Human Spaceflight and Radio Frequency Spectrum

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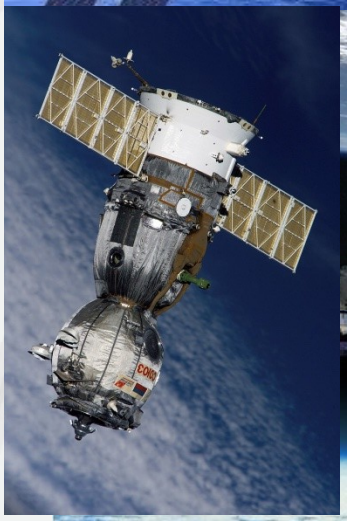
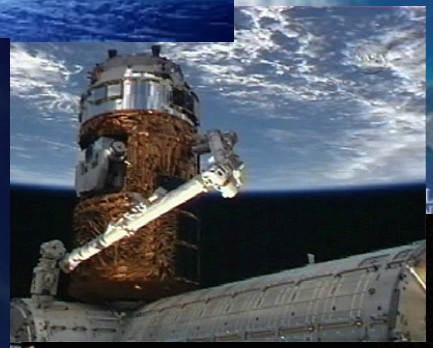
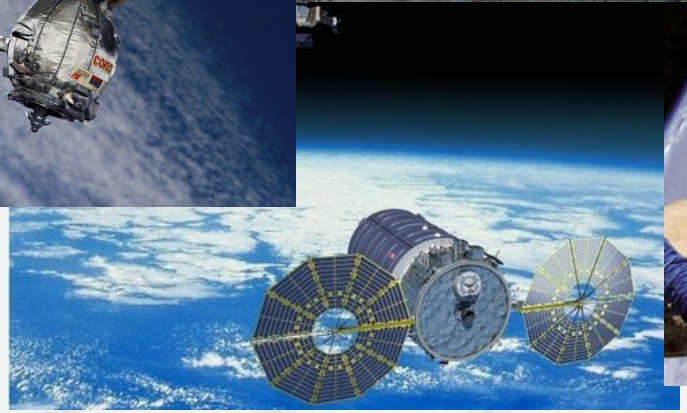
Human Spaceflight Programs

