



Lunar Exploration: Radio Frequency Applications

Dialogues on Amateur Radio and Radio Astronomy

Mexico City/virtual

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Building the Moon Base



Phase 1
Relay Satellites
w/ Observability



Phase 1
Deployable Surface
Wireless Tower



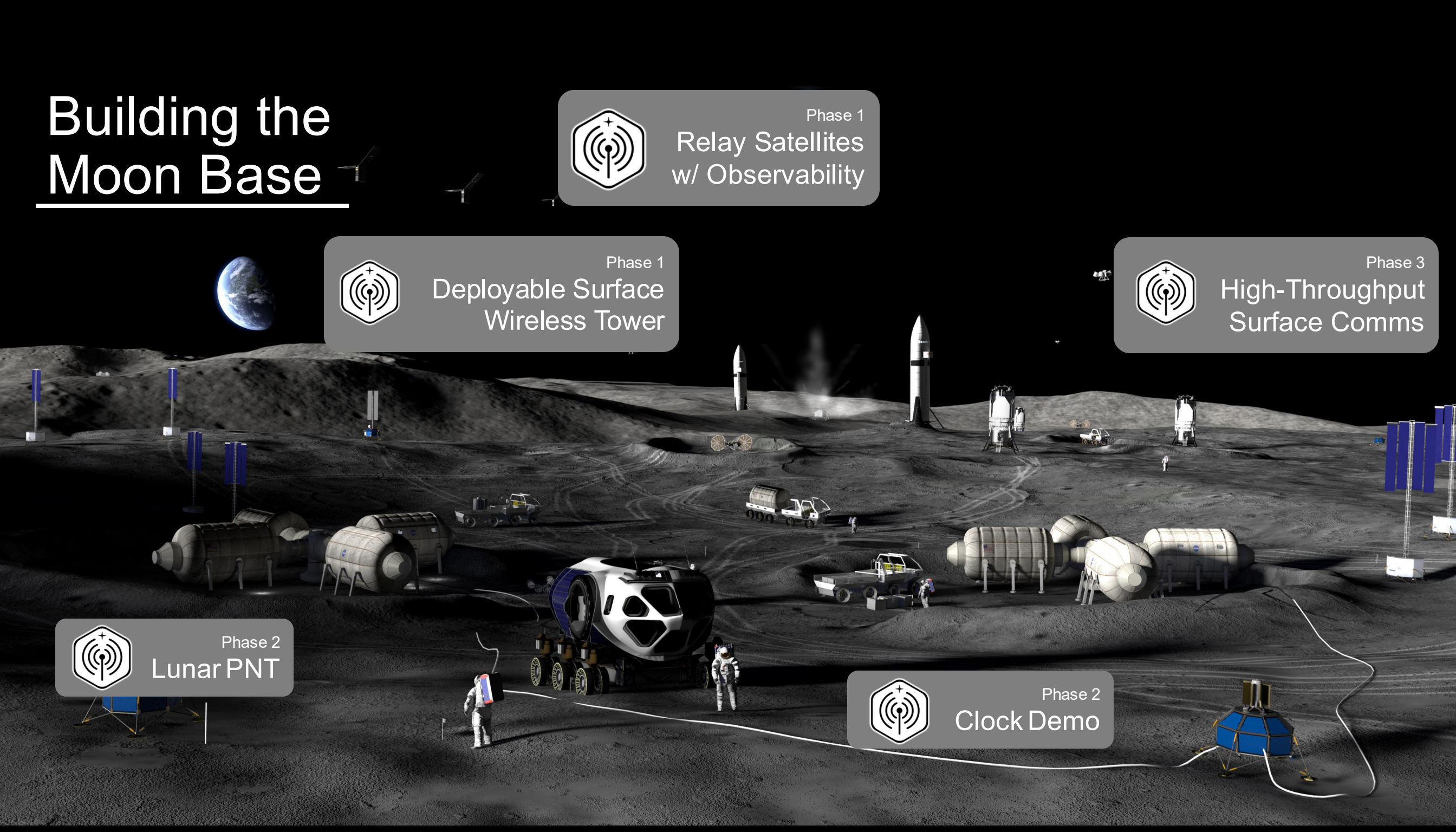
Phase 3
High-Throughput
Surface Comms

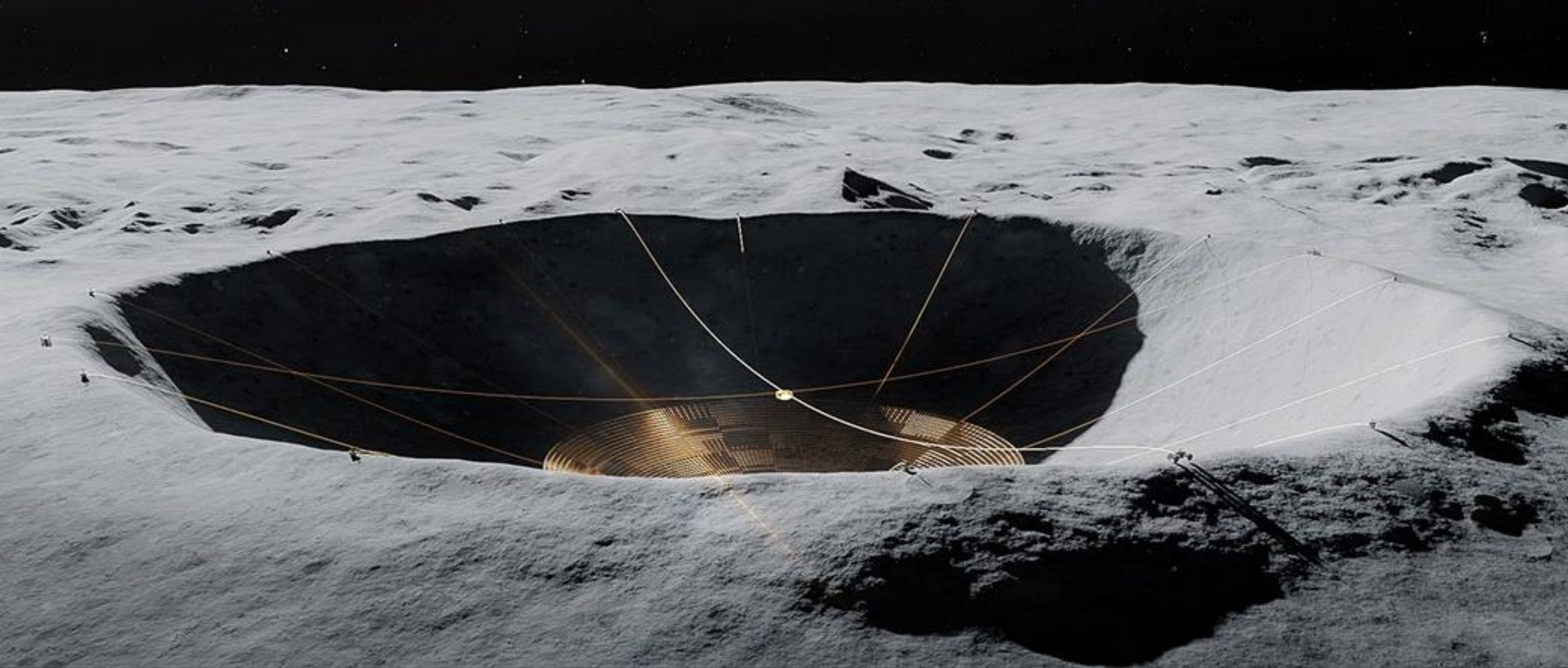


Phase 2
Lunar PNT



Phase 2
Clock Demo





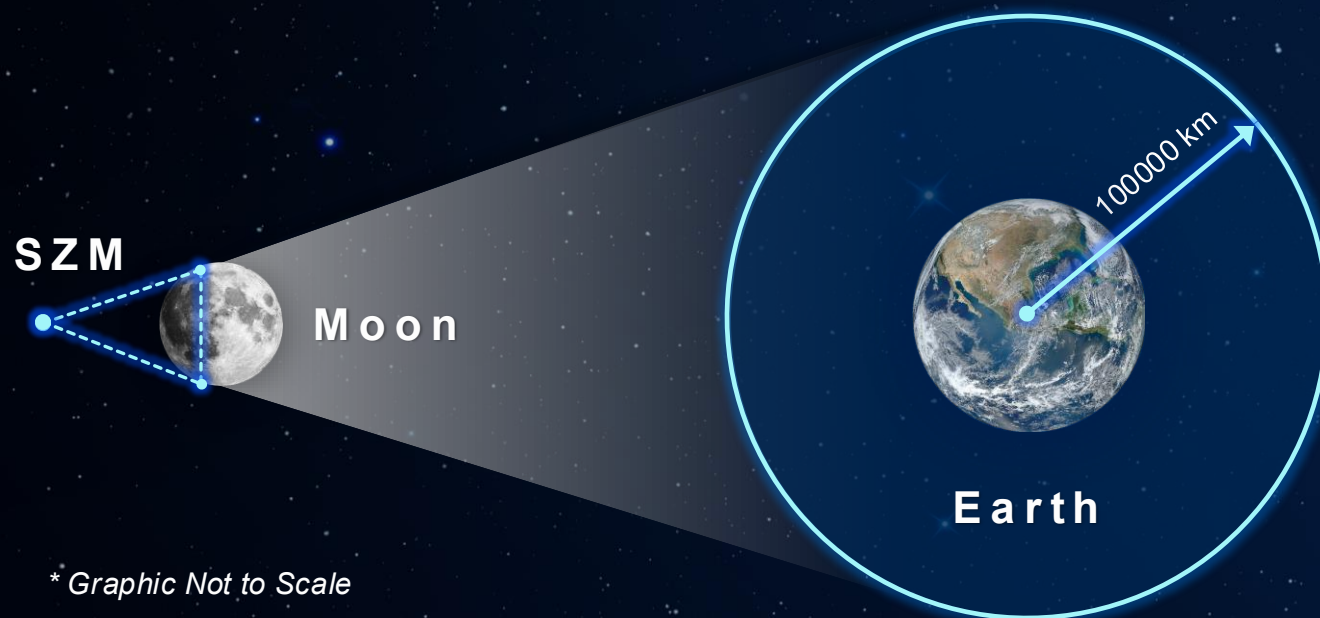
Radio Astronomy from the Shielded Zone of the Moon

