MARS Rover

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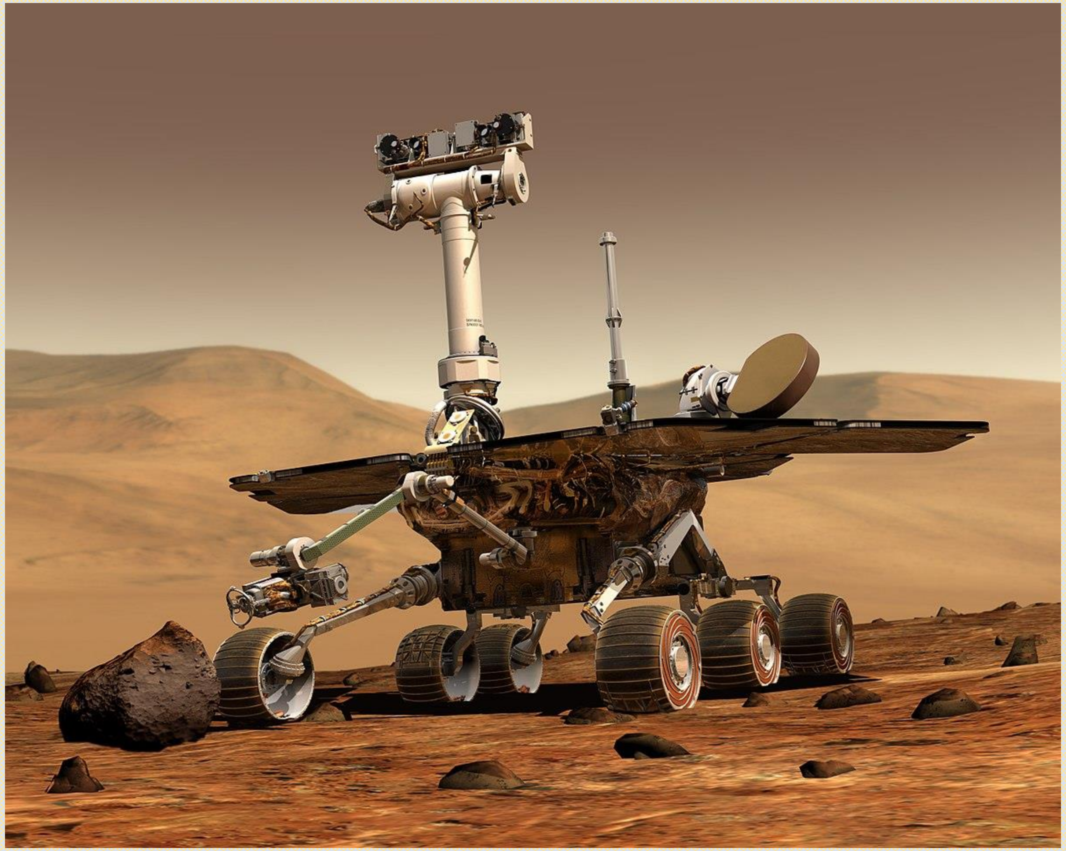