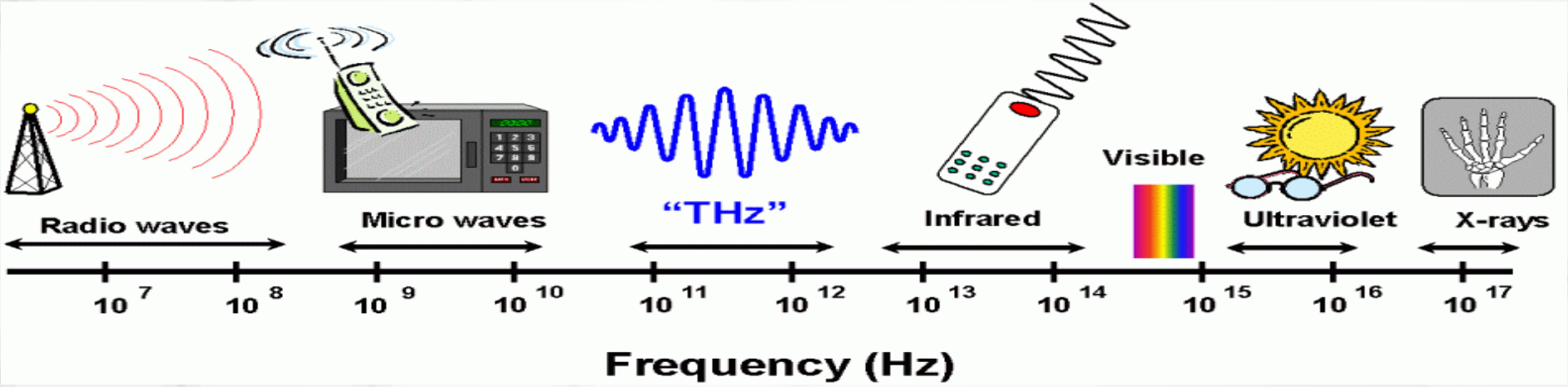






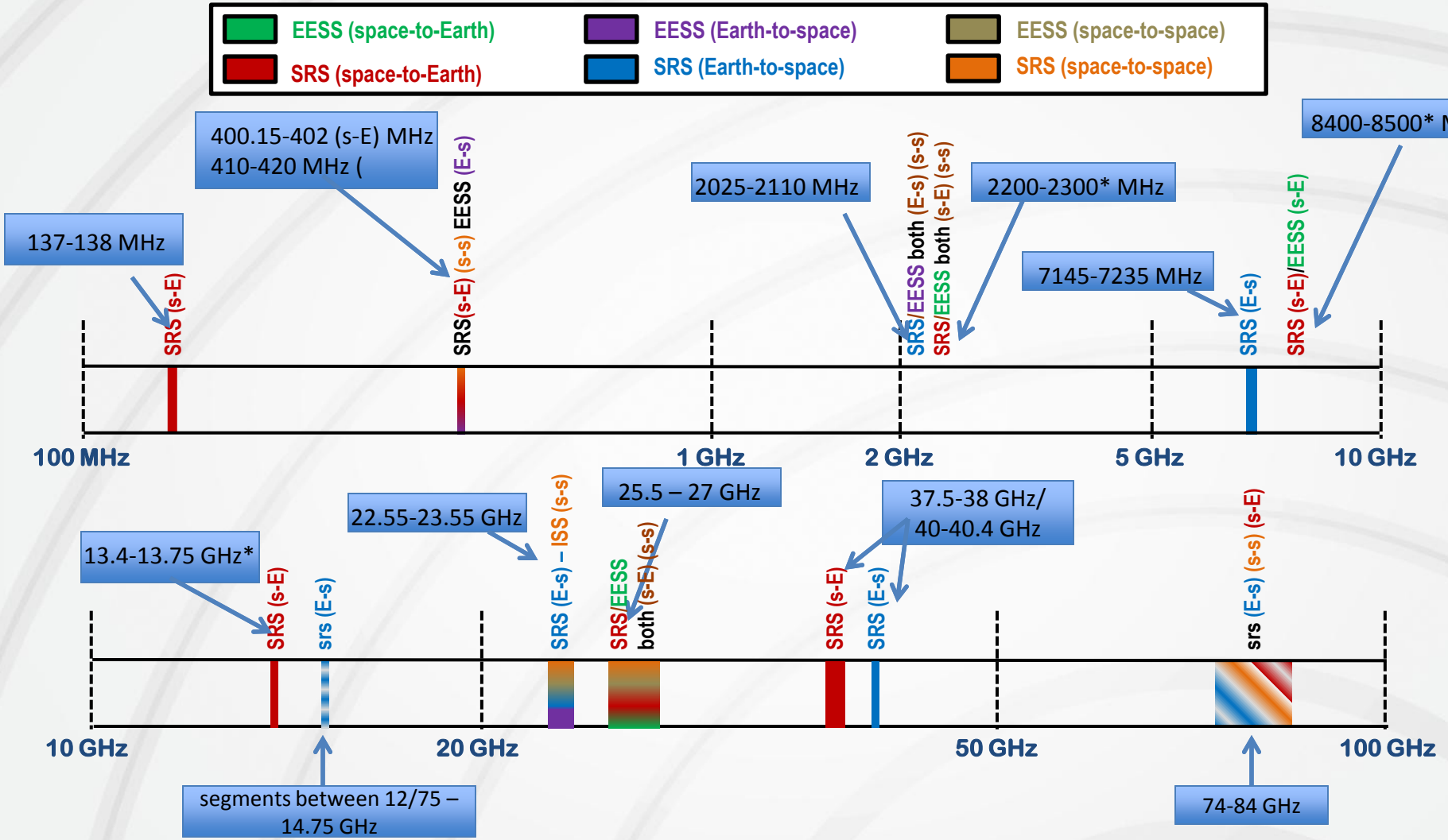
Why Have A Preferred Radio Frequency?