Lunar Crater Radio Telescope

Enabling Unique Science from the Moon

Shielded Zone of the Moon (SZM)

22.22.1 The shielded zone of the Moon comprises the area of the Moon's surface and an adjacent volume of space which are shielded from emissions originating within a distance of 100 000 km from the centre of the Earth.



* Graphic Not to Scale

SZM is an ideal physical location from which to conduct radio astronomy observations of celestial objects and phenomena not detectable by Earth-based radio astronomy systems

ITU Radio Regulations Article 22 Section V

prohibits emissions that cause harmful interference (as agreed between relevant administrations) to radio astronomy and other passive services

except:

- in frequency **bands allocated for space research using active sensors**
- Space platforms using frequencies in bands allocated for **services supporting the communications and navigation needs** of space research

Outside these exceptions, protection of radio astronomy in the SZM, is achieved through agreements between involved administrations

Existing Space Research Spectrum for Lunar Science & Research Missions

Lunar Surface Communications & Wireless Network:

- > 390 – 405 MHz ²
- > 410 – 420 MHz
- > 435 – 450 MHz ³
- > 2.4 – 2.48 GHz ²
- > 2.5035 – 2.655 GHz ²
- > 3.5 – 3.8 GHz ²
- > 5.15 – 5.835 GHz ^{3,4}
- > 5.855 – 5.925 GHz ²
- > 25.25 – 25.50 GHz ⁵
- > 27.225 – 27.5 GHz ⁵
- > 27.5 – 28.35 GHz

LO-to-LO:

- > 2025 – 2110 MHz
- > 2200 – 2290 MHz
- > 23.15 – 23.55 GHz ⁶
- > 27.0 – 27.5 GHz ⁵

Lunar SAR:

- > 406 – 406.1 MHz (emergency beacon outside of SZM)
- > 2298.36 – 2299.64 MHz

LO-to-LO (Relay Cross Link):

- > 13.75 – 14.0 GHz ³
- > 14.5 – 15.35 GHz
- > 23.15 – 23.55 GHz ⁶
- > 27.0 – 27.5 GHz

LS-to-LO:

- > 435 – 450 MHz ³
- > 2200 – 2290 MHz
- > 27.0 – 27.5 GHz

LO-to-LS:

- > 390 – 405 MHz ²
- > 2025 – 2110 MHz
- > 23.15 – 23.55 GHz ⁶



LS-to-Earth: 8450 - 8500 MHz 25.5 – 27.0 GHz

Earth-to-LS: 7190 - 7235 MHz 22.55 – 23.15 GHz

LO-to-Earth: 8450 - 8500 MHz 25.5 – 27.0 GHz

Earth-to-LO: 7190 - 7235 MHz 22.55 – 23.15 GHz

LEGEND:

-  Direct Point-to-Point Link
-  No existing service allocation for science support (identified gaps)
- LO** Lunar Orbit
- LS** Lunar Surface
- SAR** Search and Rescue

NOTES:

1. Includes space research (SRS), space operation (SOS), Earth observation-satellite (EESS), and inter-satellite service (ISS) allocations; primary allocations unless stated otherwise in these notes.
2. Possible uses for science missions on the lunar surface and relay orbiters.
3. Portions of the frequency range are not allocated on a primary basis.
4. SRS uses in 5650-5725 MHz are limited to deep space links (secondary allocation).
5. ISS allocations in these frequency ranges are limited to space research and Earth exploration-satellite applications, and also transmissions of data originating from industrial and medical activities in space.
6. Provisions in Resolution 750 (WRC-19) apply within 22.55-23.55 GHz to ensure compatibility between EESS (passive) and other allocated active services in this band.