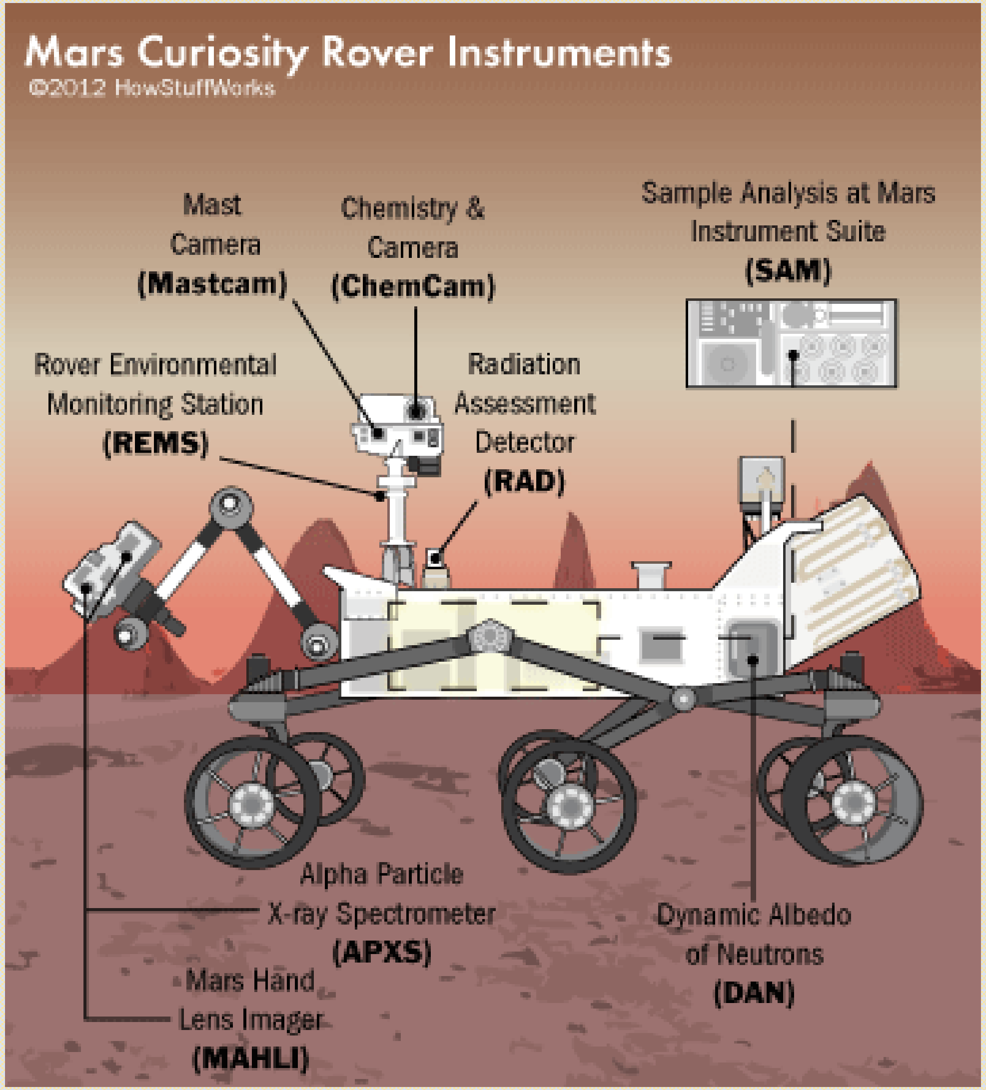
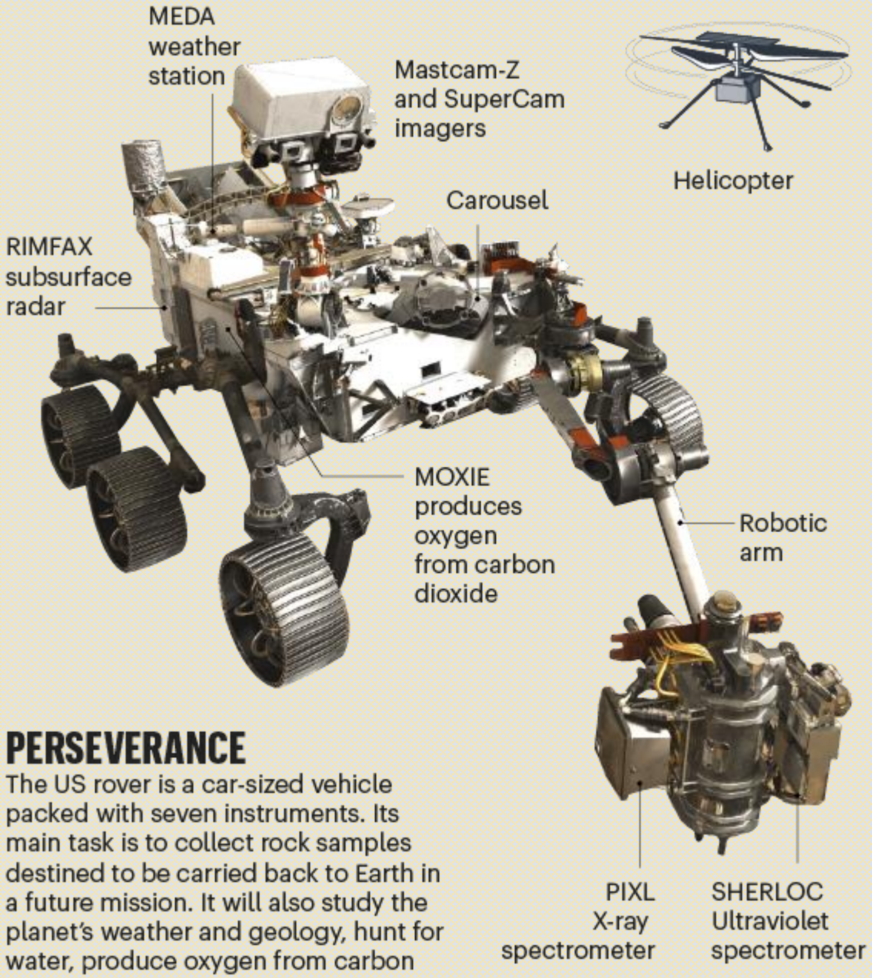
Introduction