- *The human eyes can only detect a very small portion of the electromagnetic spectrum called the visible light.*
- *Scientific instruments utilizes the full range of the electromagnetic spectrum to study the Earth, the solar system, and the universe beyond.*
- *The Sun, emits electromagnetic energy across the full spectrum. Exposure to high energy waves can alter atoms and molecules which cause damages to cells in organic matters.*



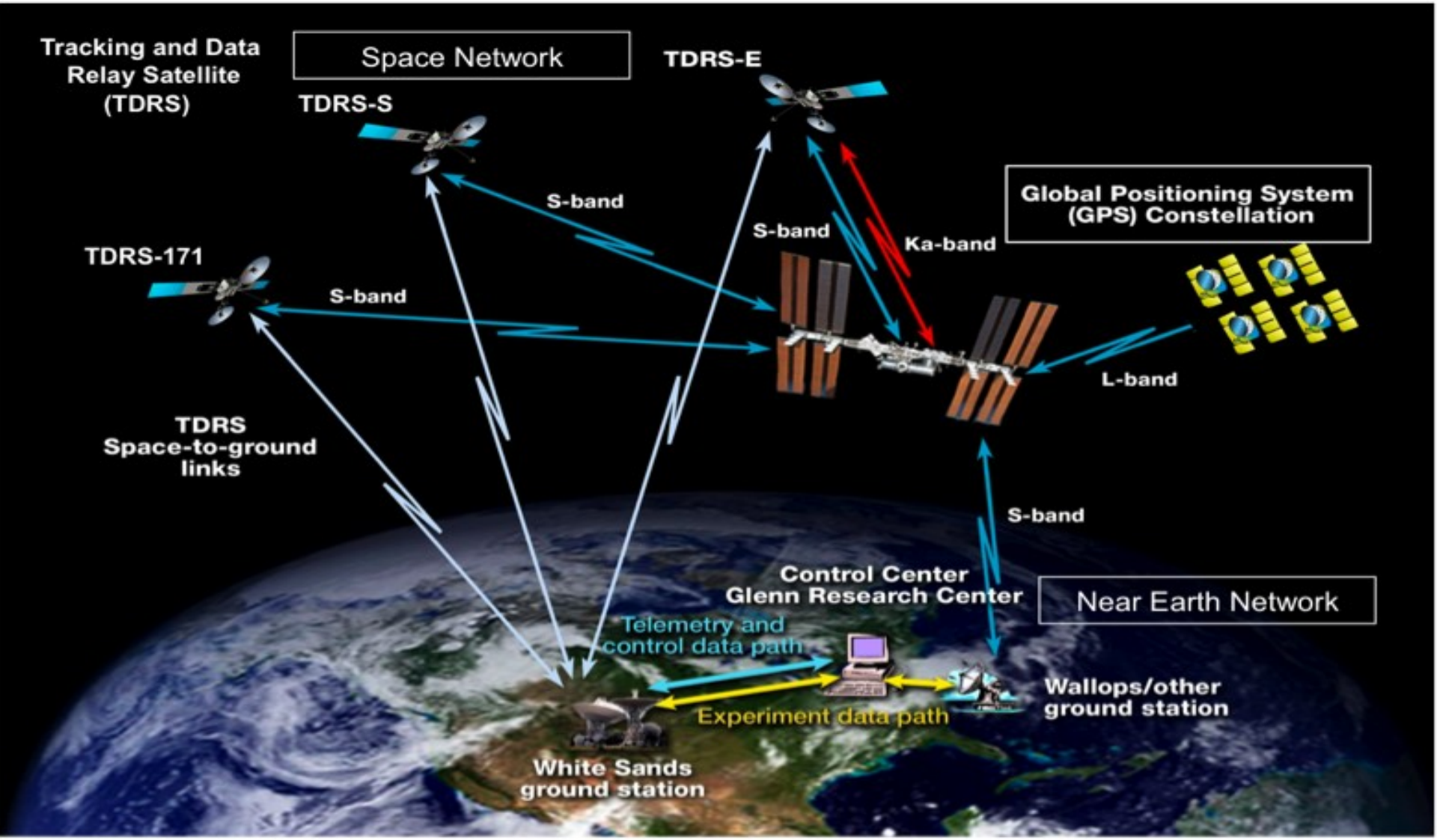
- *The Earth's atmosphere protects us from exposure to a range of higher energy waves that can be harmful to human bodies; conversely, certain waves are better suited for communications between Earth and space, while others offer better properties for communications between vehicles in space.*