WRC-2023: Report of the Director on the activities of the Radiocommunication Sector, 3.1.9.2,

- “The Bureau has received enquiries from administrations and operators about the appropriate radiocommunication service to use for stations orbiting or operating on the surface of the Moon.”
- “The Bureau has advised that such use of radiocommunication service should make use of only the allocation for space research services or the space operation service (if it is for the operation of the spacecraft.)”

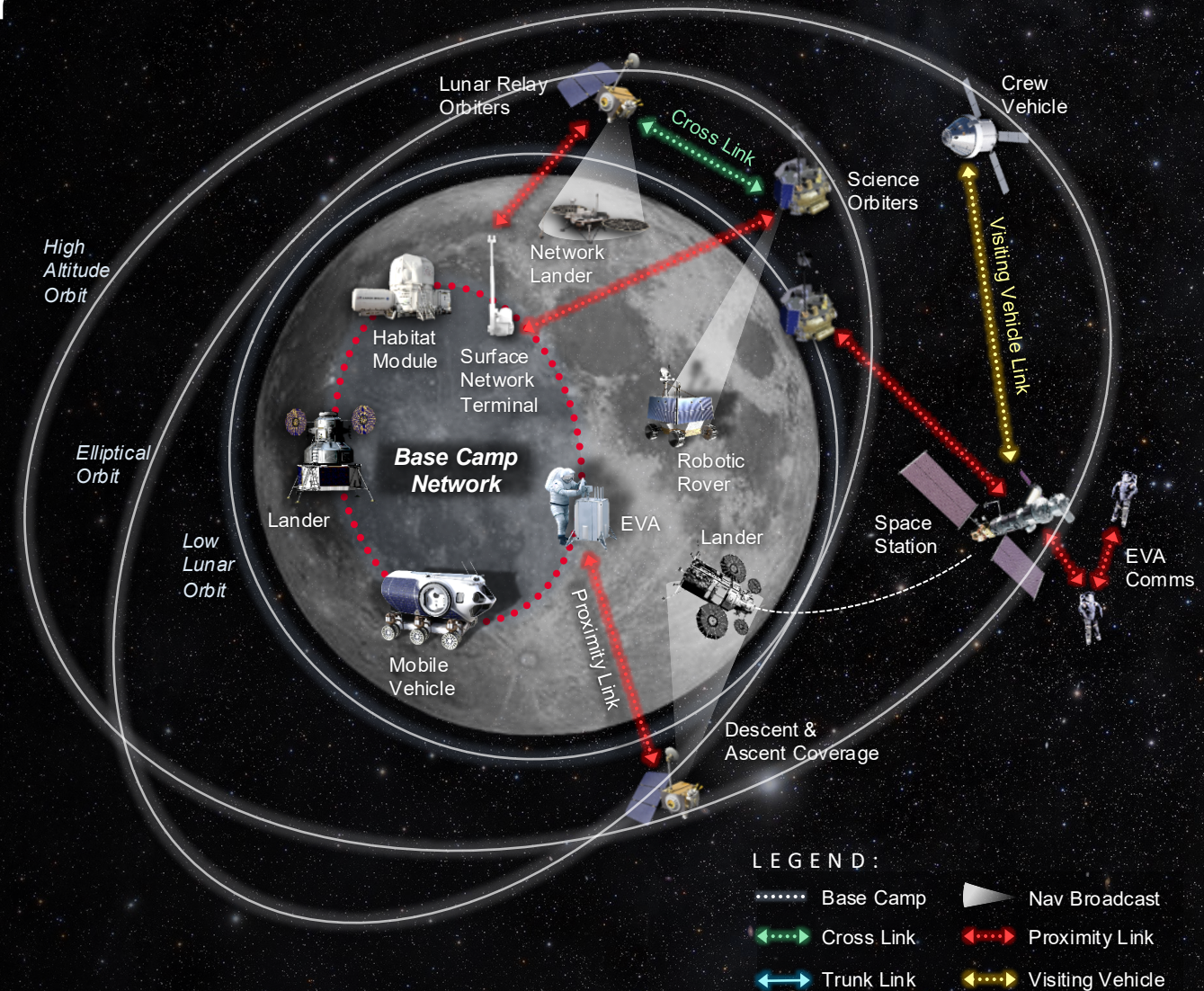
Frequency Gaps based on Near-Term Lunar Mission Needs

- Frequency gaps were identified and are now under study for a WRC-27 decision (Agenda Item 1.15) to enable near term scientific lunar exploration -- both robotic and human missions on and around the Moon.

WRC-27 Agenda Item 1.15 enables:

- advanced wireless technology infusion
- greater scientific returns
- multi-national/industry/government engagements

It will pave the way for future discovery and broader collaboration!



Inspiring the Next Generation

Connectivity between scientists and explorers in space brings inspiration home to Earth.



[NASA's Citizen Science Projects](#)
[Amateur Radio on the International Space Station](#)