- Mars rover is a motor vehicle that travels across the surface of the planet Mars upon arrival.
- There have been five successful robotically operated Mars rovers, all managed by the Jet Propulsion Laboratory: Sojourner, Opportunity, Spirit, Curiosity, and Perseverance.
- Each vehicle is sent with specific mission to accomplish



General design for various application





PERSEVERANCE

The US rover is a car-sized vehicle packed with seven instruments. Its main task is to collect rock samples destined to be carried back to Earth in a future mission. It will also study the planet's weather and geology, hunt for water, produce oxygen from carbon dioxide, record sounds for the first time and test a solar-powered helicopter.

Perseverance Rover Key Hardware

- Mastcam-Z, an advanced camera system with panoramic and stereoscopic imaging capability with the ability to zoom. The instrument also will determine mineralogy of the Martian surface and assist with rover operations. The principal investigator is James Bell, Arizona State University in Tempe.

- SuperCam, an instrument that can provide imaging, chemical composition analysis, and mineralogy at a distance

- Planetary Instrument for X-ray Lithochemistry (PIXL), an X-ray fluorescence spectrometer and high-resolution imager to map the fine-scale elemental composition of Martian surface materials. PIXL will provide capabilities that permit more detailed detection and analysis of chemical elements than ever before.

- The Mars Oxygen In-Situ Resource Utilization Experiment (MOXIE), a technology demonstration that will produce oxygen from Martian atmospheric carbon dioxide. If successful, MOXIE’s technology could be used by future astronauts on Mars to burn rocket fuel for returning to Earth

