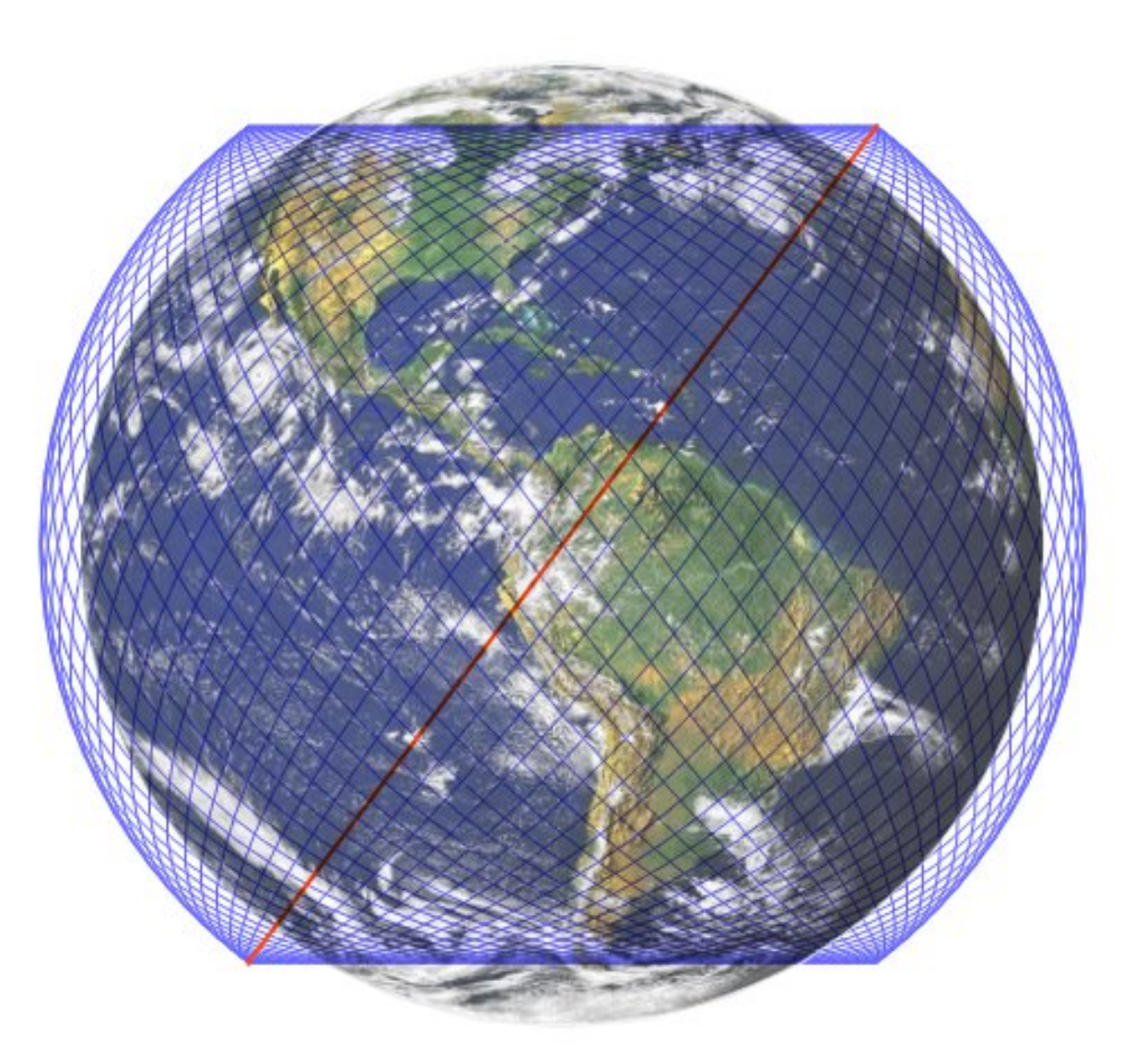
- First orbital launch vehicle that is fully reusable
- Cost will be less than that of the Falcon 9 and Falcon Heavy
- Will replace the Falcon 9 and Falcon Heavy
- Once proven safe to carry humans, it would also replace SpaceX’s Dragon spacecraft

