

Monthly space news 2022 Year end review

Greg Stanley

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James Webb Space Telescope image credit: NASA



Earth orbit (or beyond) launches in 2022, 2021, 2020

 US: 85/87 successes/launches vs. 48/51 vs. 40/44 (includes Rocket Lab)

 China: 62/64 vs. 45/48 vs. 35/39

 Russia: 22/22 vs. 23/24 vs. 17/17

 Europe (ESA): 4/5 vs. 6/6 vs. 4/5

 India: 4/5 vs. 1/2 vs. 2/2

 Japan: 0/1 vs. 2/2 vs. 4/5

 South Korea: 1/1 vs. 0/1 vs. 0/0

 Israel: 0/0 vs. 0/0 vs. 1/1

 Iran: 1/1 vs. 0/0 vs. 1/2

- Total: 179/186 vs. 125/134 vs. 104/114 vs. 97/102

- *SpaceX alone launched/succeeded 61 times (60 on Falcon 9, including 34 for Starlink)*

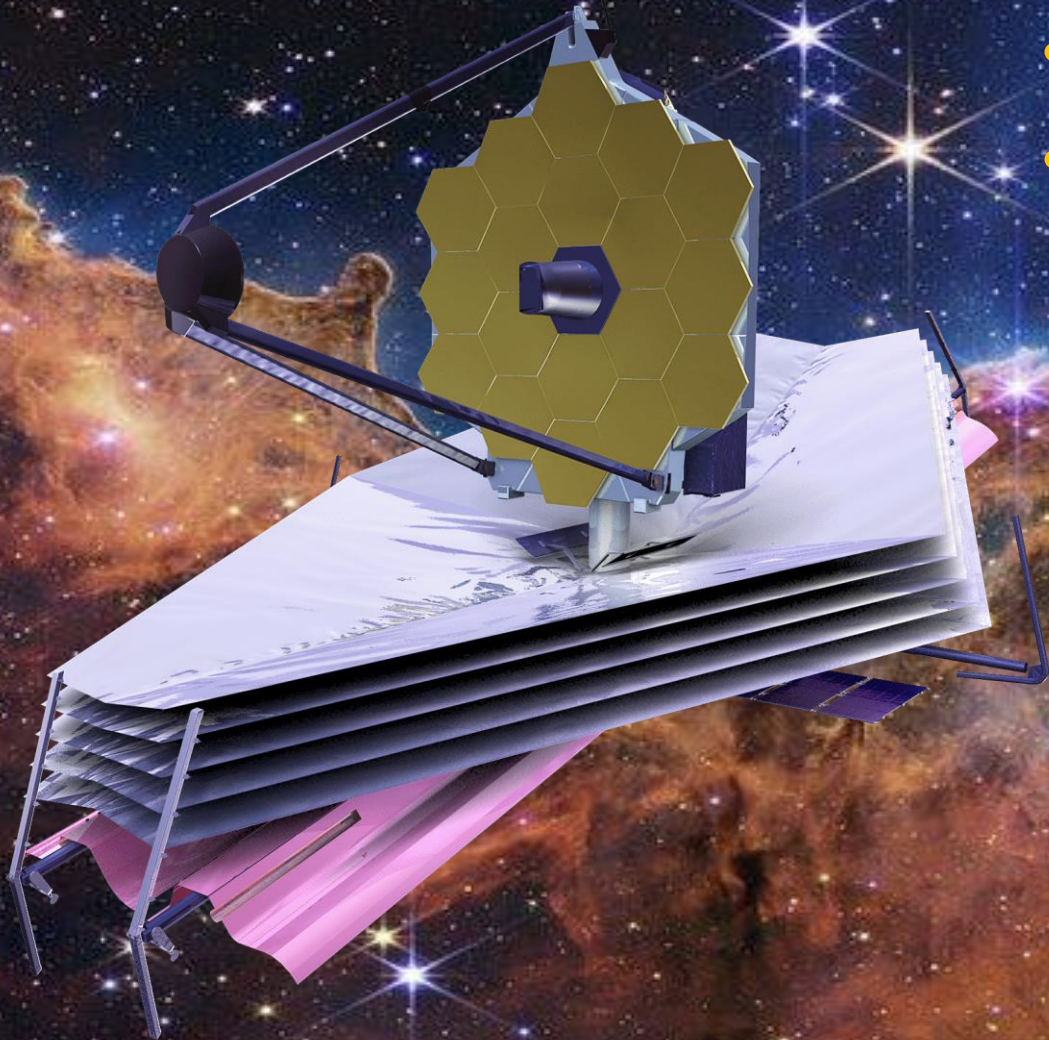
- Exceeded records set in 1976/2021 (125 successes) and 1967 (139 launches)

Based on Monthly Space News reports (+1 for missed China launch). Failure counts vary based on failure definition (Firefly)



Year end review: James Webb Space Telescope (JWST)

- Infrared space telescope orbiting the Sun
- Launched Dec 25, 2021
- Deployment & first images in 2022
 - Images as good as theoretically possible
 - Minor micrometeorite hits



