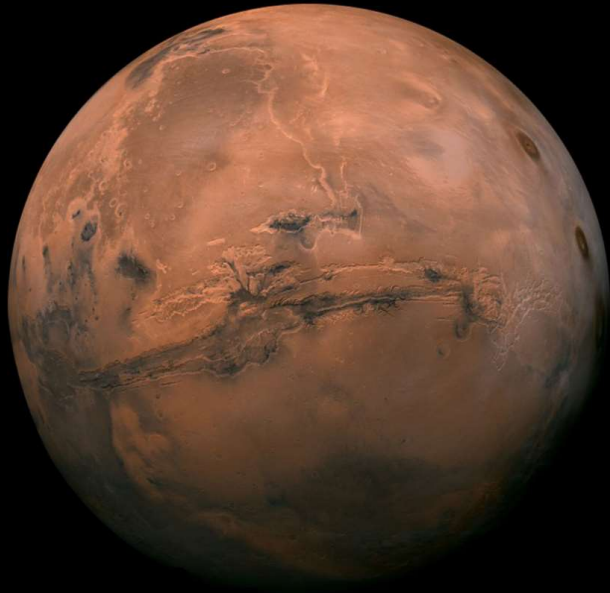


Space News

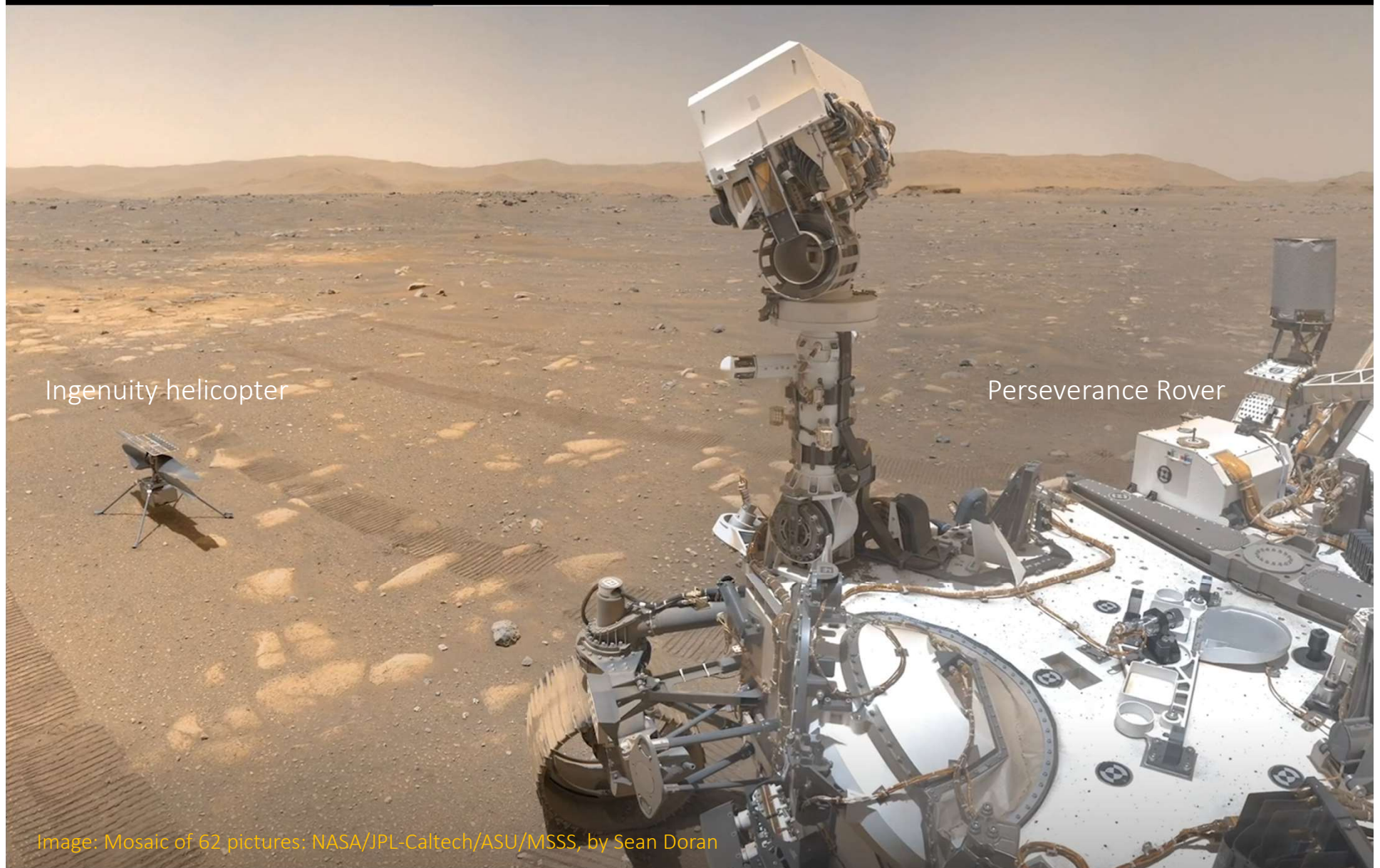
May 1, 2021

Greg Stanley



NSS North Houston
 **Space Society**

Mars update: Perseverance rover, Ingenuity helicopter



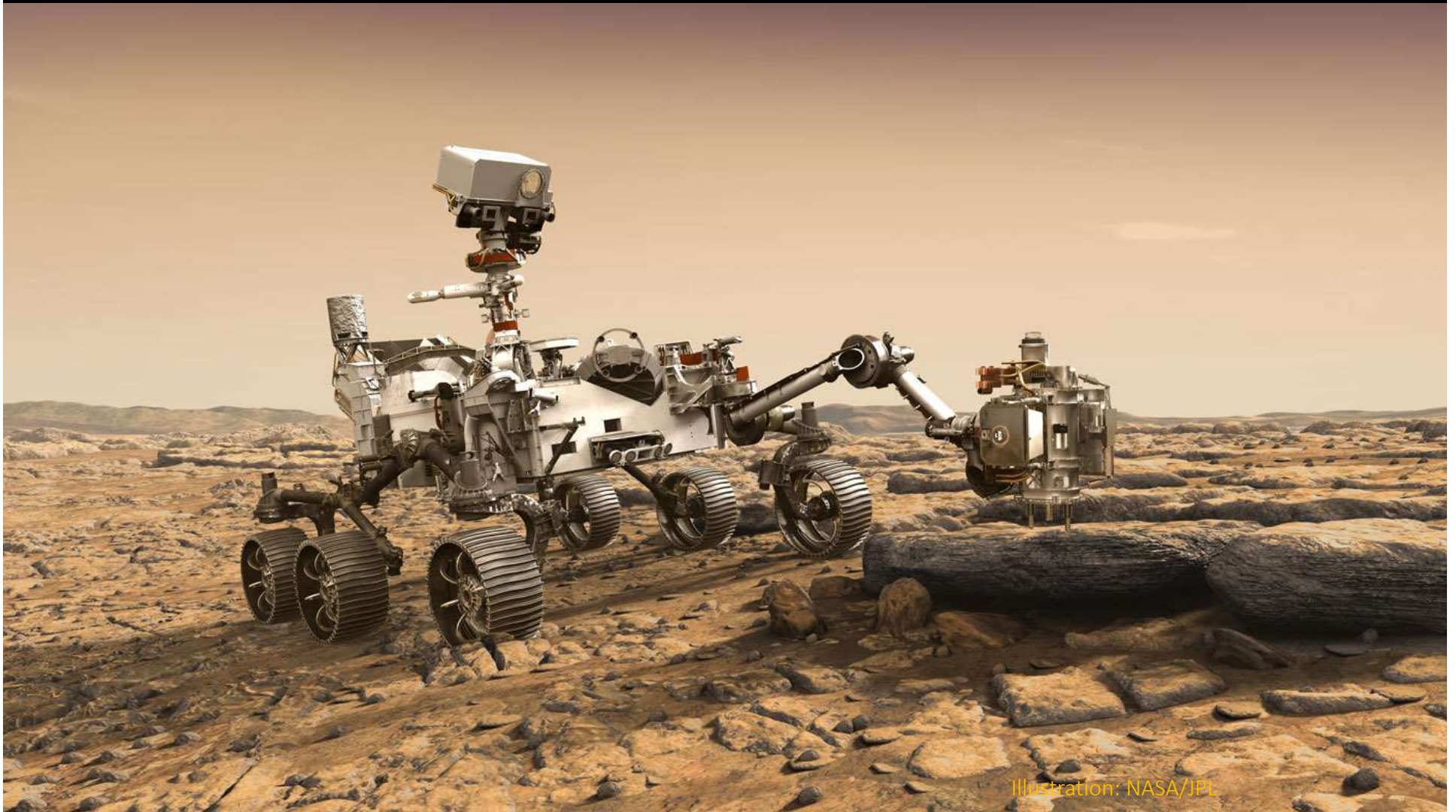
Ingenuity helicopter

Perseverance Rover

Image: Mosaic of 62 pictures: NASA/JPL-Caltech/ASU/MSSS, by Sean Doran

NASA's Perseverance Mars rover update

- Generated O_2 from Mars CO_2 atmosphere – first in situ resource demo
 - First 1 hour run produced 5.4 grams O_2 (about 10 minutes of breathing)
- Month of Ingenuity testing: mostly waiting, photographing, relaying data



Where is Perseverance now? (Watching Ingenuity)

Perseverance's Location Sol 66 | Distance Driven 0.18 miles / 0.29 km

Friday, April 30, 2021 (Sol 66) Distance Driven 0.18 miles

Ingenuity flight zone in blue

Landing site

Current rover position

Interactive (zoomable) map at <https://mars.nasa.gov/mars2020/mission/where-is-the-rover/>