Starlink Satellites: Revenue Source for Starship Development

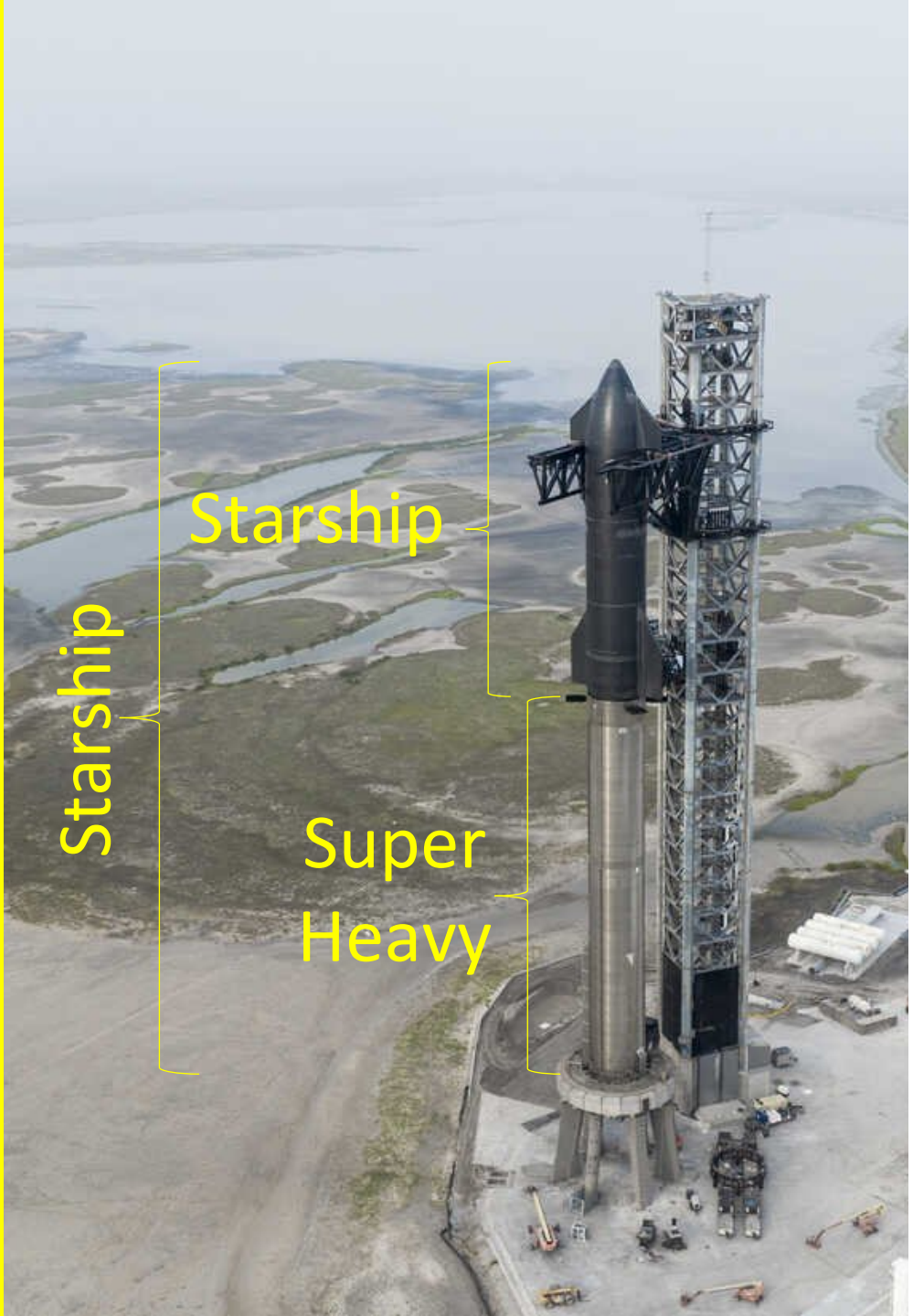


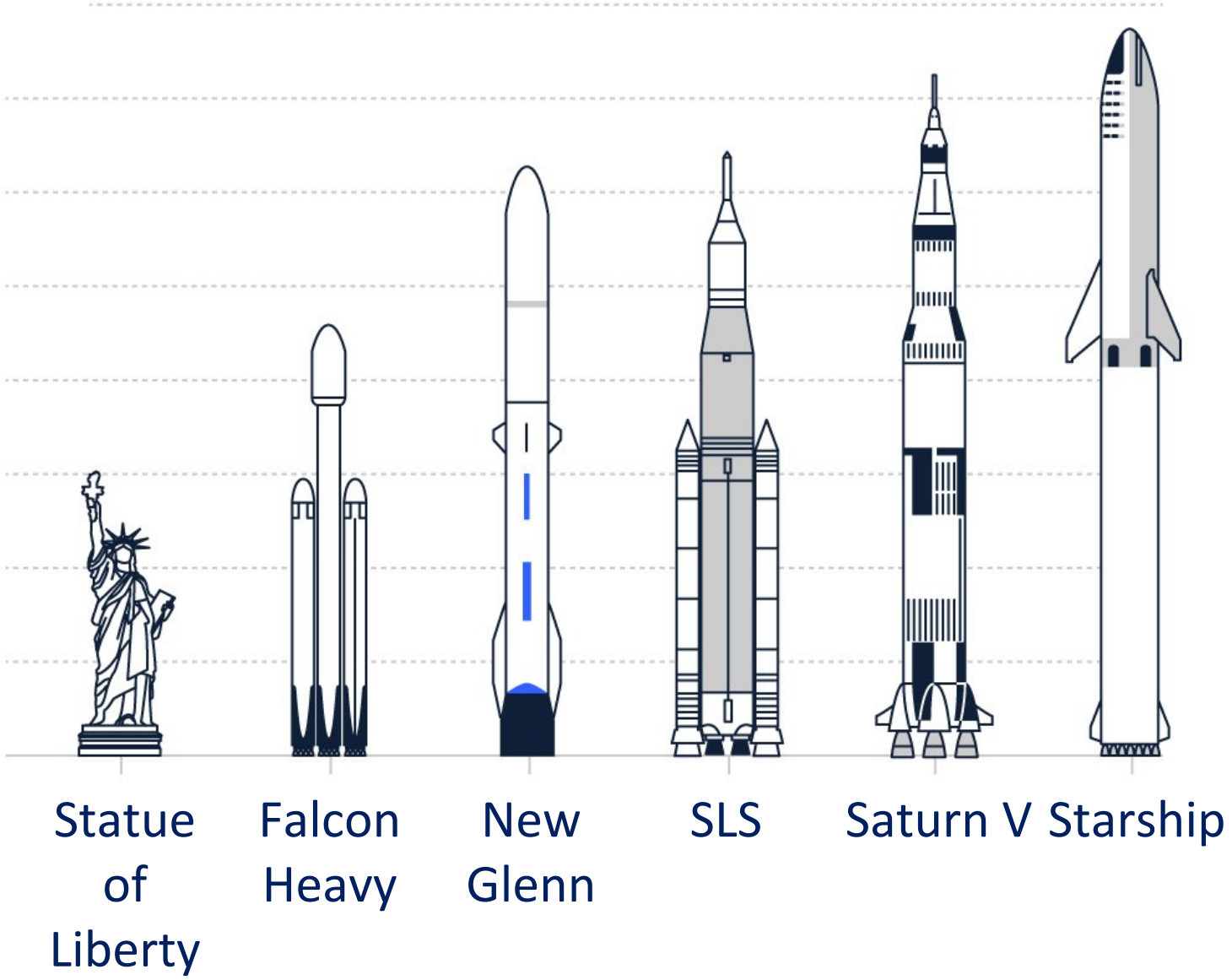
- SpaceX is mass-producing Starlink communication satellites
- 2/3 of the Falcon 9 launches last year were for Starlink satellites
- 10,000+ functional Starlink satellites in orbit (at least 15,000 planned)
- Providing internet access and cell phone service worldwide, including remote regions
- Great benefit for poor countries such as Africa