James Webb Space Telescope and its image credits: NASA



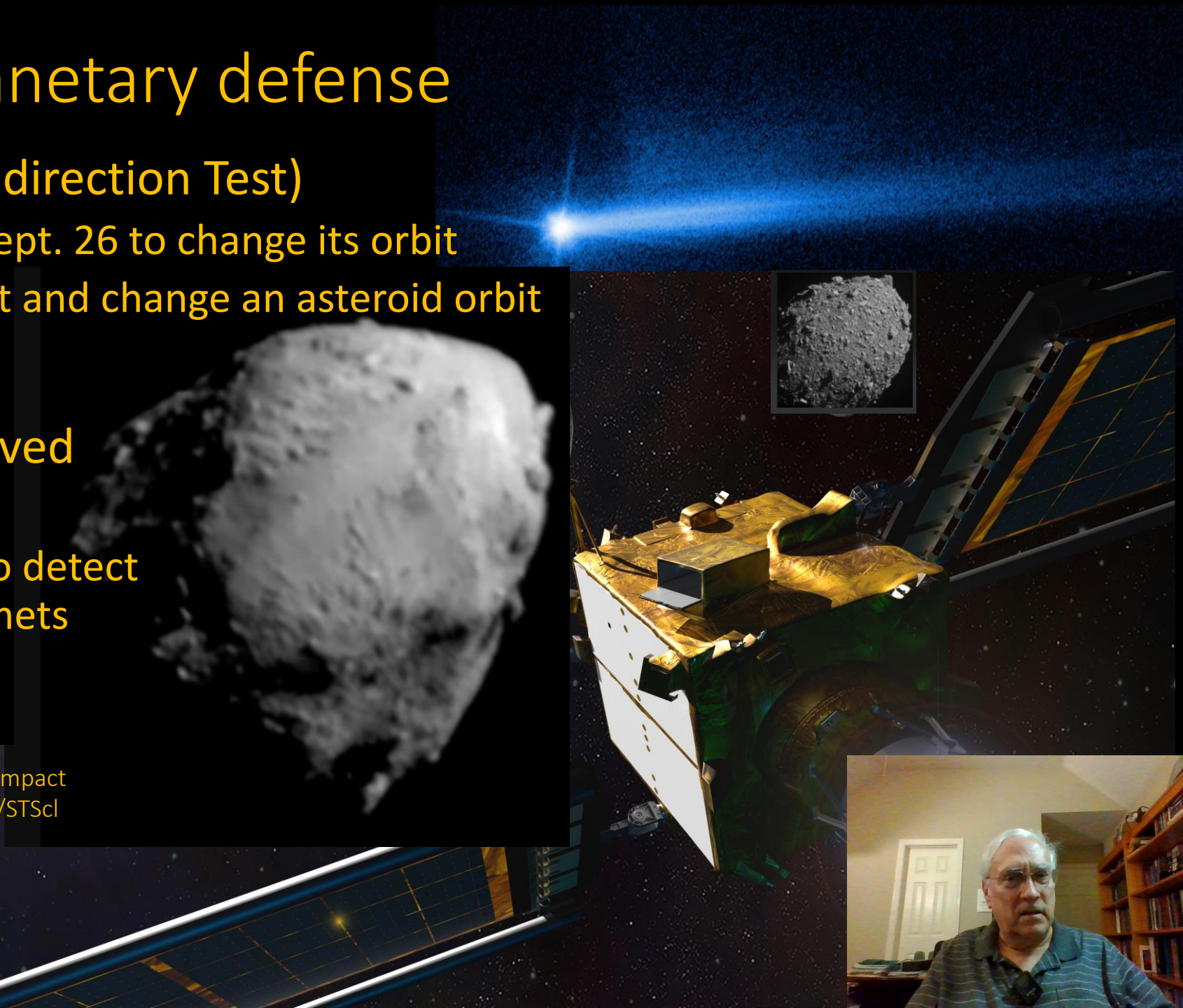
Year end review: planetary defense

- DART (Double Asteroid Redirection Test)
 - Crashed into an asteroid Sept. 26 to change its orbit
 - Successful proof we can hit and change an asteroid orbit
- NEO Surveyor project revived
 - NEO = Near Earth Object
 - Infrared space telescope to detect dangerous asteroids & comets

Upper right:

Didymos-Dimorphos system several weeks after DART impact
Hubble Space Telescope photo. Credit: NASA/ESA/PSI/STScI
(esahubble.org/images/opo22056a/)

Artist impression. Credit: NASA/Johns Hopkins APL,
updated with actual NASA asteroid photos



Year end review: other deep space exploration

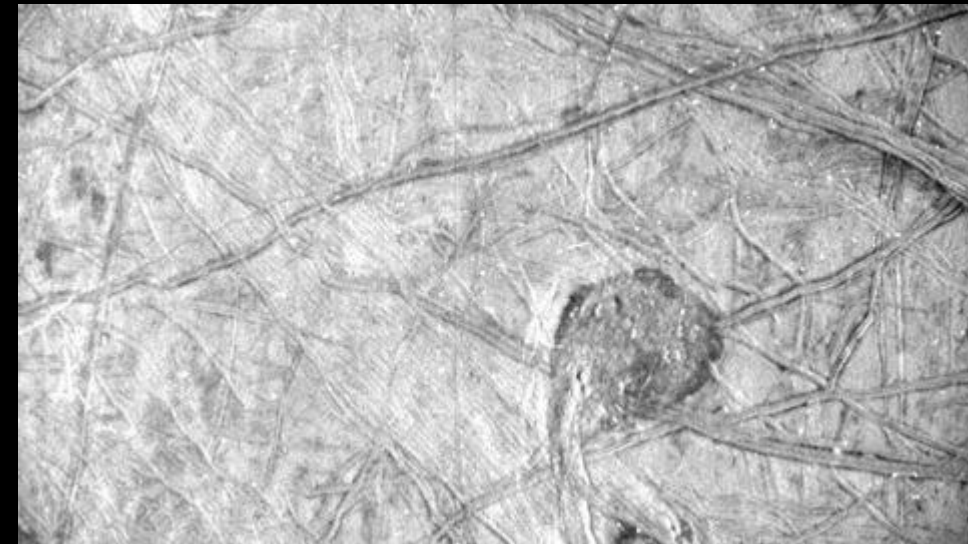
- Lucy asteroid mission continued despite problems latching a solar array
- Juno probe passed within 220 miles of Jupiter's moon Europa Sept. 29
- Parker Solar Probe "touched the Sun's corona in 4 times, getting closer & closer to the Sun over time