Perseverance Rover Key Hardware

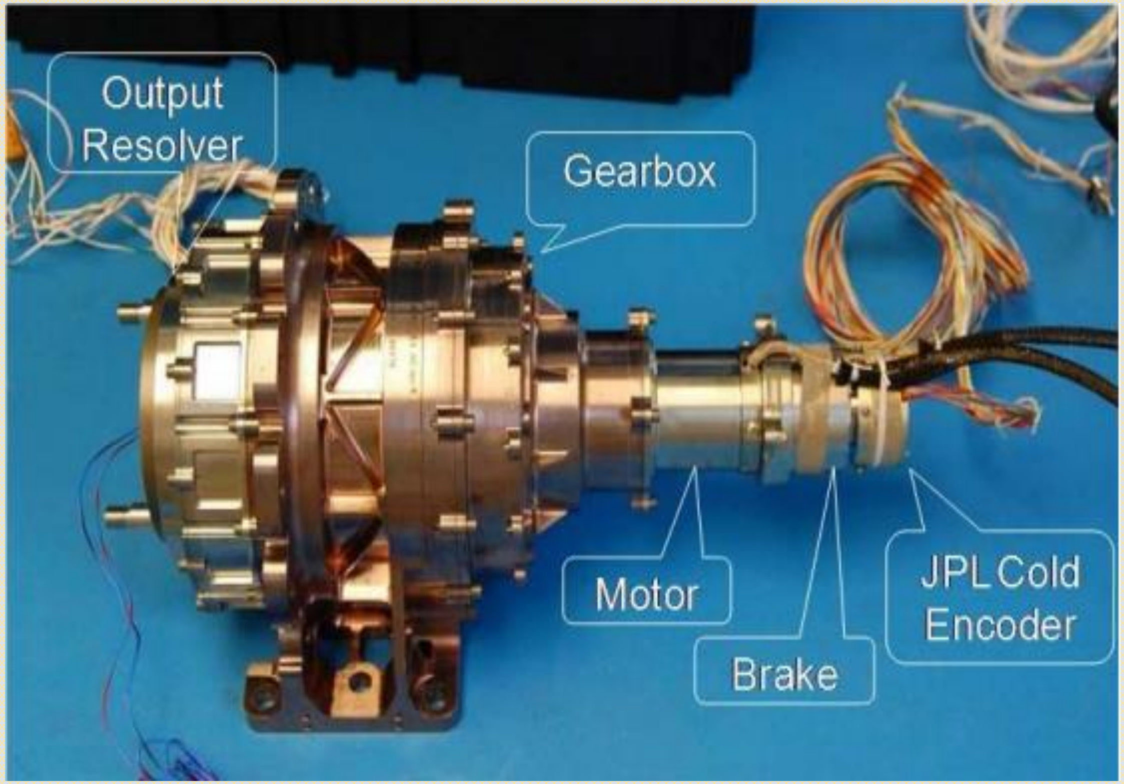
- Scanning Habitable Environments with Raman & Luminescence for Organics and Chemicals (SHERLOC), a spectrometer that will provide fine-scale imaging and uses an ultraviolet (UV) laser to map mineralogy and organic compounds. SHERLOC will be the first UV Raman spectrometer to fly to the surface of Mars and will provide complementary measurements with other instruments in the payload. SHERLOC includes a high-resolution color camera for microscopic imaging of Mars' surface.