SRS Spectrum Available for Human Spaceflight Missions



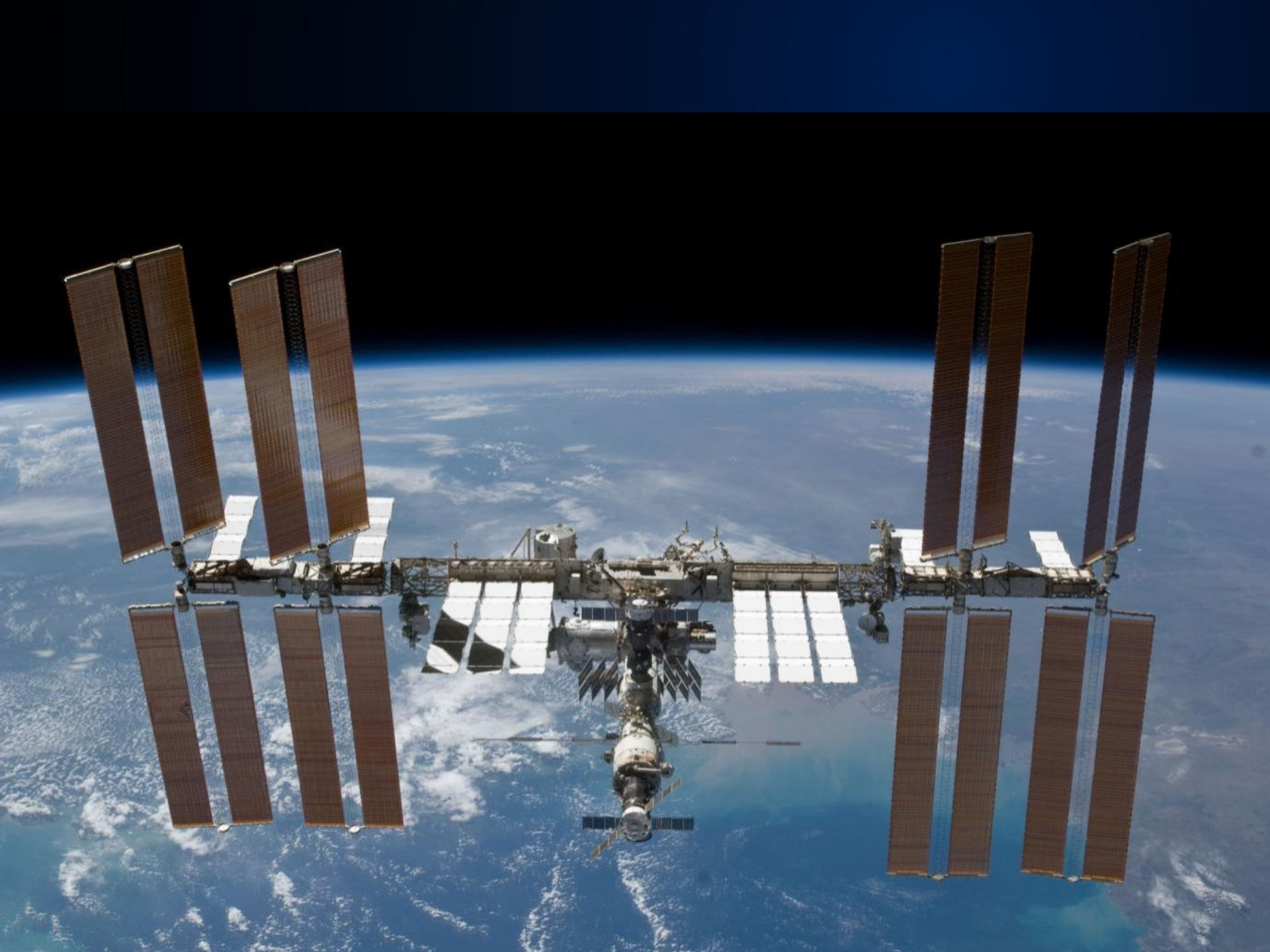
(100 MHz – 100 GHz)