Lucy asteroid probe. Credit: NASA



Parker Solar Probe
Image credits: NASA



Europa photo (100 miles wide)
Credit: NASA/JPL-Caltech/SWRI



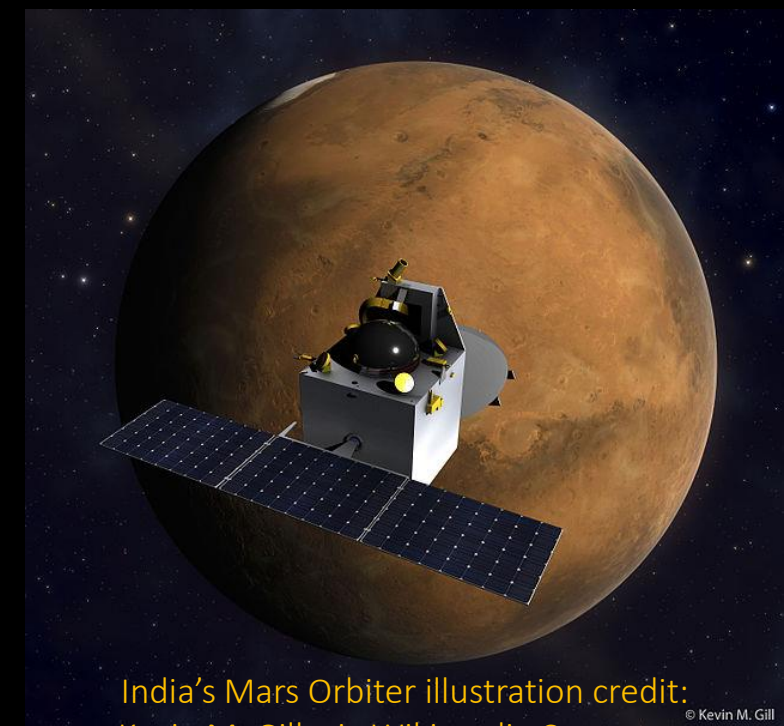
Year end review: Mars operations

- India's Mars Orbiter exhausted propellant, couldn't avoid eclipse, died of power loss/battery failure after 8 years
 - Other orbiters still going strong: 3 US, 2 ESA, 1 UAE, 1 China
- Insight lander solar cells covered with dust, declared dead Dec. 18, after 4 years, 19 days
 - Analyzed Marsquakes, planet interior structure
- Perseverance, Curiosity, Tianwen rovers going strong
 - Perseverance started depositing samples for later retrieval
 - Ingenuity helicopter 35th flight set new altitude record of 46 ft.

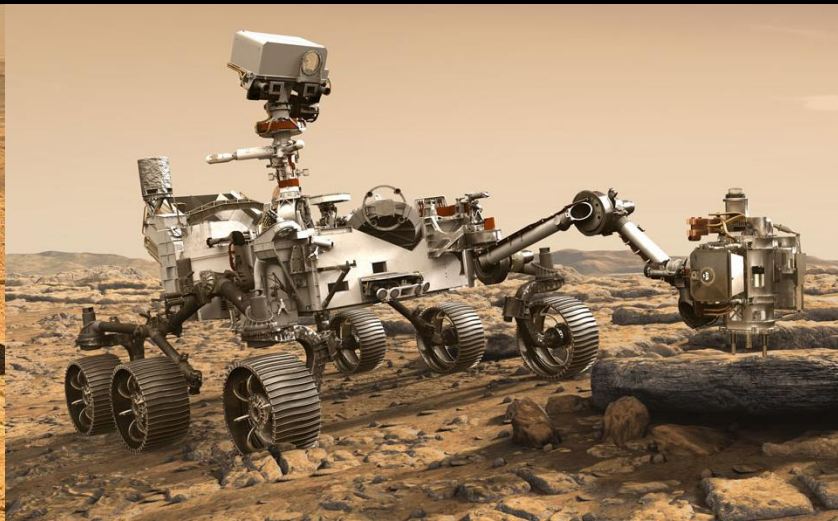
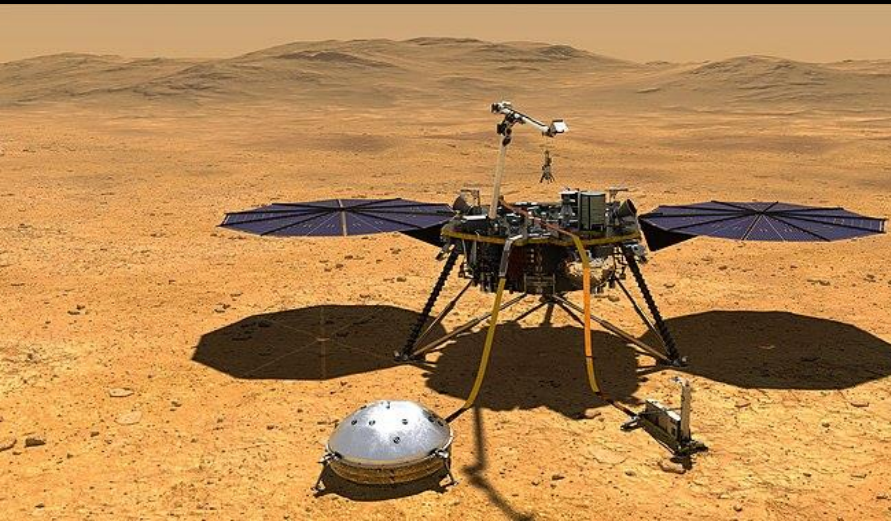
Insight lander. Credit: NASA/JPL