Map Scale ↗

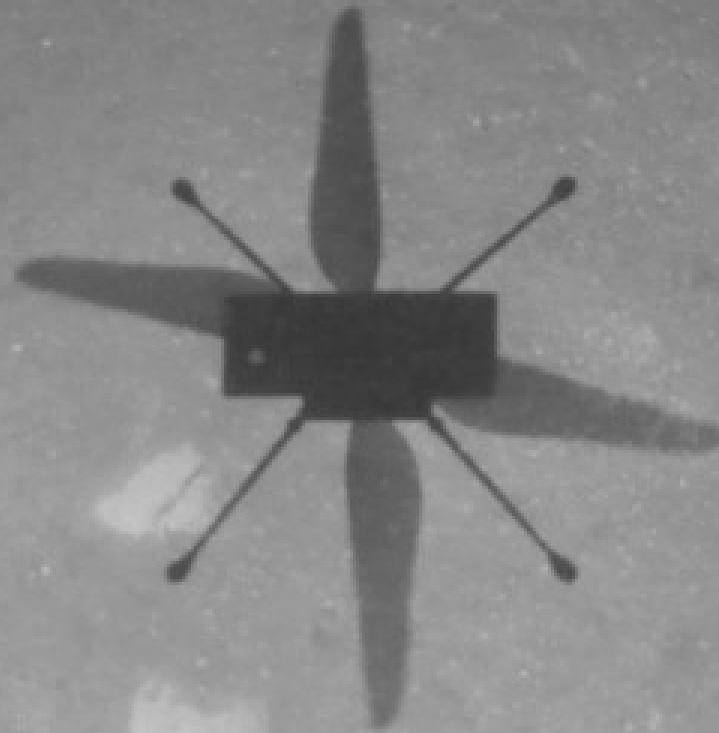
0 20m

Image: NASA

Longitude, Latitude

Ingenuity Mars helicopter flights 1-2

- First flight delayed for software glitch. Command sequence changed, accepting 15% timeout chance on transition to flight mode.

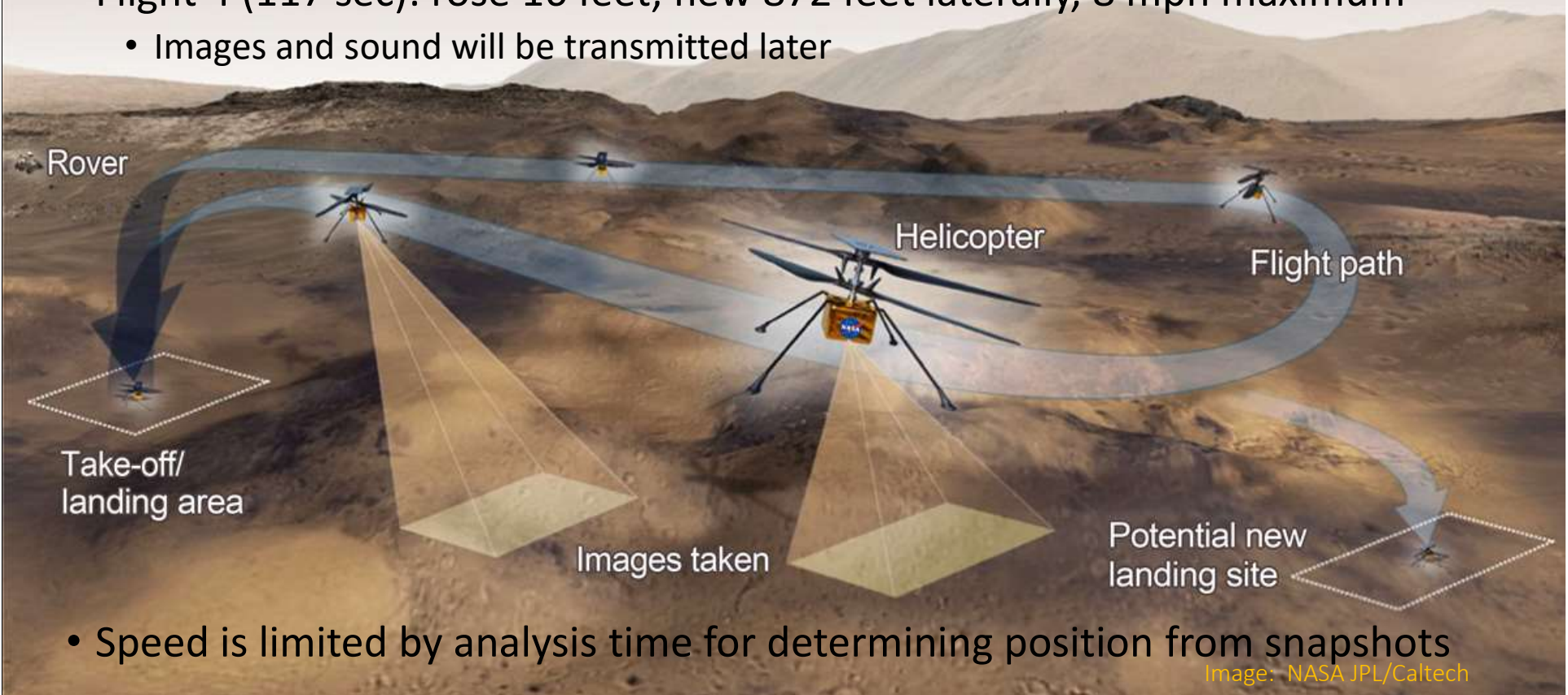


- Flight 1 (39.1 sec): rose 10 feet, hovered, turned, returned
- Flight 2 (51.9 sec): rose 16 feet, moved laterally 7 feet, turned, returned
- 16 - 33 foot altitude limit due to limitations of altimeter (laser rangefinder)