Starlink Satellites: Revenue Source for Starship Development

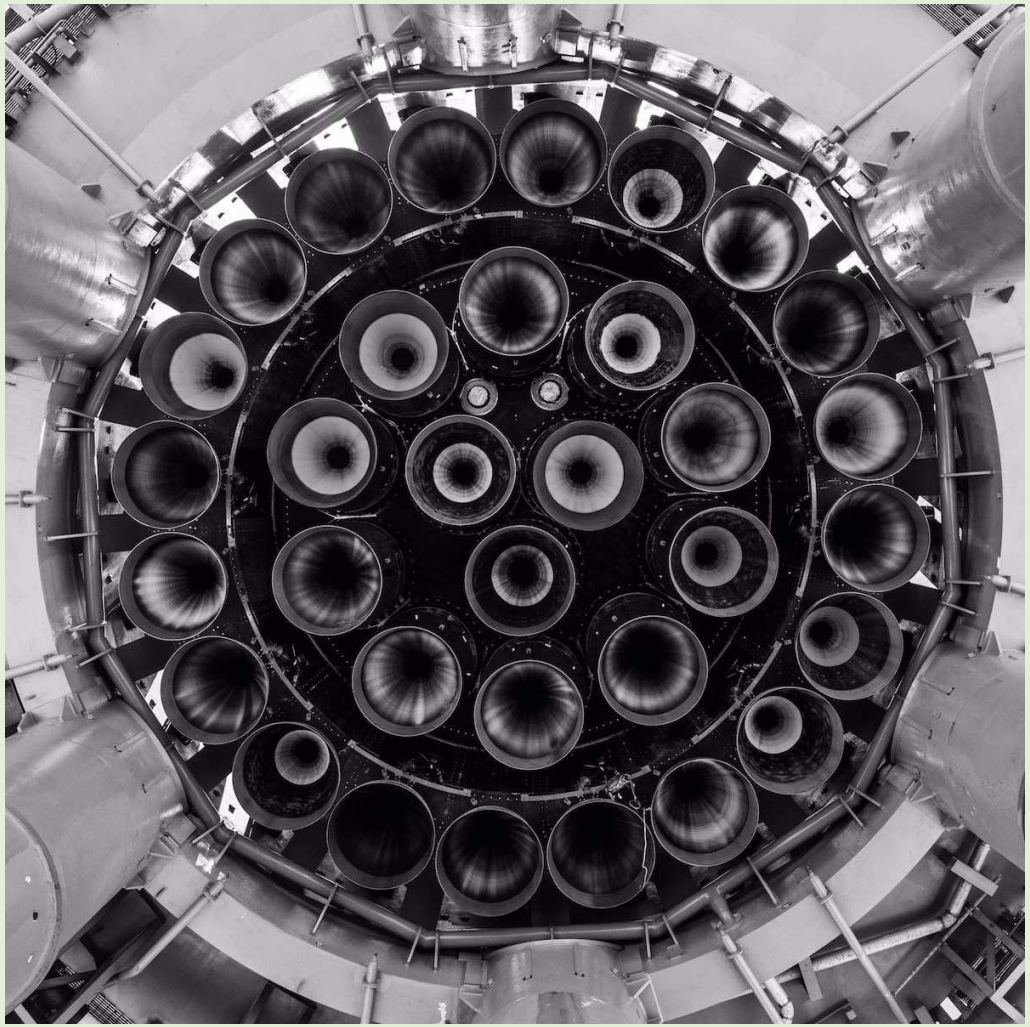


- Starlink is SpaceX’s most profitable division by far
- Over 10 million subscribers worldwide - up from 4.6 million at the end of 2024 and rapidly increasing
- SpaceX’s revenue for 2026 will exceed the entire NASA budget (about $24 billion)
- Starlink revenue is funding Starship development, and that will help fulfill Musk’s goal of making life multiplanetary


Starship
Starship
Super
Heavy


Statue of Liberty
Falcon Heavy
New Glenn
SLS
Saturn V
Starship

Super Heavy
(1st stage of Starship)



The Starship (2nd stage)

- Four fins for aerodynamic control
- Several possible versions
  - Cargo and crew Earth orbit
  - Cargo and crew lunar landers
  - Cargo and crew Mars landers
  - Fuel depot and tankers
  - Space Station

The Starship 2nd stage

- Can land on:
  - Earth
  - Moon
  - Mars
  - Other (Europa, etc.)
- With orbital refueling can land 100+ tons of cargo or 100 people on the surface of Moon or Mars

Trips to Texas for the first two launches of the Starship April and November of 2023

Starbase

- The site where starships are built and launched
- SpaceX is the owner
- One of the first commercial spaceports for orbital launches
- Charles Knecht, Doug Plata and Jerry Black


GATEWAY TO MARS


I'd go.


I'd go.

Second Texas Trip
November, 2023

- Shared a hotel room with John Strickland
- Photo of Jerry and John the day before the second Starship launch

Rocket Garden at Starbase

The Shipyard

- Two large buildings are called megabays - where the starships are currently assembled
- A Starfactory has been constructed
- gigabay under construction
- Plan to build more than 1 starship per day
- Many launches every day
- Starlink satellites, orbiting data center satellites, cities on the Moon and Mars

Mechazilla Launch Tower

- Chopsticks open and close, move up and down and rotate side to side
- Chopsticks lift Super Heavy atop orbital launch mount
- Chopsticks lift Starship atop Super Heavy
- Chopsticks catch Super Heavy and Starship after each flight

Chopsticks lift Super Heavy onto the orbital launch mount

Chopsticks lift Starship atop the Super Heavy

Starship flights of Complete Vehicle

- 2 in 2023, 4 in 2024, 5 in 2025
- Suborbital trajectory, just short of orbital velocity, most second stages attempting a soft landing in the Indian ocean
- No payloads – only purpose was to collect data on vehicle performance
- SpaceX’s philosophy is to test often, that way quickly find and fix the problems
- Some failures, but also some successes
- Succeeded in catching the first stage on 2 flights (one reused)
- Soft landed second stage in the Indian ocean on 5 flights

Starship flights of Complete Vehicle

- Flight 12 scheduled for the first half of May (still suborbital)
- If flight 12 succeeds, flight 13 may be the first orbital flight, and they may attempt to recover both stages
- Orbital refueling test planned for later this year
- New gigabays and more launch pads in both Texas and Florida completed by end of this year
- Expect big increase in launch rate in 2027

Flight 5 Video:

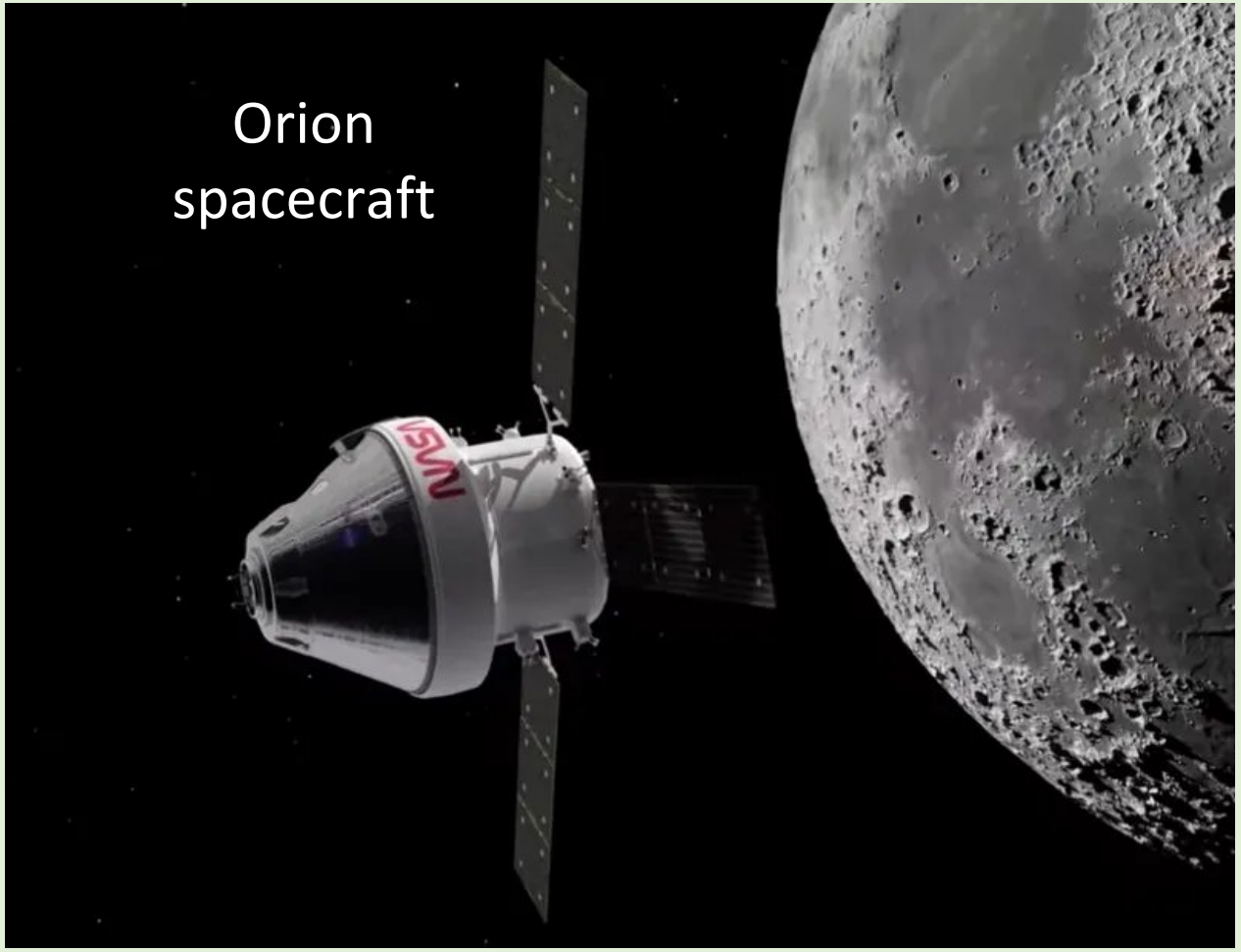
1. Launch
2. Catch of first stage by the chopsticks on the Meckazilla launch tower
3. Soft landing of 2nd stage in the Indian ocean

Space Launch System (SLS)

NASA's Space Launch System (SLS)

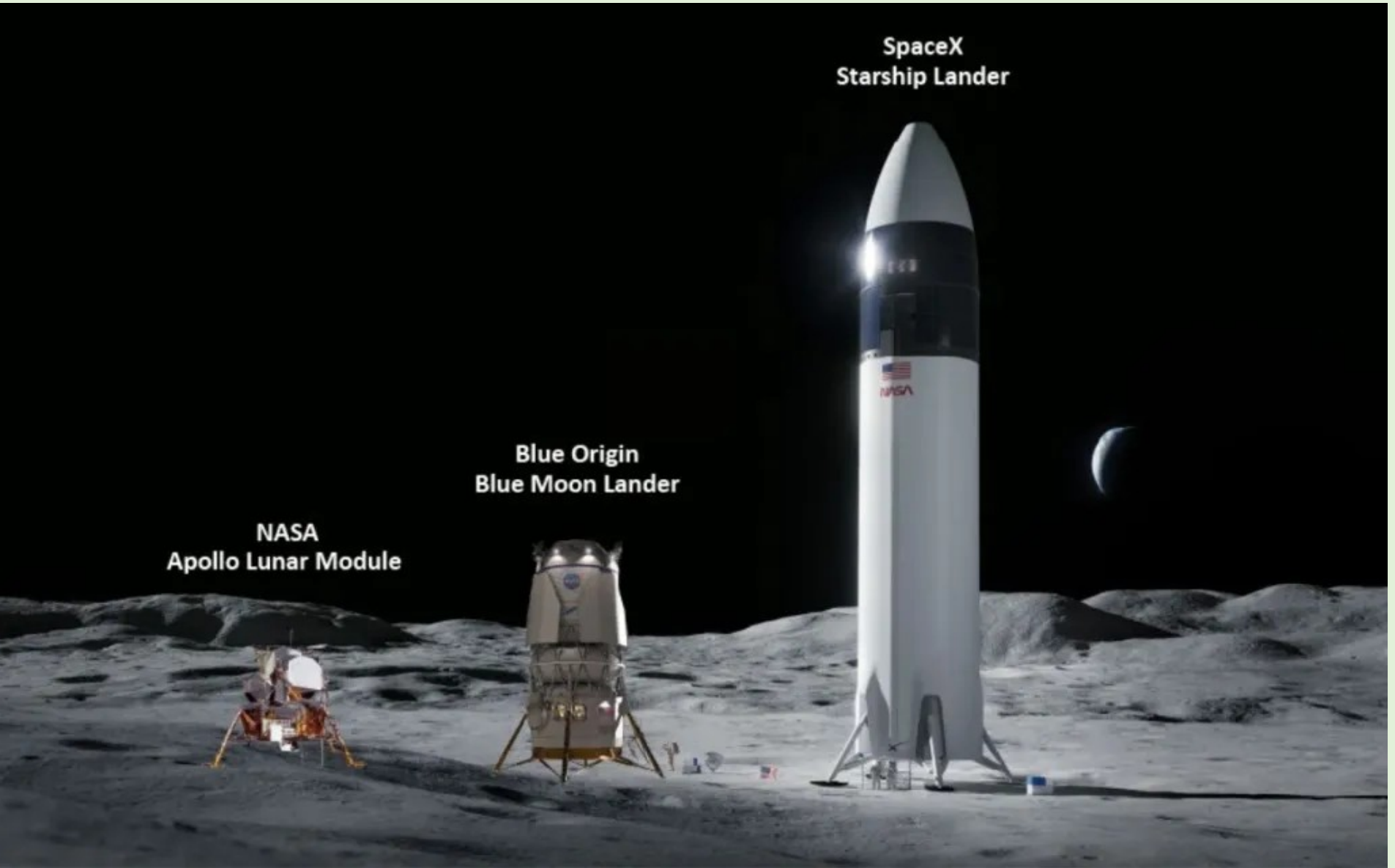
- Not as capable as the Starship
- Expendable
- SLS cost: $4.2 billion per launch initially
- Starship cost: $40 million per launch initially
- First launch November of 2022 (Artemis 1)
- Second launch April of 2026 (Artemis 2)