Perseverance rover. Credit: NASA/JPL

Ingenuity helicopter. Credit: NASA/JPL



India's Mars Orbiter illustration credit: Kevin M. Gill, via Wikimedia Commons



Year end review: Artemis/Moon-to-Mars

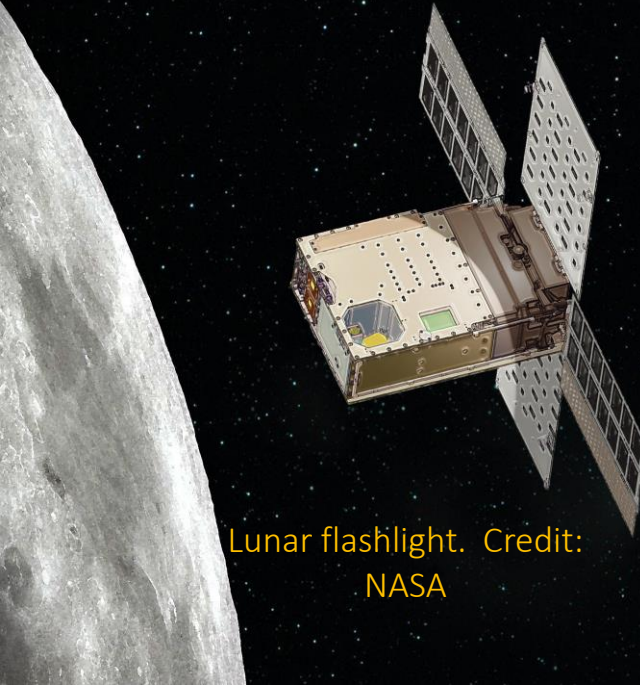
- CAPSTONE launch June 28 on an Electron rocket
 - Testing orbit for future Gateway (lunar space station)
 - Arrived in lunar orbit November 14
- CLPS (Commercial Lunar Payload Services) robotic lunar explorers mostly delayed
- Artemis 1 (finally) launched uncrewed test Nov. 16
 - SLS (Space Launch System) + Orion capsule
 - Successful mission around the Moon, returning Orion on Dec. 11
 - 10 small “rideshares” included lunar and solar orbiters, and a JAXA (Japanese space agency) lunar lander
 - 4-6 failures, including solar sail to an asteroid, JAXA lander

Credits: NASA



Year end review: other lunar launches

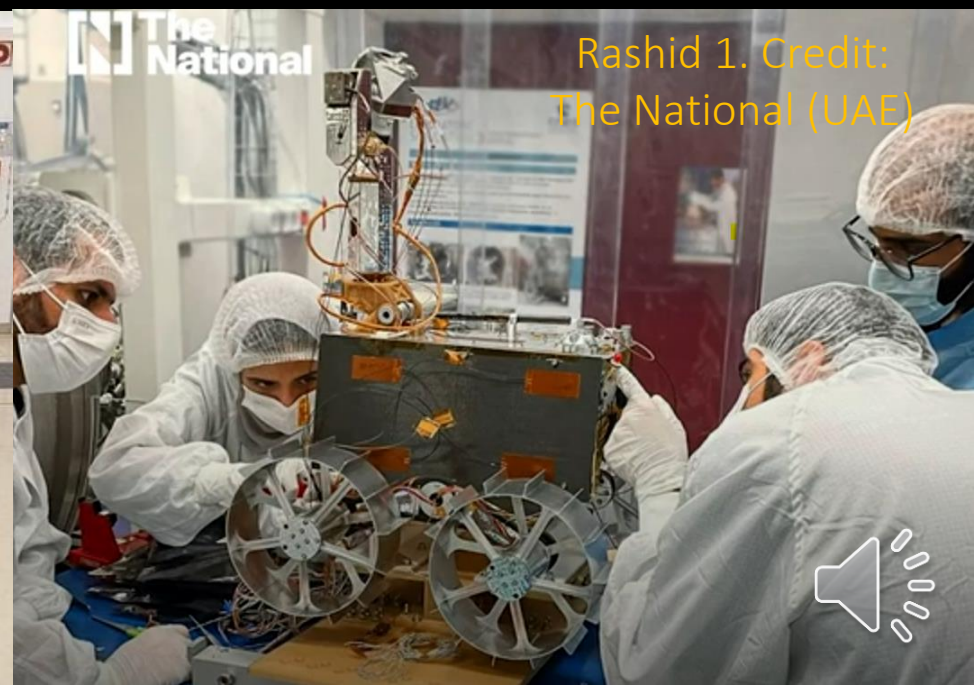
- South Korea's first lunar orbiter launched Aug. 4 on a Falcon 9, arrived Dec. 16
- Dec 11 Falcon 9 launch
 - NASA's Lunar Flashlight
 - Surveying water ice in craters with infrared lasers, supporting future ISRU (In Situ Resource Utilization)
 - Uses improved ASCENT monopropellant to replace hydrazine
 - Hakuto-R Mission 1 lunar lander
 - First private lunar lander (ispace, Japan)
 - UAE Rashid-1 rover, other small payloads