- The Radar Imager for Mars' Subsurface Experiment (RIMFAX), a ground-penetrating radar that will provide centimeter-scale resolution of the geologic structure of the subsurface.

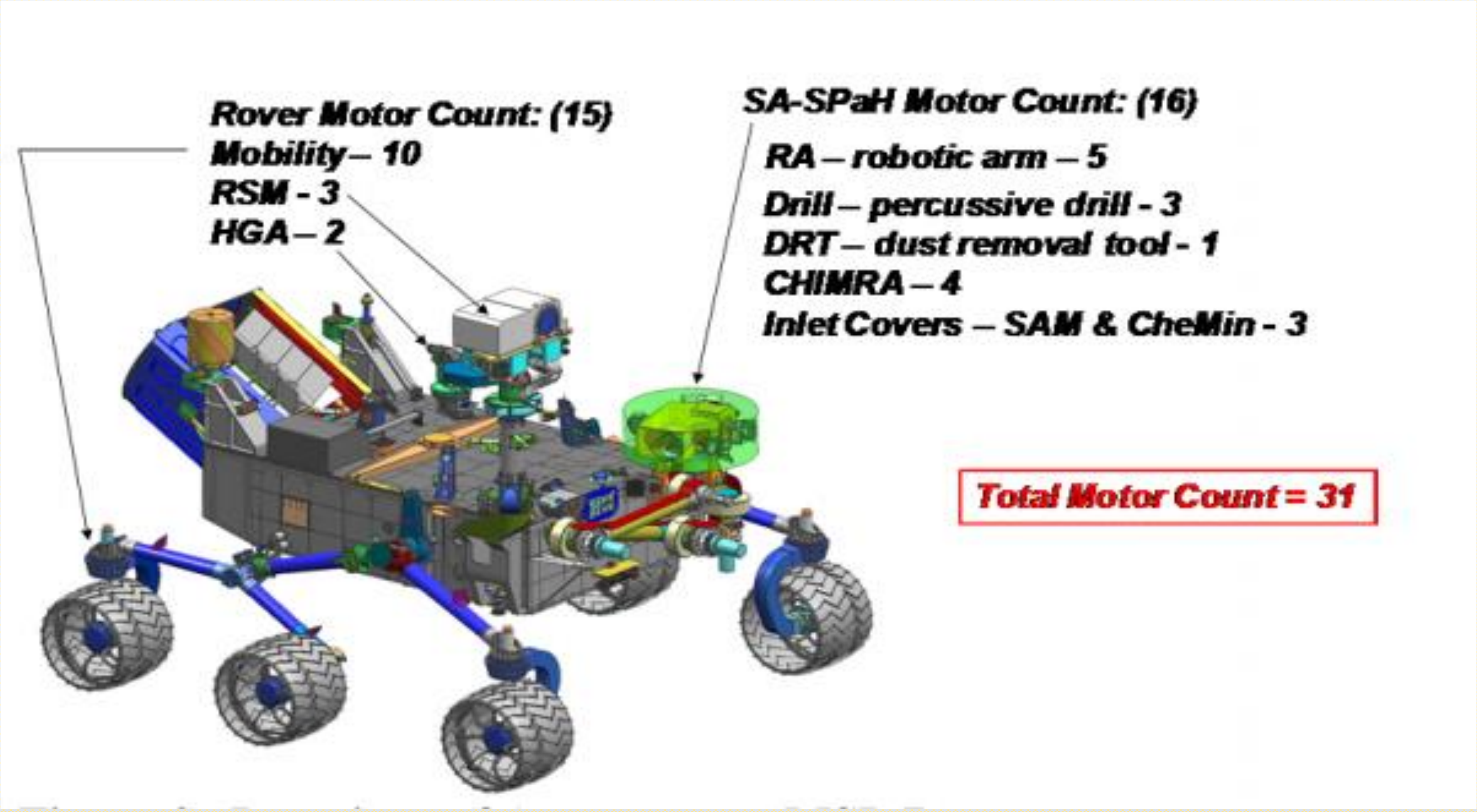
- Mars Environmental Dynamics Analyzer (MEDA), a set of sensors that will provide measurements of temperature, wind speed and direction, pressure, relative humidity, and dust size and shape