Artemis Program: Humans returning to the Moon



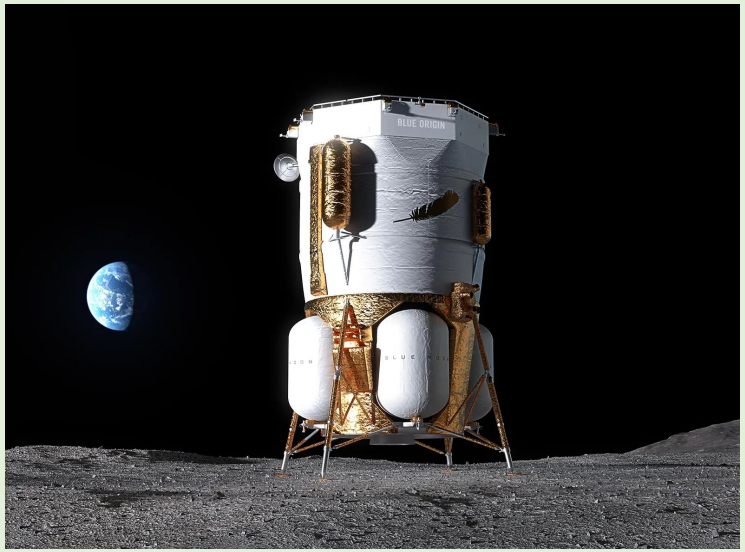
- Artemis 1 (November 2022): The SLS launched an uncrewed Orion spacecraft around the Moon and back
- Artemis 2 (April 2026): The SLS launched a crew of 4 on the Orion spacecraft around the Moon and back.

Two U.S. Lunar Human Landing Systems



- Competition to build crewed lunar landers
- SpaceX (modified version of Starship second stage)
- Blue Origin –Blue Moon
- Apollo Lunar Module shown for reference

Orion Spacecraft

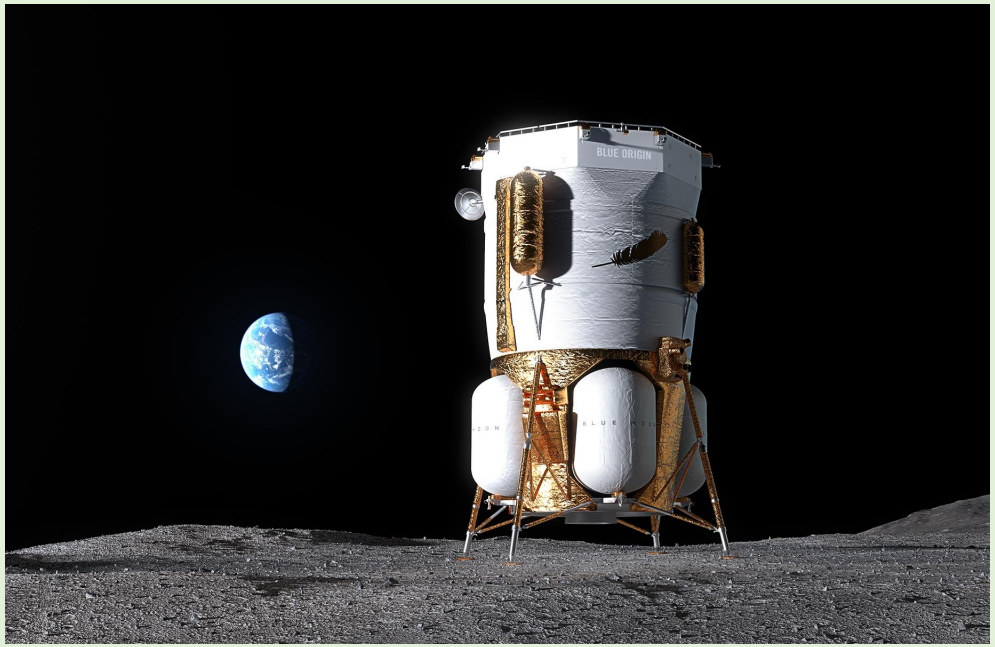


Blue Moon Lander

Starship Lander

Artemis 3 Mission

- Will test Orion and one or both landers in Earth orbit
- SLS will launch the Orion; lander(s) launched separately
- Practice rendezvous, docking, test fly the lander, etc.
- Repeat with the other lander if it is ready in time
- Goal is to launch in mid-2027