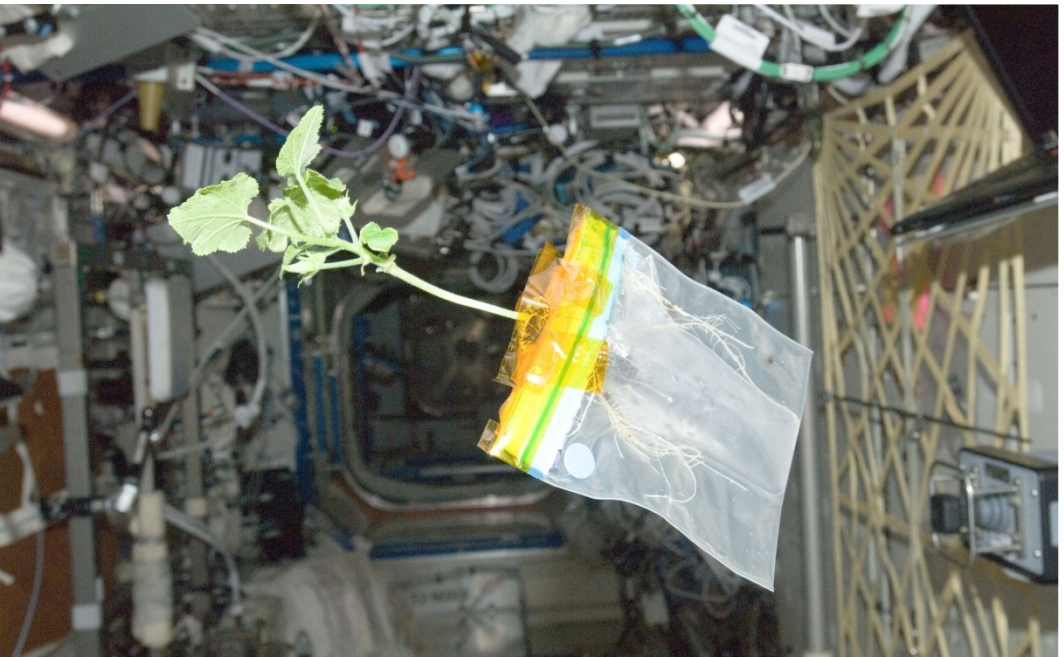
Human Spaceflight - LEO Missions



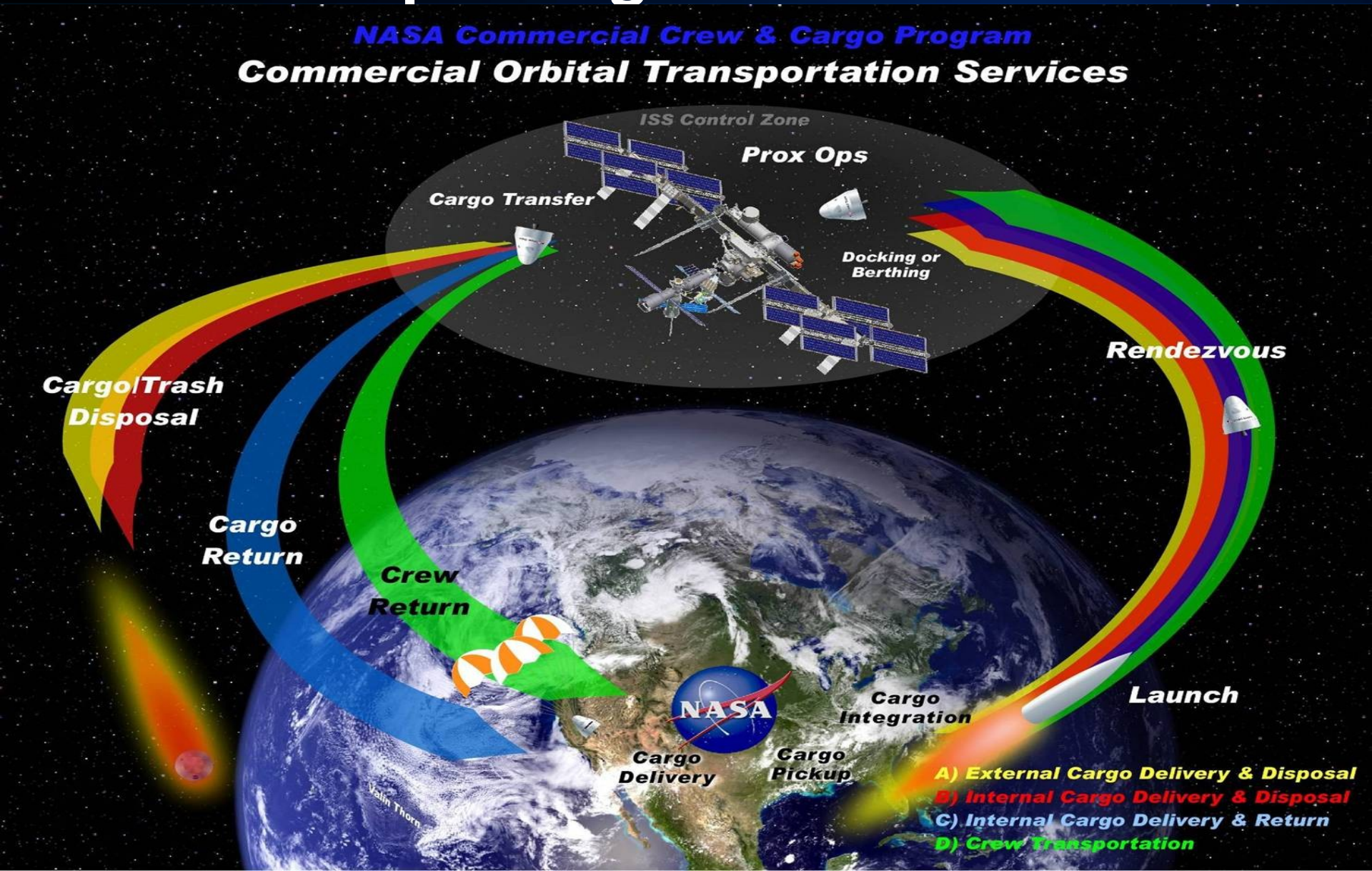
Human Spaceflight Mission RF Concept of Operations