Picture of shadow of Ingenuity from downward-facing camera: NASA/JPL

Ingenuity Mars helicopter flights 3-4

- Flight 3 (80 sec): rose 16 feet, flew 330 feet laterally, 4.5 mph, returned
- Flight 4 – Nothing happened at first attempt. Same 15% timeout problem
- Flight 4 (117 sec): rose 16 feet, flew 872 feet laterally, 8 mph maximum
 - Images and sound will be transmitted later



Ingenuity gets an extension

- Originally allocated one 1 month, starting April 3
- Technology demonstration was successfully completed
- Flight 5 will be a 1-way trip to a new flight zone
- New “operations demo” mission: extended another 30 sols (Martian days)
 - Show usefulness as an aerial scout, possibly until late August
 - Fly less often (every 2 or 3 weeks) so Perseverance can do its science tasks
 - Relaying video and data take a significant portion of Perseverance capability
 - Perseverance has science goals to meet before mid-October: Mars & Earth are on opposite sides of the sun, blocking communications



View of Ingenuity Mars helicopter from Perseverance rover : NASA JPL/Caltech

Lunar news

Updates to human and robotic landing plans



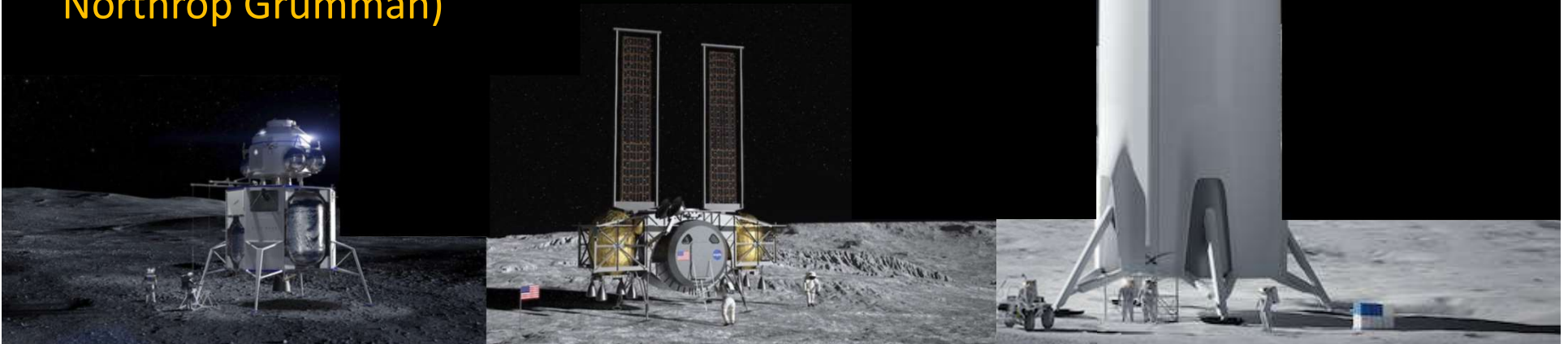
NASA Human Landing System (HLS) choices (lunar lander for Artemis program)

- Decision to narrow down to 2 vendors had been delayed
- Surprisingly, a single vendor was selected
 - Forced by HLS budget limits
- But it's already suspended due to protest until GAO (Government Accountability Office) resolves ALL outstanding litigation
 - 2024 human landing getting less likely again

Blue Origin (partnered
with Lockheed Martin &
Northrop Grumman)

Dynetics (partnered with
Sierra Nevada Corp)

SpaceX



NASA selects SpaceX for Human Landing System (HLS)