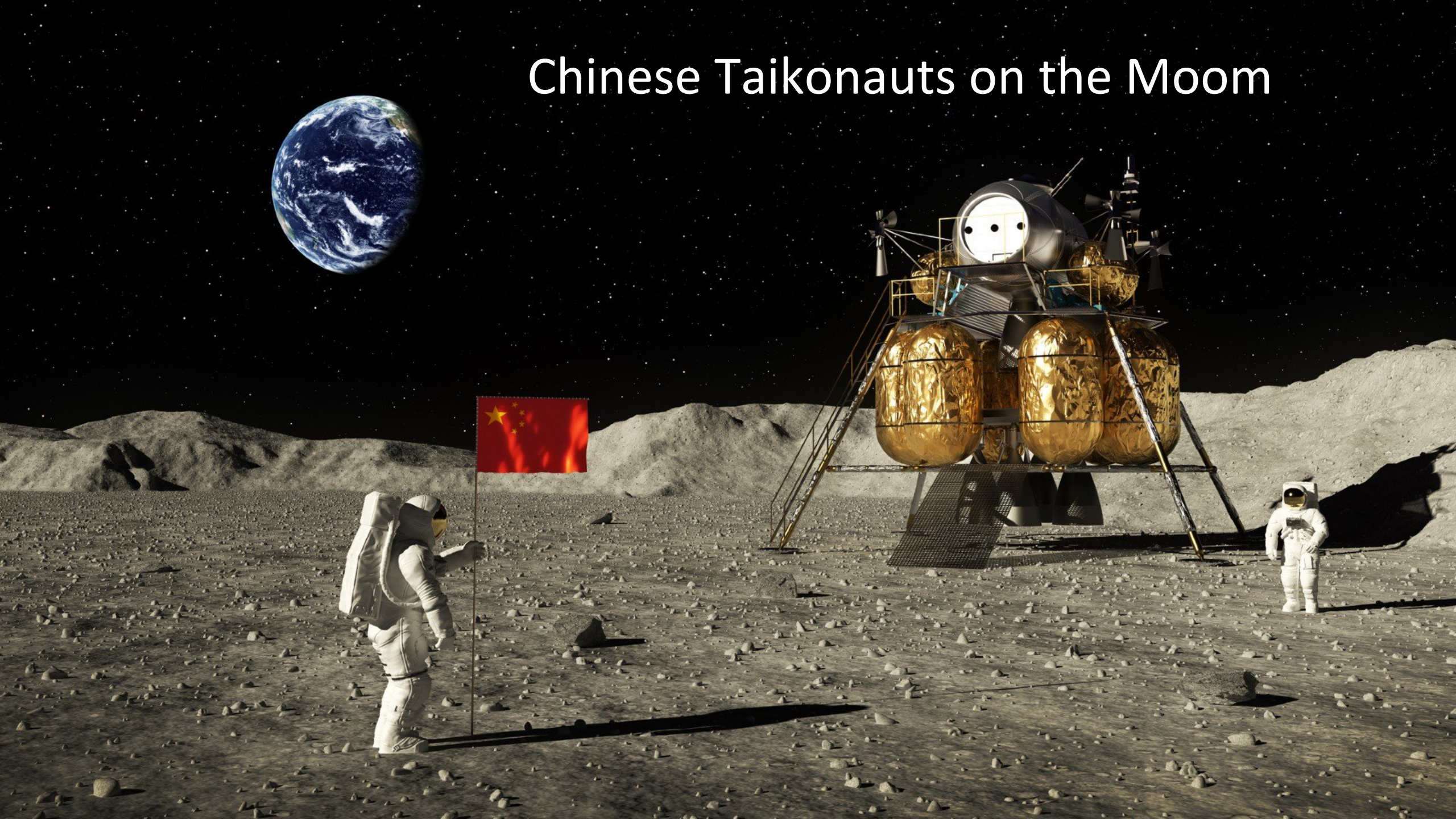
Blue Moon Lunar Lander

Starship Lunar Lander

Artemis 4 and 5 Missions

- Both are human landing missions – landers TBD
- Goal is to launch Artemis 4 in early 2028 and Artemis 5 in late 2028