- **Categories of Data**
  - Tracking, Telemetry &Command (TT&C) to/from spacecraft (s/c), including navigation/location of the spacecraft, its movement and direction to MCC
  - Imagery/video – still or motion
  - Experiment/science results
  - Voice
  - files
- **Mission Phases**
  - **Launch/powered ascent -** Launch vehicle and spacecraft comm with MCC
  - **Orbit Operation/spacecraft free flight –** spacecraft communication with MCC
  - **Proximity operation -** Rendezvous and docking operations with co-orbiting vehicles; direct comm between co-orbiting vehicles and comm with MCC
  - **Extra-vehicular activity (EVA)** – spacewalkers comm with base stations
  - **Robotics Operations –** construction/installation and module transfer operation, comm with other crew/EVAs and MCC
  - **Nominal re-entry/landing –** communication with MCC and landing site
  - **Emergency communications** – humans/spacecraft to Ground stations

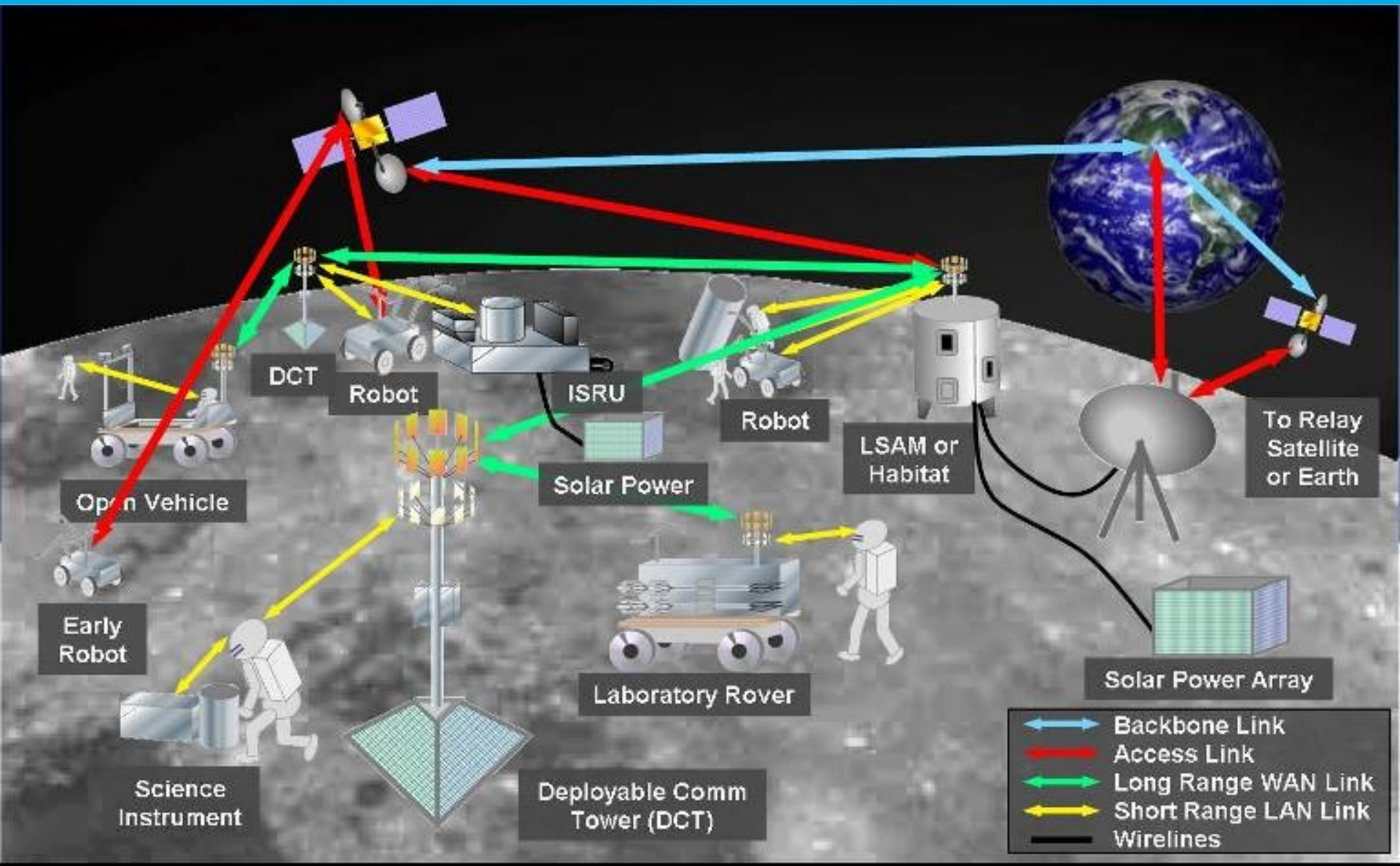




Unique RF Environment of Human Spaceflight Missions

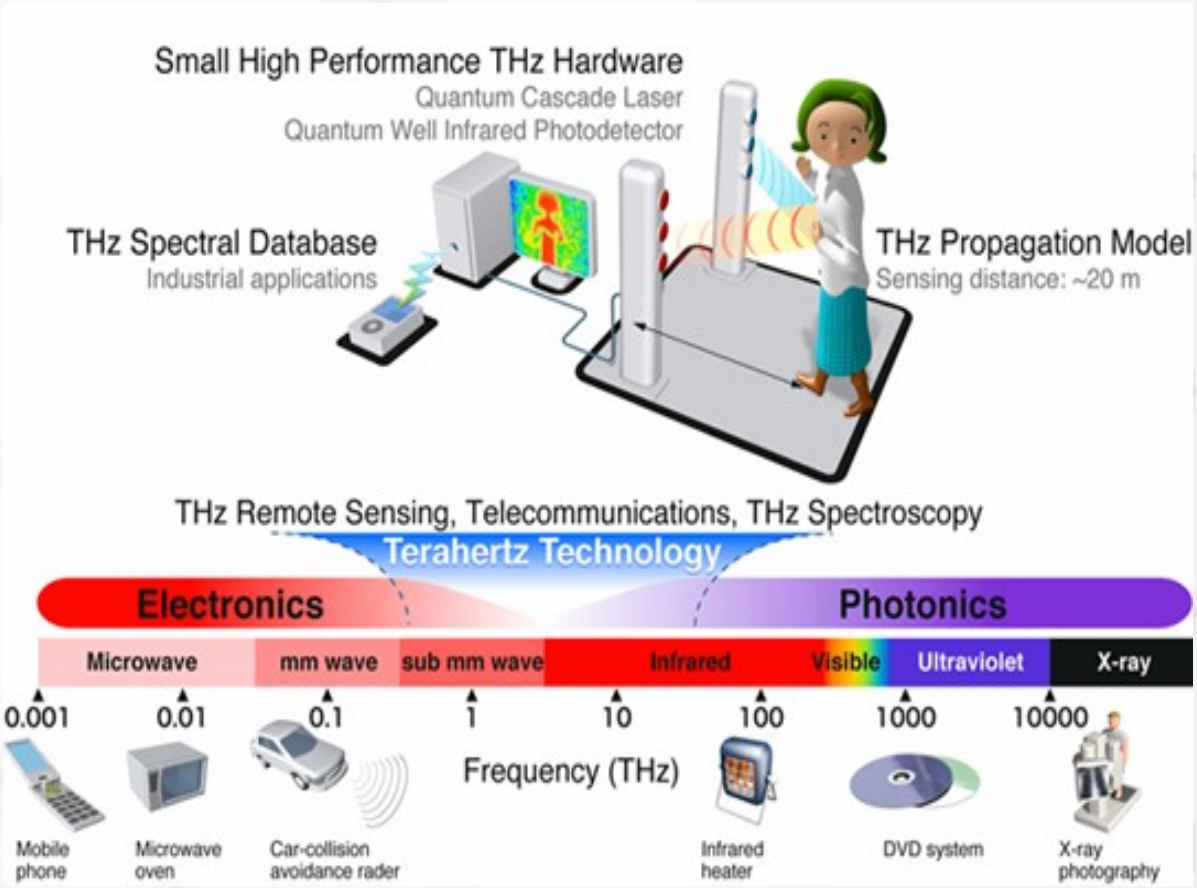


Human Exploration Mission Radio Links



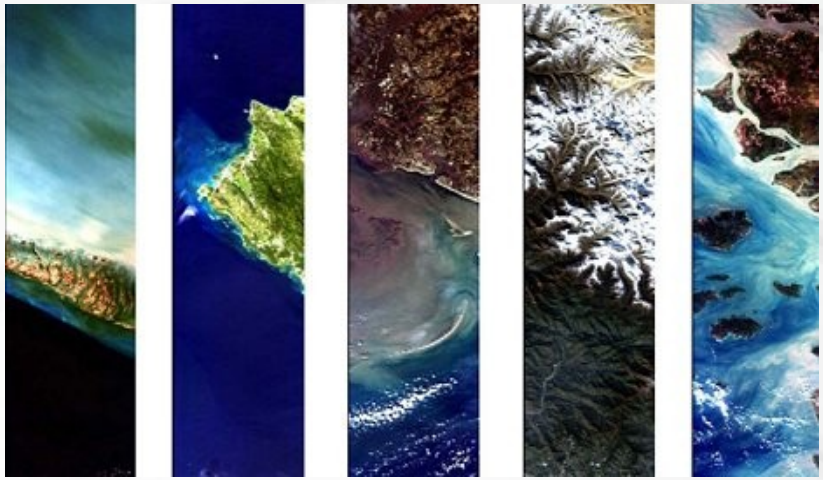
Emerging Wireless Technologies for Human Spaceflight Missions

- Cognitive Radios
  - 54-862 MHz over TV white space
  - IEEE 802.22 and 802.11af
- Gigabit WLAN
  - 60GHz
  - IEEE 802.11ad