Locomotion system & actuators

- There is a total of 31 actuators in Mars rover
- The actuators provide all of the articulation needed to move and point the science camera, to move communication antenna, to drive and steer the rover, to collect, process and deliver solid samples the laboratory science instruments inside the rover body.
- Each actuator consists of an electric, brushless, DC motor, a brake, an encoder, a gear box and output resolver.
- The electric motor provides the energy to move the mechanism.



Locomotion system & actuators



Guidance, Navigation, and Control

- This system also includes the reaction wheels, gyro-like devices used along with thrusters to control the spacecraft's orientation. Like most spacecraft, Odyssey's orientation is held fixed in relation to space ("three-axis stabilized") as opposed to being stabilized via spinning. There are a total of four reaction wheels, with three used for primary control and one as a backup.
- Using three redundant pairs of sensors, the guidance, navigation and control subsystem determines the spacecraft's orientation, or "attitude." A sun sensor is used to detect the position of the sun as a backup to the star camera. A star camera is used to look at star fields. Between star camera updates, a device called the inertial measurement unit collects information on spacecraft orientation.
- The guidance, navigation and control subsystem weighs 23.4 kilograms (51.6 pounds).

Communication system in Curiosity Rover

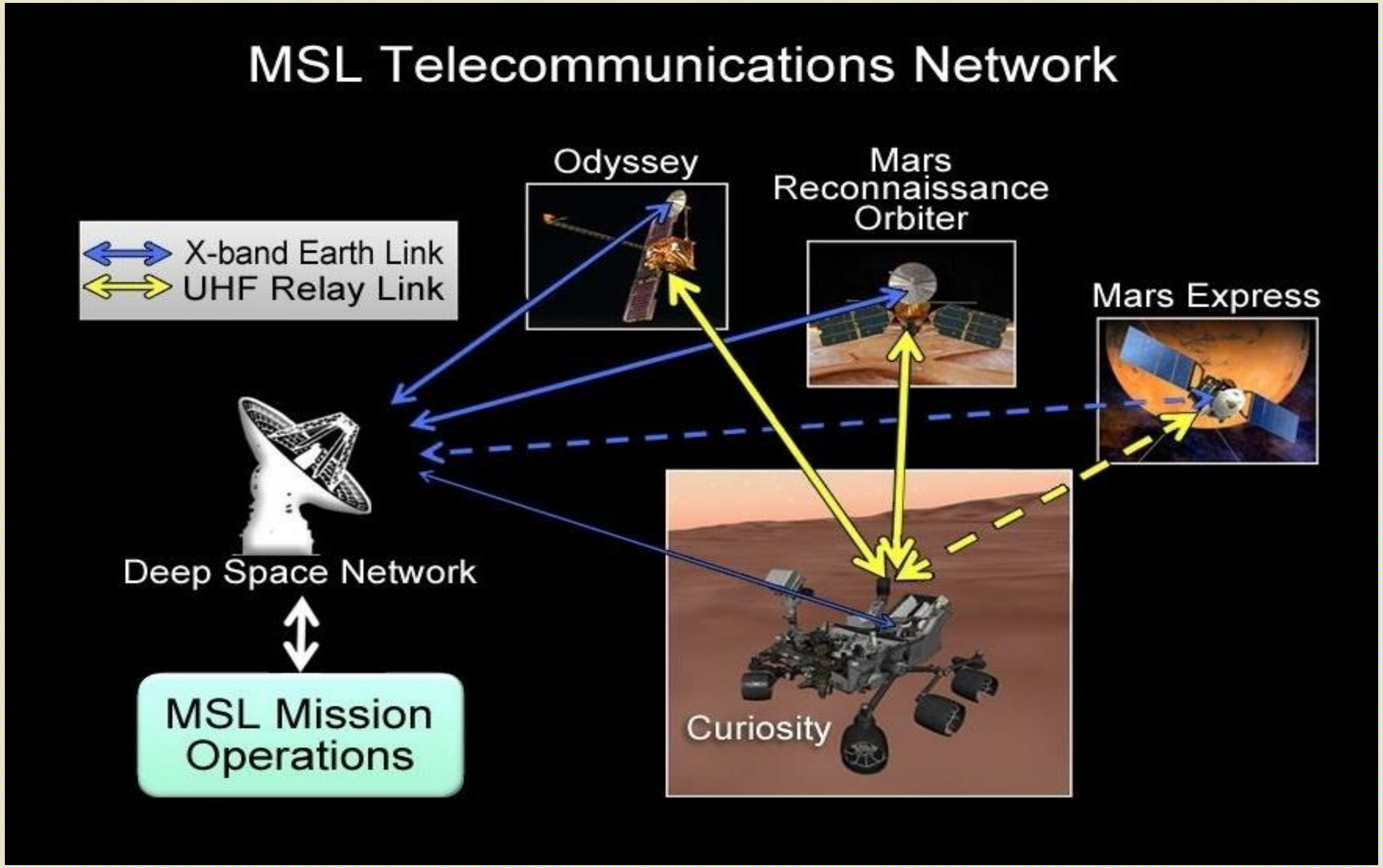
- The Curiosity rover can send messages directly to Deep Space Network antennas on Earth via X-band, but it is also able to uplink information to other spacecraft orbiting Mars, utilizing mainly the Mars Reconnaissance Orbiter and Mars Odyssey (if necessary) spacecraft as messengers that pass along data to Earth. The spacecraft mainly talk via UHF.

- The data rate direct-to-Earth varies from about 500 bits per second to 32,000 bits per second. The data rate to the Mars Reconnaissance Orbiter can be as high as 2 million bits per second. The data rate to the Odyssey orbiter is 128,000 or 256,000 bits per second.

- An orbiter passes over the rover and is in the vicinity of the sky to communicate for about eight minutes at a time, per Martian day. In that time, between 100 and 250 megabits of data can be transmitted to an orbiter. That same 250 megabits would take up to 20 hours to transmit direct to Earth.

- The rover can only transmit direct-to-Earth for a few hours a day due to power limitations or conflicts with other planned activities, even though Earth may be in view. The Mars satellites can send much more data direct-to-Earth than the rover, because they can see Earth longer and because they have a lot of power and bigger antennas than the rover.