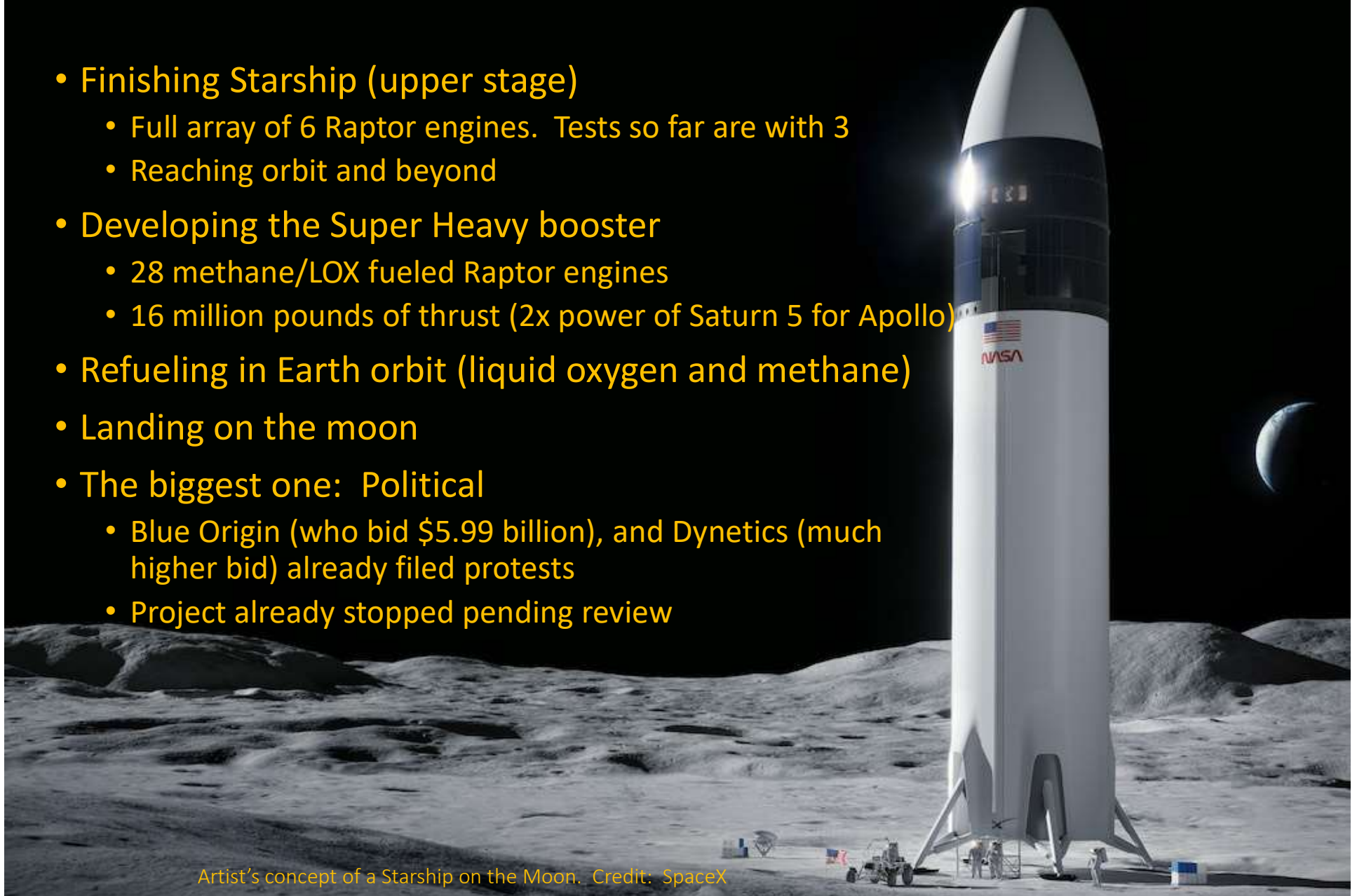
- Lander will be a derivative of Starship (e.g., no fins)
- \$2.89 billion fixed price contract for 2 missions
 - Test flight to land without astronauts
 - 2nd flight will carry a crew to Moon's south pole
- SpaceX will continue investing its own money
- NASA plan for next human moon landing:
 - Starship gets to lunar orbit (refueling in earth orbit)
 - Astronauts fly on Space Launch System (SLS) to lunar orbit in Orion capsule
 - Astronauts transfer to Starship for landing on surface & return to Orion (no "gateway" involved)
 - Orion returns to Earth, splashes down with parachutes



Artist's concept of a Starship on the Moon. Credit: SpaceX

Starship to the Moon: some hurdles

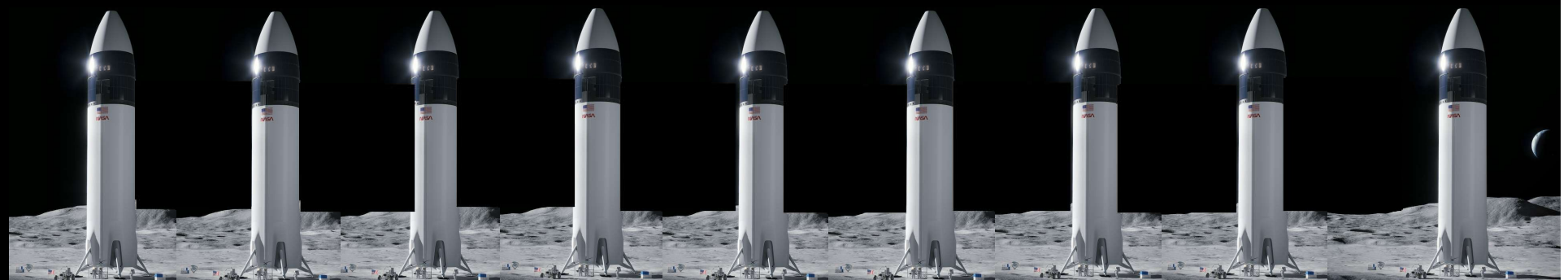
- Finishing Starship (upper stage)
 - Full array of 6 Raptor engines. Tests so far are with 3
 - Reaching orbit and beyond
- Developing the Super Heavy booster
 - 28 methane/LOX fueled Raptor engines
 - 16 million pounds of thrust (2x power of Saturn 5 for Apollo)
- Refueling in Earth orbit (liquid oxygen and methane)
- Landing on the moon
- The biggest one: Political
 - Blue Origin (who bid \$5.99 billion), and Dynetics (much higher bid) already filed protests
 - Project already stopped pending review