Lunar flashlight. Credit: NASA



M1 lander. Credit: ispace



Rashid 1. Credit: The National (UAE)



Year end review: Chinese Lunar program

- China advanced lunar base and related mission goals by 8 years
 - Robotic and manned missions
- Will the U.S. catch up with the Chinese on the Moon's surface?

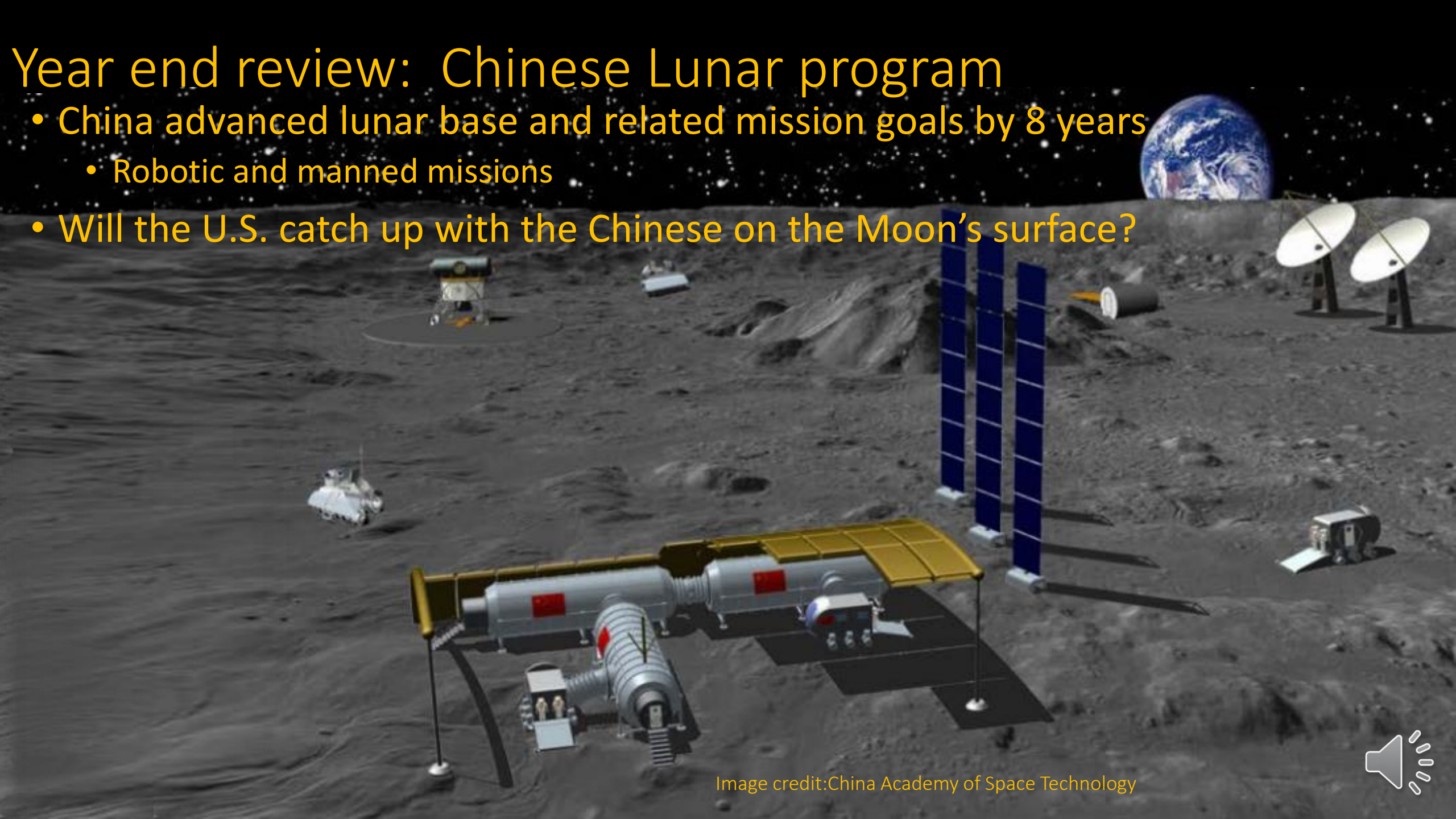


Image credit:China Academy of Space Technology



Year end review: Ukraine war disruption

- Ukraine war disrupted space business worldwide
 - The “West” (incl. Japan, Korea, Taiwan) is dropping Russian business
 - European heavy dependence on Russian launches stopped science, exploration, commercial launches, even some spy satellites
 - Satellite constellation builders scrambling for new launchers (OneWeb, Kuiper, ...)
 - Solidified dominance of SpaceX for launch by removing a major competitor
 - But also caused massive funding for SpaceX future competition
 - Commercial satellite use grew for spying and military communications. Provider risk!
 - Ukrainian aerospace industry mostly demolished (affected Antares, Vega, Vega-C)