- E-band (Wireless Fiber)
  - 71-86 GHz
- Terahertz (THz)
  - 300-3000 GHz

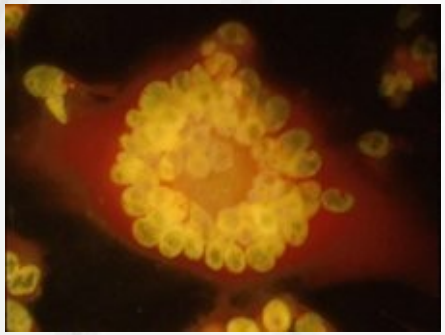


Summary

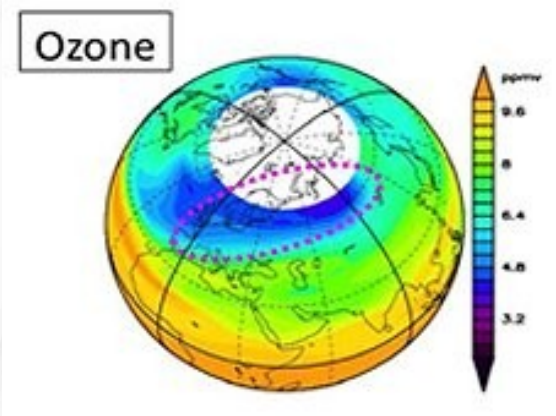
- **Radio Frequency spectrum is one of the key enablers of human spaceflight missions - research, education, advanced technology and medicine, Earth observation and study, vaccine development, disaster relief for the benefit of human kind.**



Hyperspectral Imager for the Costal Ocean (HICO)



Early Detection of Immune Changes Prevents Painful Shingles in Astronauts and Earth-Bound Patients



Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES)

SOdium LOad in microgravity (SOLO)

Questions