Artist's concept of a Starship on the Moon. Credit: SpaceX

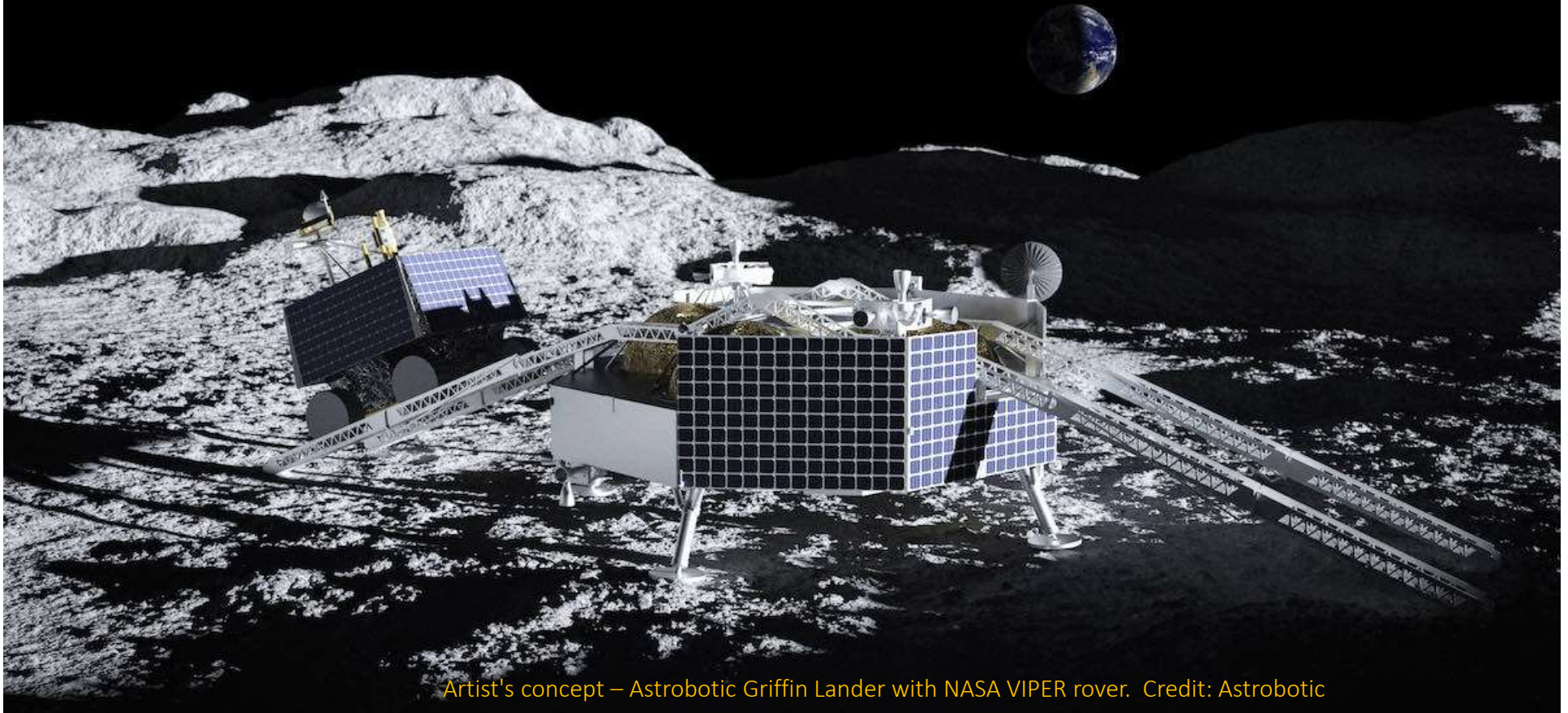
Implications of Starship to the Moon: it's a big deal

- Radical departure for deep space
 - NASA buys into in-orbit refueling, reusability, large scale transport of people and cargo
 - Possibility of larger scale presence on the Moon, and a shorter time to Mars rockets
- NASA collaboration solidifies SpaceX position, Starship funding
 - NASA in effect is funding the SpaceX plans for Mars, but at a bargain price
 - NASA gets a Mars program, not just a few small lunar landings with craft only usable on the Moon
 - SpaceX needs the NASA collaboration on life support, power for deep space & Mars
- Longer term, could hasten the end of SLS, Orion, and Gateway
 - Boeing builds one throwaway SLS/year for \$2 B to deliver a few astronauts, 5 years late
 - SpaceX is already building rockets monthly
 - SpaceX making rapid progress with monthly Starship flight tests
 - Inevitable question: Why not just launch humans from Earth on Starship
- Politics will be tricky, with many vested interests
 - SLS, Orion, Gateway programs were jobs programs for most states, aerospace companies
 - Foreign partners were building modules for Gateway, ...
 - New NASA administrator was a supporter of SLS, with lots of traditional aerospace friends



Other lunar news – nearer term robotic landings

- Astrobotic chooses SpaceX Falcon Heavy as rocket for its 2023 lunar mission
 - Part of NASA's CLPS program ("Commercial Lunar Payload Services")
 - \$200 million contract: deliver 950 lb water-hunting NASA rover to Moon's south pole
 - Using Astrobotic's Griffin lander
 - VIPER rover has 3 spectrometers to detect water ice, drill to bore 3.3 feet to sample below surface
 - Smaller lander launching late this year on a United Launch Alliance Vulcan rocket
 - Falcon Heavy will deliver Griffin directly to lunar orbit – no earth orbit pause