Communication system in Curiosity Rover

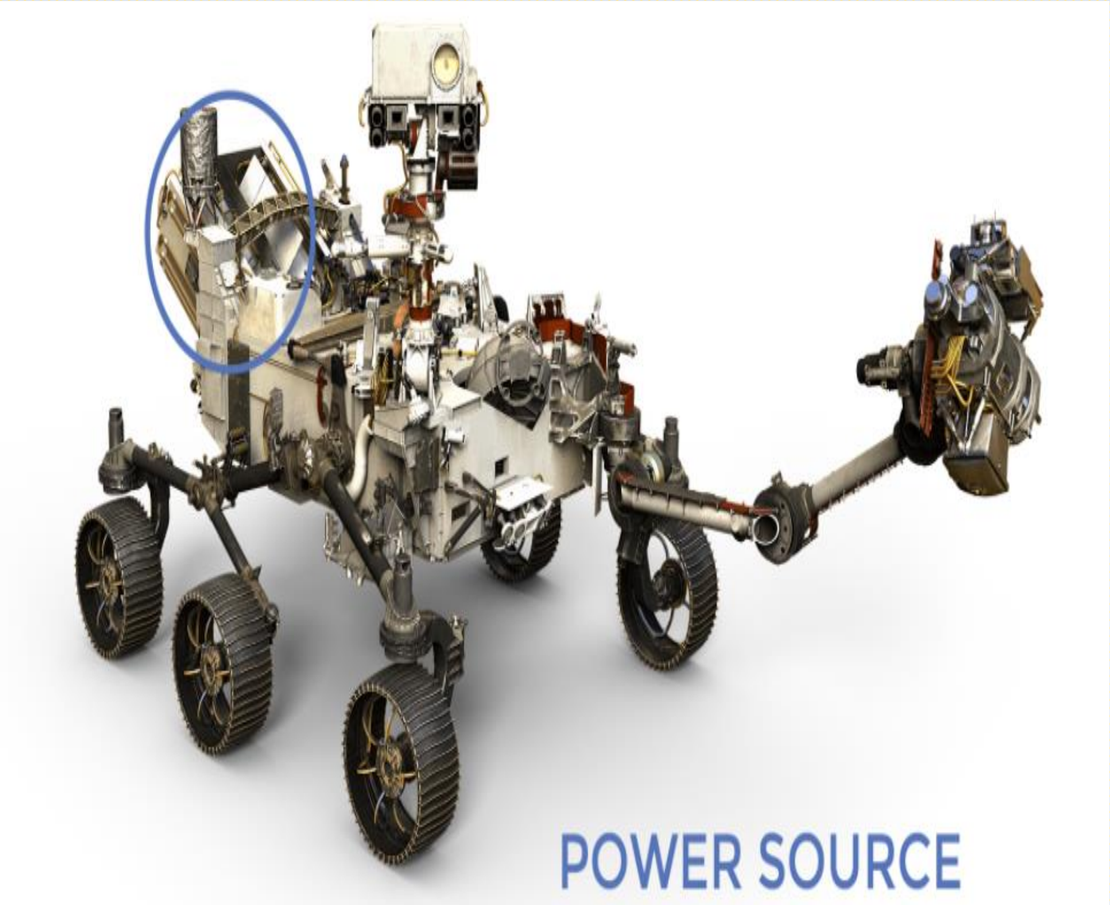


Power Management

- The Perseverance rover requires electrical power to operate. Without power, the rover cannot move, use its science instruments, or communicate with Earth.

- Perseverance carries a radioisotope power system. This power system produces a dependable flow of electricity using the heat of plutonium's radioactive decay as its "fuel."

- The power source is called a "Multi-Mission Radioisotope Thermoelectric Generator" or MMRTG for short. The MMRTG converts heat from the natural radioactive decay of plutonium into electricity. This power system charges the rover's two primary batteries. The heat from the MMRTG is also used to keep the rover's tools and systems at their correct operating temperatures.



Power Management

- **Main Job:**
Provide electricity to the rover
- **Location:**
 Aft end of the rover
- **Size:**
25 inches (64 centimeters) in diameter by 26 inches (66 centimeters) long
- **Weight:**
About 99 pounds (45 kilograms)
- **Power System:**
Uses 10.6 pounds (4.8 kilograms) of plutonium dioxide as the source of the steady supply of heat
- **Electrical Power Produced:**
About 110 watts at launch, declining a few percent per year
- **Batteries:**
Two lithium-ion rechargeable batteries to meet peak demands of rover activities when the demand temporarily exceeds the MMRTG's steady electrical output levels.

THANK YOU!