Antares Rocket. Credit: Northrop Grumman



ESA Exomars Rover. Credit: ESA

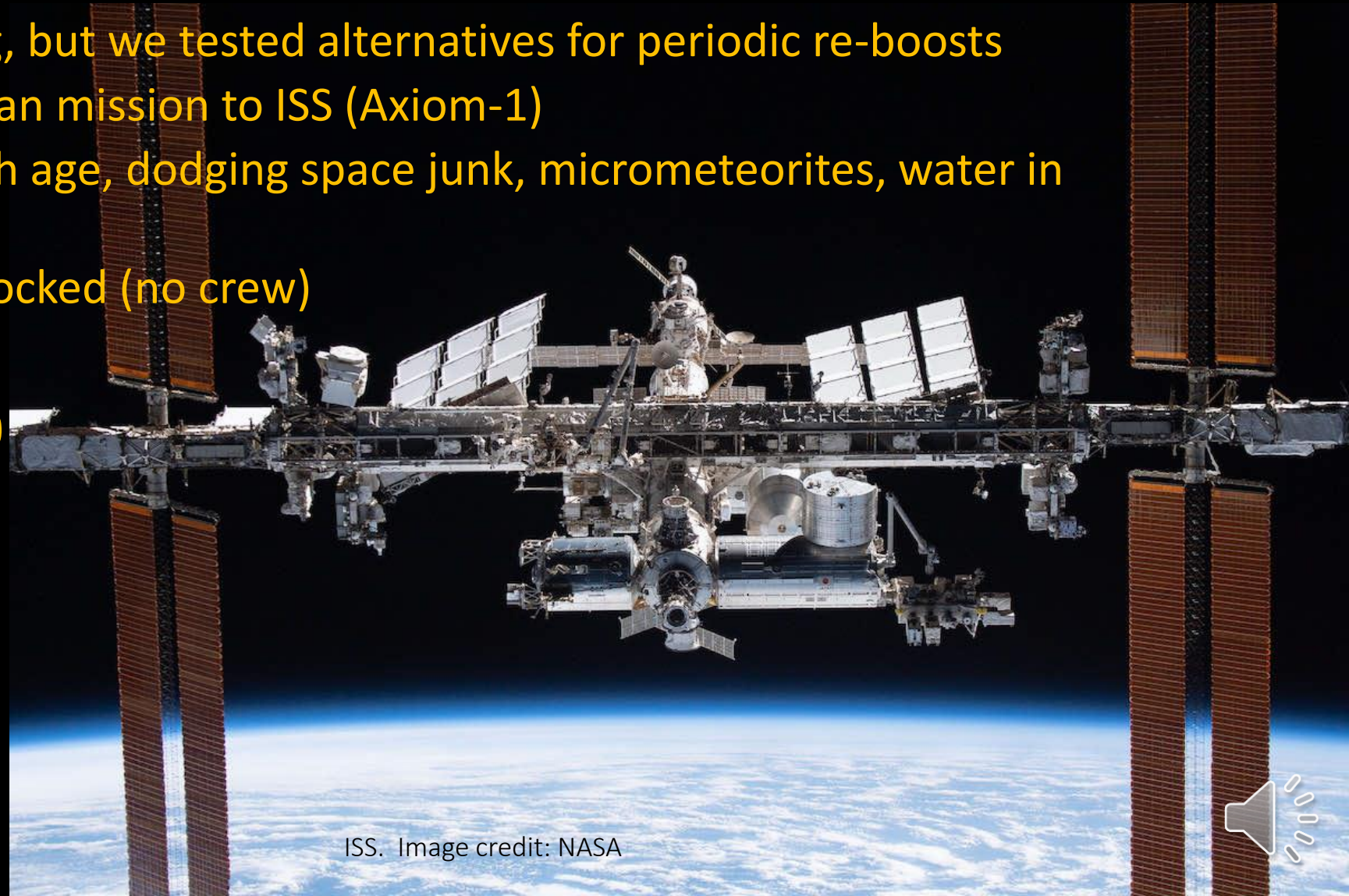


Image credit: Maxar Technologies



Year end review: International Space Station (ISS)

- ISS operations increased with increased flights, despite age
 - Russians still cooperating, but we tested alternatives for periodic re-boosts
 - First all-commercial human mission to ISS (Axiom-1)
 - Continuing problems with age, dodging space junk, micrometeorites, water in spacesuits, ...
 - Boeing Starliner finally docked (no crew)
 - New solar arrays, ...
- US says ISS good to 2030