Artist's concept – Astrobotic Griffin Lander with NASA VIPER rover. Credit: Astrobotic

Update on space tourism by Blue Origin

- New Shepard booster and “Reusable Spaceship” (RSS) passenger capsule
 - Reusable booster lands back on launch pad
 - RSS falls back to earth using parachutes
- Signup May 5 to fly people to the “edge” of space (suborbital). Fly this year?
 - 6 passengers will fly up 62 miles (100 km) from launch site in West Texas
 - Passengers will experience weightlessness for 3 minutes. Total ride: 10 minutes
 - Fully automated: no pilot
- 15/15 successful launches, some already carrying payloads
 - Apr. 14 test included rehearsing entry and exit of passengers, but no passengers yet
- Orbital-class New Glenn rocket debut launch not until late 2022
 - Amazon’s Kuiper internet constellation has to buy launches on ULA rockets



Blue Origin's West Texas launch site: Blue Origin



Northrup Grumman grabs another satellite

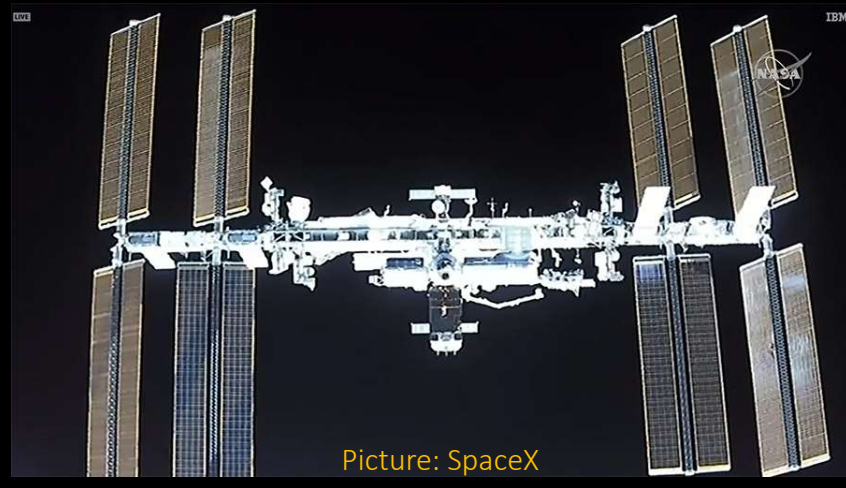


- SpaceLogistics (Northrup Grumman) “Mission Extension Vehicle” (MEV) series, capture satellites in geosynchronous orbits (22,000 miles)
 - Purpose: extend life of functional satellites out of maneuvering fuel (5 years)
 - MEV-1 captured a “zombie” Intelsat satellite back in April, 2020 (previously reported)
 - MEV-2 captured another 17-year old Intelsat satellite, this one operational
- Next generation “Mission Robotic Vehicle” (MRV) will have robotic arms to repair or upgrade satellites, place new propulsion pods and move on, and assemble structures in space (DARPA funded)

Image (artist's concept of MEV): Northrop Grumman

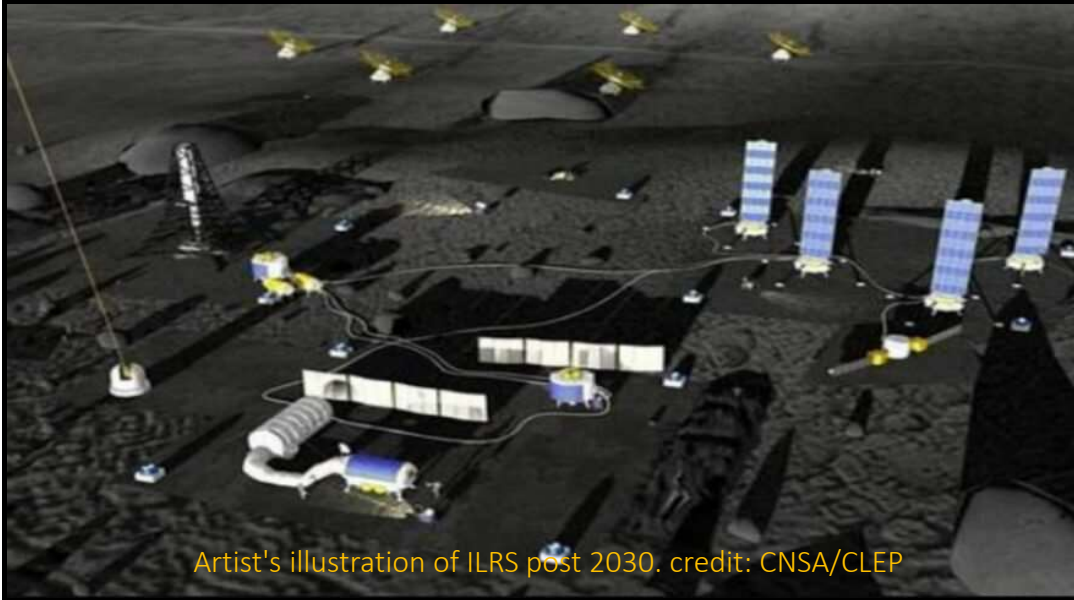
A busy month at the International Space Station (ISS)