Chinese Taikonauts on the Moom



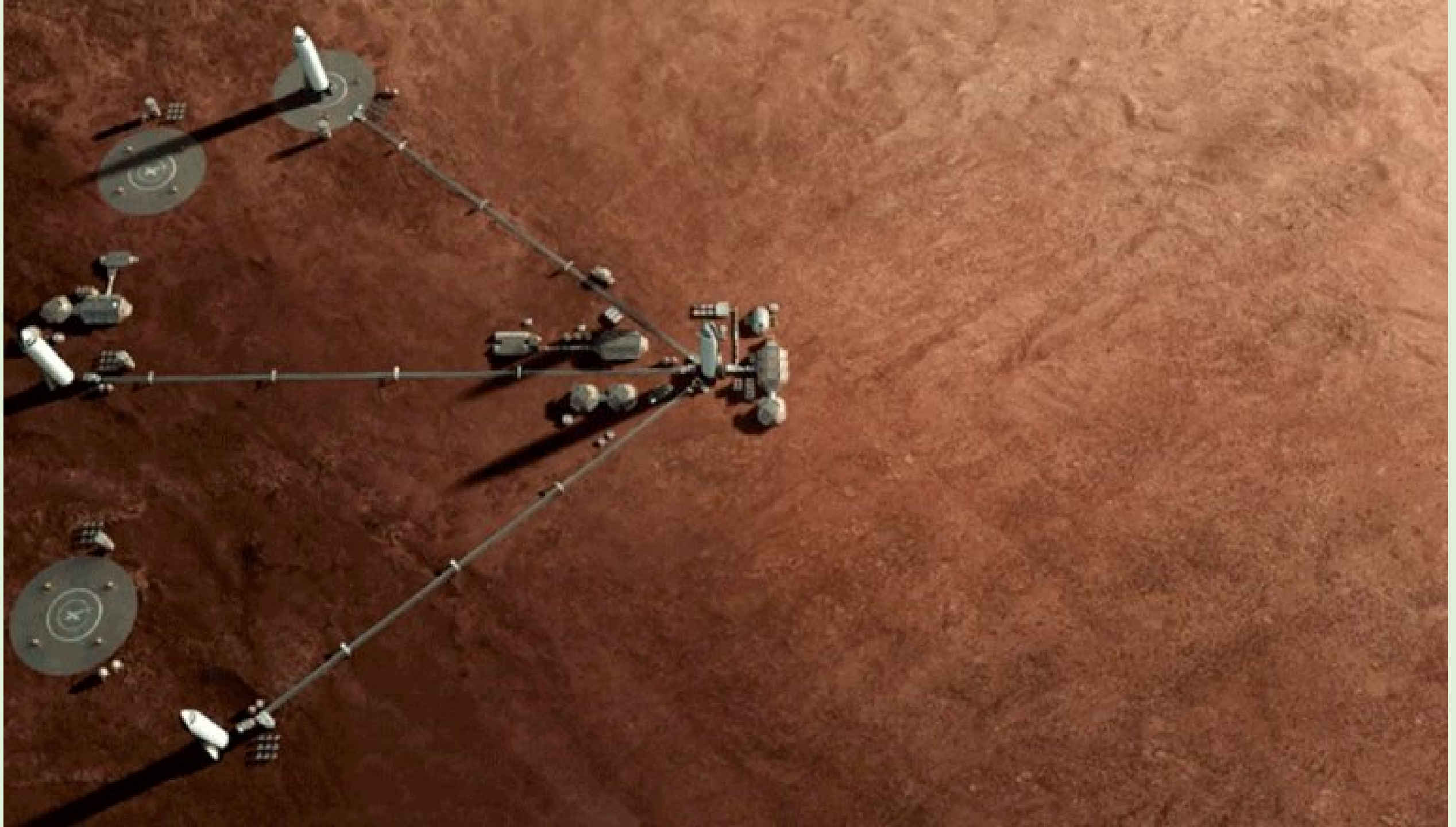
Possible later Artemis Missions

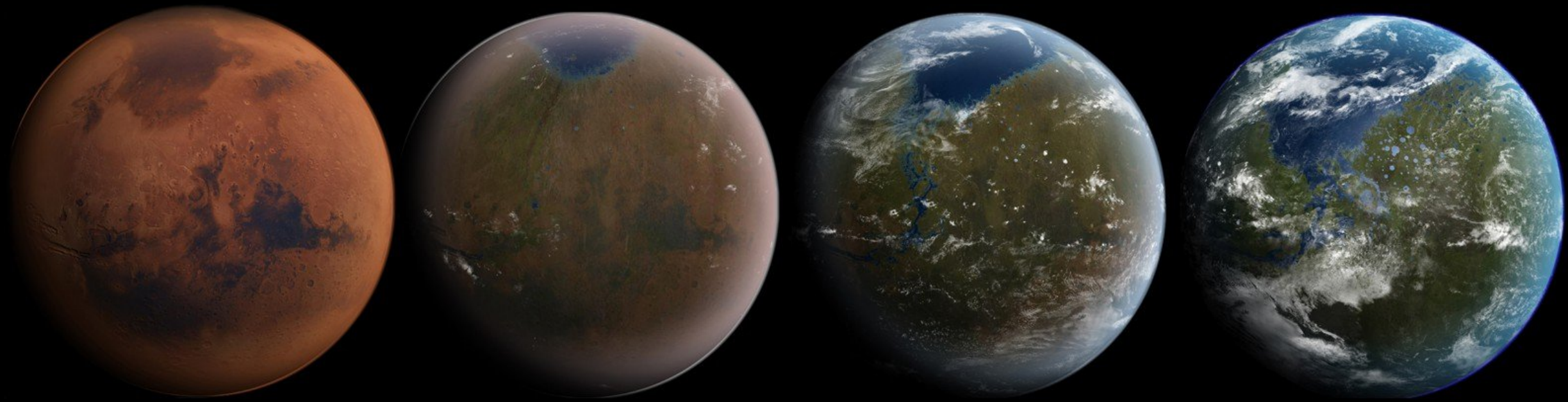
Starship
Replaces SLS/Orion

Starship lunar lander

Lunar lander version of the Starship

International Lunar Base





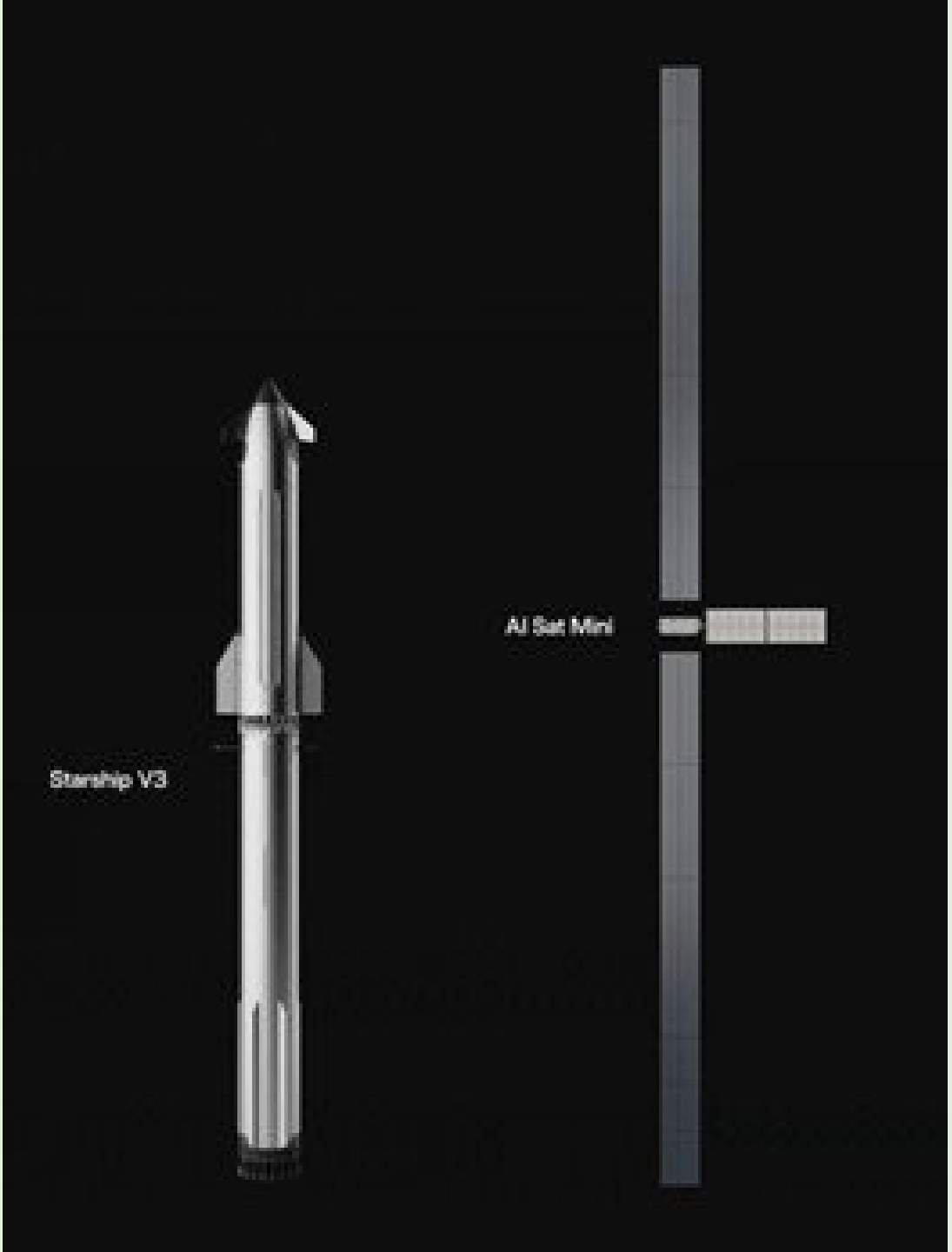
Terraforming Mars

Moving Outward

- In a future century, interstellar travel may become possible
- Humans could settle on Earth-like worlds that we haven’t even discovered yet
- The gift of life could be given to more people

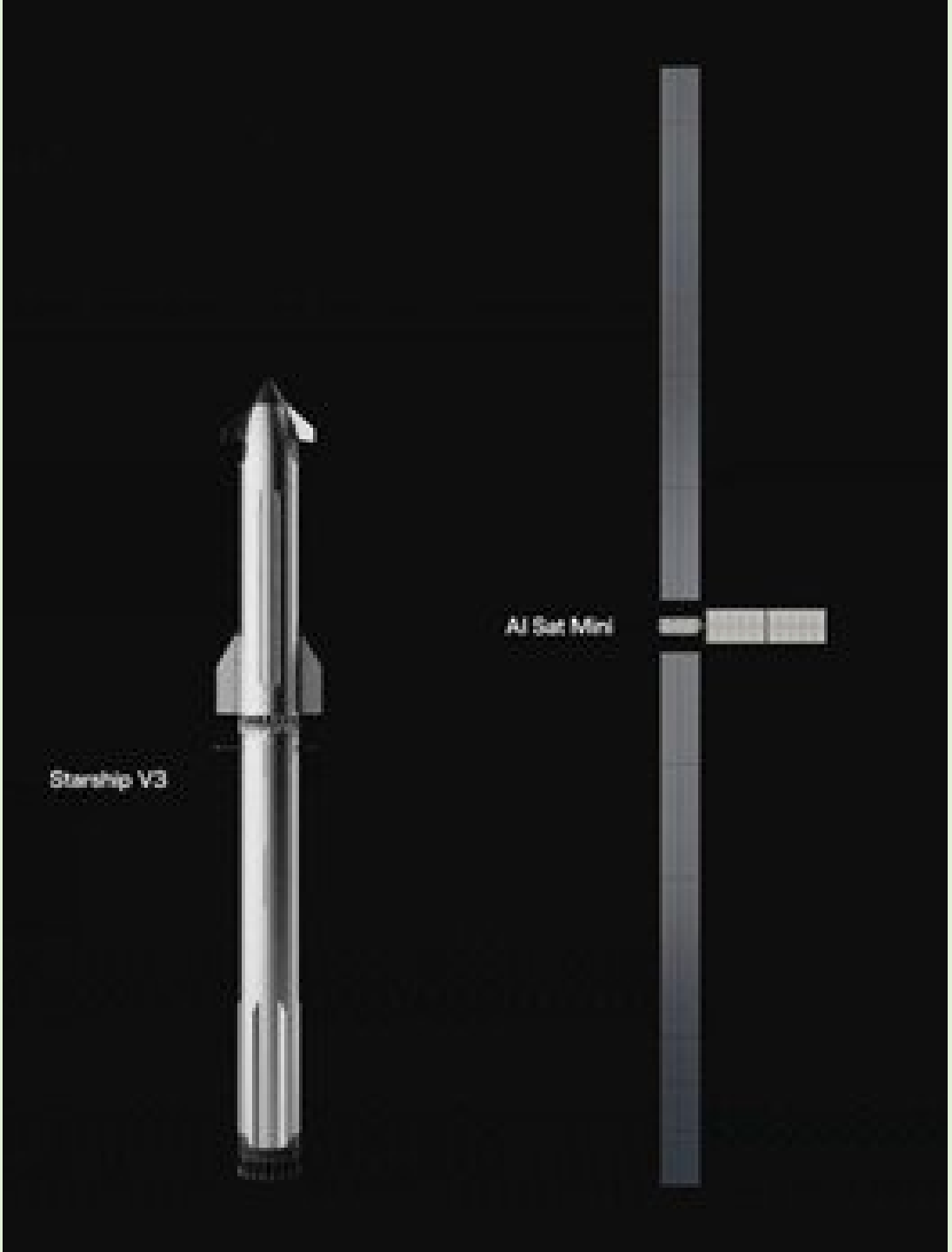
Thanks for listening

Appendix



Orbiting Data Centers

- SpaceX acquired xAI in February 2026, creating a $1.25 trillion company
- xAI was a Musk company, heavy into AI, and is best known for X and Grok
- The AI division of SpaceX will require large expenditures for data centers
- Will have an IPO about June, 2026. Hope to raise $40 to $80 billion
- Data center satellites will be large
- SpaceX has filed with the FCC for to launch up to 1,000,000 satellites
- Jeff Bezo’s company Blue Origin has filed for up to 51,600 satellites



Data Centers Problems

<u>Surface based data centers</u>

- Consume prodigious amounts of water and power
- Would contribute to global warming
- Public opposition (NIMBY)

<u>Orbiting data centers</u>

- Bad for astronomy and science
- May not be as economical as surface based data centers
- Huge risk for SpaceX – the AI division could become a drag on the company