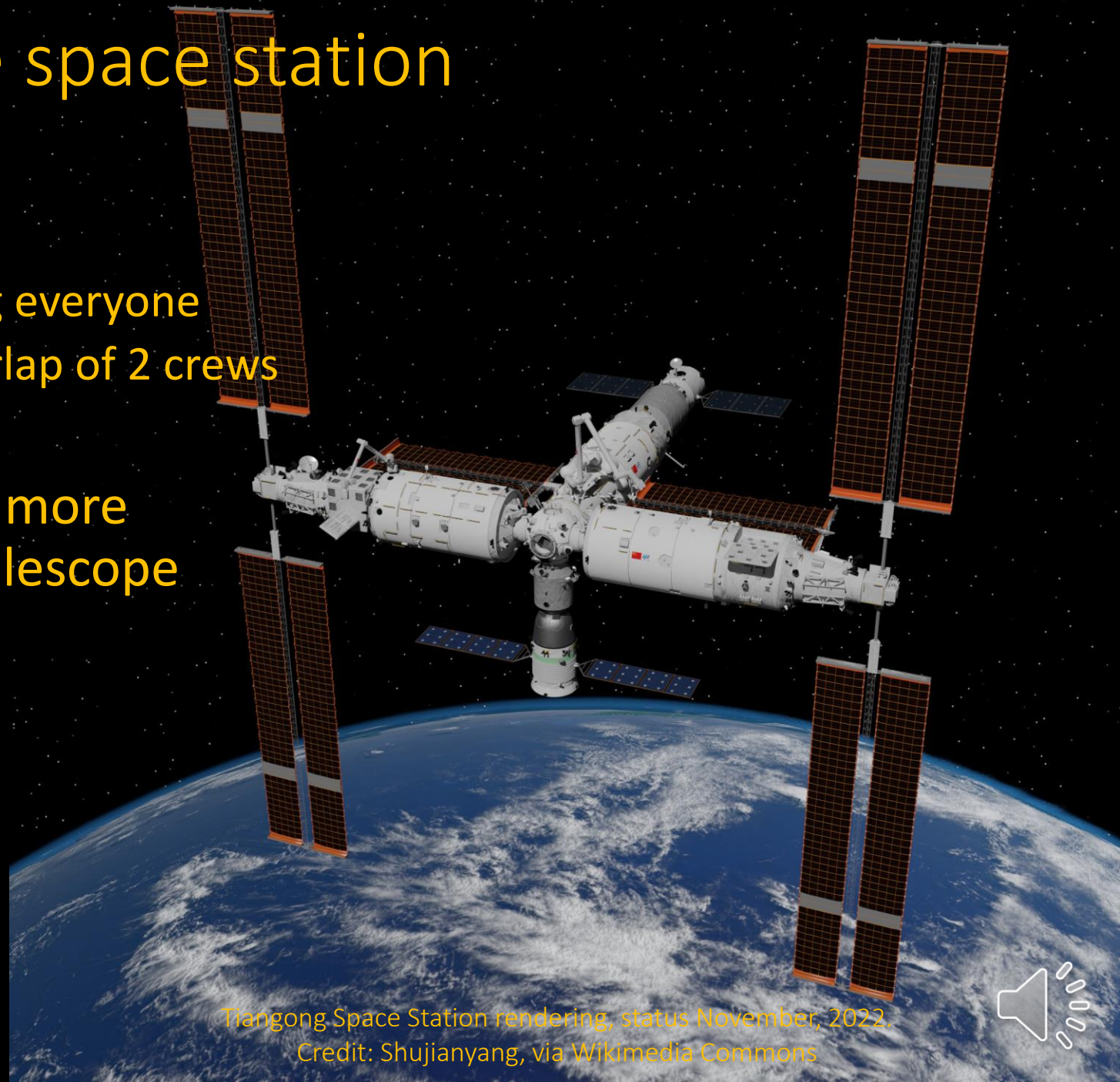


ISS. Image credit: NASA



Year end review: Chinese space station

- Phase 1 complete and occupied
 - Third module added Oct. 31
 - Boosters fall uncontrolled, worrying everyone
 - Capacity: 6 crew, tested during overlap of 2 crews
 - 1/5 mass of ISS
- Will be expanded and joined by a more powerful version of the Hubble telescope



Tiangong Space Station rendering, status November, 2022.
Credit: Shujianyang, via Wikimedia Commons



Year end review: large satellite internet constellations

- SpaceX Starlink internet service

- 3200 satellites (1,722 launched in 2022), 1 million subscribers
- Space weather matters: Lost 40 satellites after launch in February due to solar flare/geomagnetic storm increasing atmospheric size and drag

- OneWeb internet service

- 502 satellites (110 in 2022), now launching by SpaceX & India instead of Russian Soyuz