- Apr 9 – Soyuz – 3 astronauts (2 Russian/1 American) launched to ISS
 - Russians and Americans expect to trade seats via Axiom Space (Houston) on each other's launches, ensuring there's always both Russian and Americans on ISS. Not complete cross training!
- Apr 17 – Soyuz – 3 astronauts (2 Russian, 1 American) return from ISS
- Apr 23 – Falcon 9/Crew Dragon – 4 astronauts to ISS
 - Astronauts: 2 NASA, 1 Japanese, 1 European Space Agency
 - First ISS human flight with re-use of both booster and spaceship
 - Peak of 11 crew for a few days, the most since 2011
 - Increased tempo of SpaceX flights will allow more crew, time for experiments on ISS
- May 1? – return of 4 outgoing astronauts, postponed for weather



Some Chinese missions update

- Tianwen-1 Mars rover landing: mid-May
 - Spacecraft in 2-day elliptical orbit 174 miles – 36,660 miles
- Launched core module (22.5 tons) for its space station
 - Rocket will tumble in uncontrolled reentry within a week
 - 10 more launches to go for completion in 2022
- China and Russia formally invited other countries to join in Chinese International Lunar Research Station (ILRS)



Other space news

- Bill Nelson confirmed as NASA's next administrator by unanimous consent

How many launches since the last meeting (Apr 3)?

This includes failed launches only if they lift off the launch pad and only includes launches that attempt going into orbit

- This successful Blue Origin New Shepard/Reusable Spaceship test April 14 didn't count: it was sub-orbital (100 km/62 miles)



Credit: Blue Origin

Launches since last meeting (Apr 3, 2021)



Apr 7 – Falcon 9 – 24th batch of 60 Starlink (internet service) satellites



Apr 8 – Long March 4B – experimental satellite



Apr 9 – Soyuz – 3 astronauts (2 Russian/1 American) to ISS



Apr 23 – Falcon 9/Crew Dragon – 4 astronauts to ISS



April 25 – Soyuz – 36 OneWeb (internet service) satellites



Apr 26 – ULA Delta 4-Heavy – US Spy satellite

- Only 3 of these left



Apr 26 – Long March 6 – 9 satellites(8 commercial, 1 debris removal test)



Apr 28 – Arianespace Vega – 6 satellites

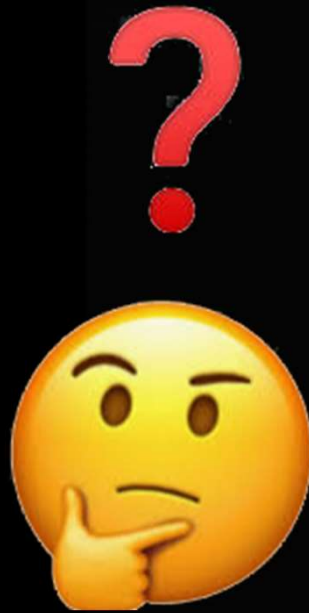


Apr 28 – Long March 5B – Core module for Chinese Space Station (CSS)



Apr 28 – Falcon 9 – 25th batch of 60 Starlink (internet service) satellites

Discussion & questions?



A closing quote from Elon Musk:

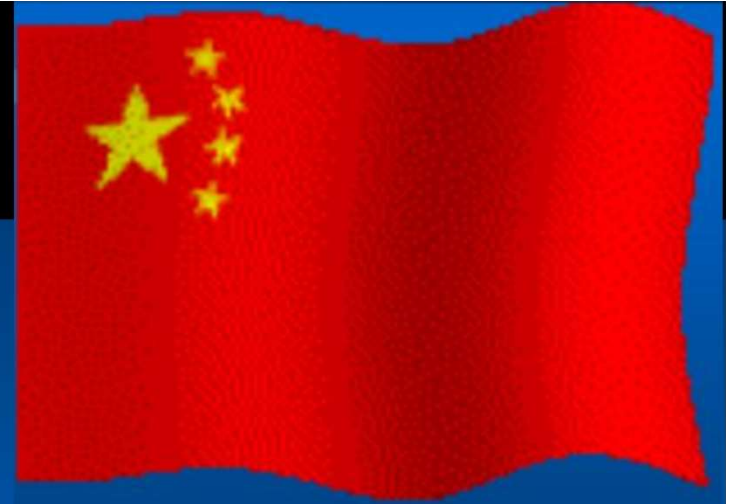
"We don't want to be one of those single planet species, we want to be a multi-planet species"

Image: NASA

Featured speaker: Ben J. Huset

China in Space

from Wan Hu to Tianwen-1



- Lifelong promoter of space travel and space technology
 - NSS, regional director
 - Minnesota Space Frontier society, Exec. Dir.
 - MN Astronomical Society, President
 - Mars Society, Moon Society as MDRS crew member
 - MarsCon: 2 time conference chair, 23x Science Room director
- Worked for decades in IT, including NASA, FAA contractors
- BA., Computer Science, University of North Dakota