- Astronomers are concerned about satellite streaks in every picture



Credit: SpaceX



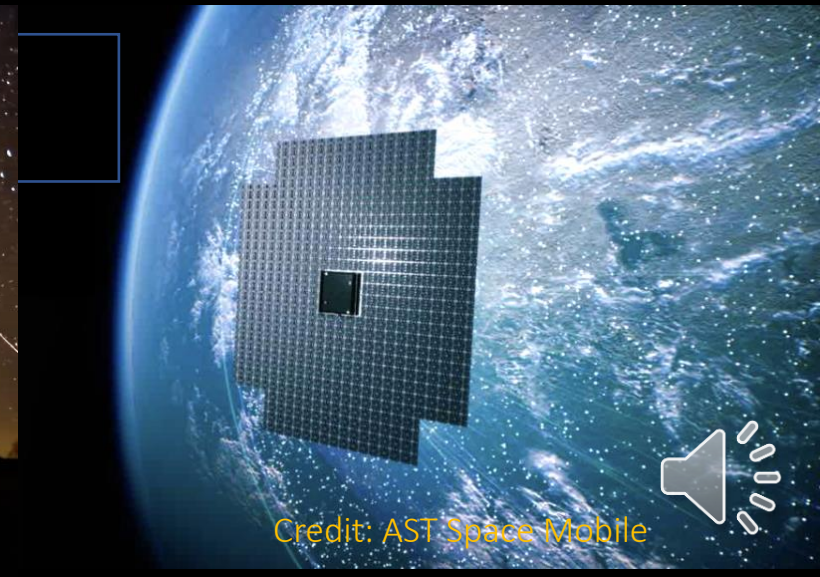
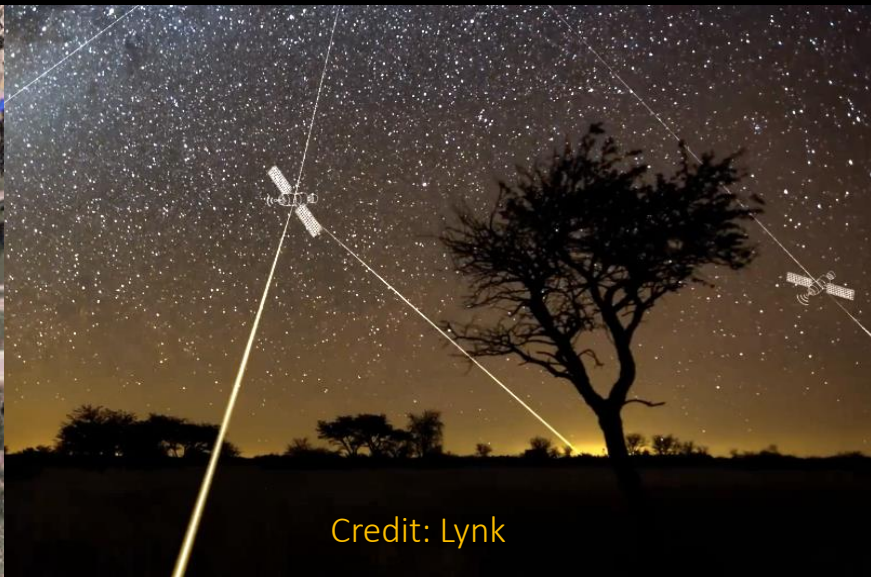
Year end review: what about Amazon's Kuiper project?

- Amazon's \$10B Kuiper internet service still years out
 - No prototypes have flown – awaiting ABL's RS1 rocket, ULA Vulcan Centaur
- Time pressure: FCC license requires ½ of satellites (1618 satellites) in orbit by 2026, rest by 2029
- Booked 83 launches in 2022 (\$5B ?)
 - All on rockets that don't yet fly:
 - 38 ULA's Vulcan Centaur
 - 12 Blue Origin New Glenn + option for 15 more
 - 18 Arianespace Ariane 6
 - Not counting 9 Atlas 5 (ULA) launches already bought
- Driving rocket development for SpaceX competitors



Year end review: other satellite constellations growth

- Direct satellite to ordinary cell phones is starting, somewhat
 - Apple began emergency messaging, investing heavily in Globalstar ground stations
 - 24 satellites, 85% capacity dedicated to Apple, with new ground station investment
 - AST Space Mobile launched their 26x26 ft. antenna direct satellite-phone test satellite
 - Lynk has 4 satellites testing text messages. Goal: thousands of satellites by 2025
 - SpaceX announced T-Mobile deal for texts, adding 16x16 ft. antenna to V2 Starlink
- Satellite constellations for earth observation are growing & almost profitable
 - Planet Labs has over 200 active satellites. Others: BlackSky, Maxar, ICEYE, Capella, ...



Year end review: Testing enabling technologies

- LOFTID inflatable heat shield tech demo
 - Creates large shields for cheap landing on Earth or Mars



- MOXIE success results (starting in 2021) published
 - Repeatedly generated O₂ from Mars 95% CO₂ atmosphere
 - $2 \text{ CO}_2 \rightarrow 2 \text{ CO} + \text{O}_2$ by solid oxide electrolysis
 - First demo of ISRU (In Situ Resource Utilization) on another planetary body

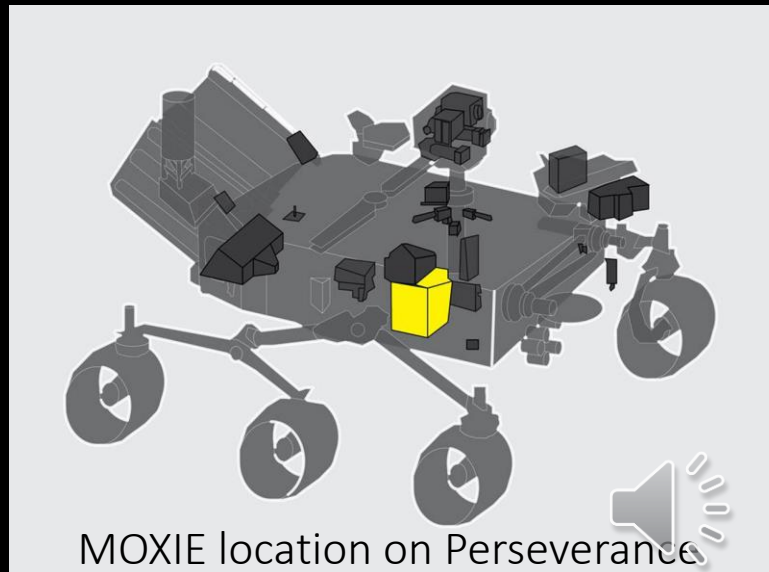


Image credits: NASA

MOXIE location on Perseverance

Discussion & questions?



Image: NASA



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