SPACE ROBOTICS
- An Overview

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SPACE ROBOTICS

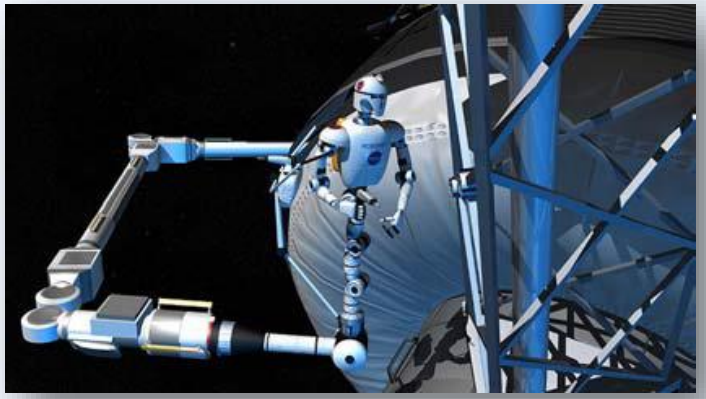
- Space Robotics is the development of machines for the space environment that perform exploration or to Assemble/Construct, Maintain, or Service other hardware in Space.

- Humans generally control space robots locally (e.g. Space Shuttle robotic arm) or from a great distance (e.g. Mars Exploration Rovers)

NEED FOR SPACE ROBOTS

NEED FOR SPACE ROBOTS

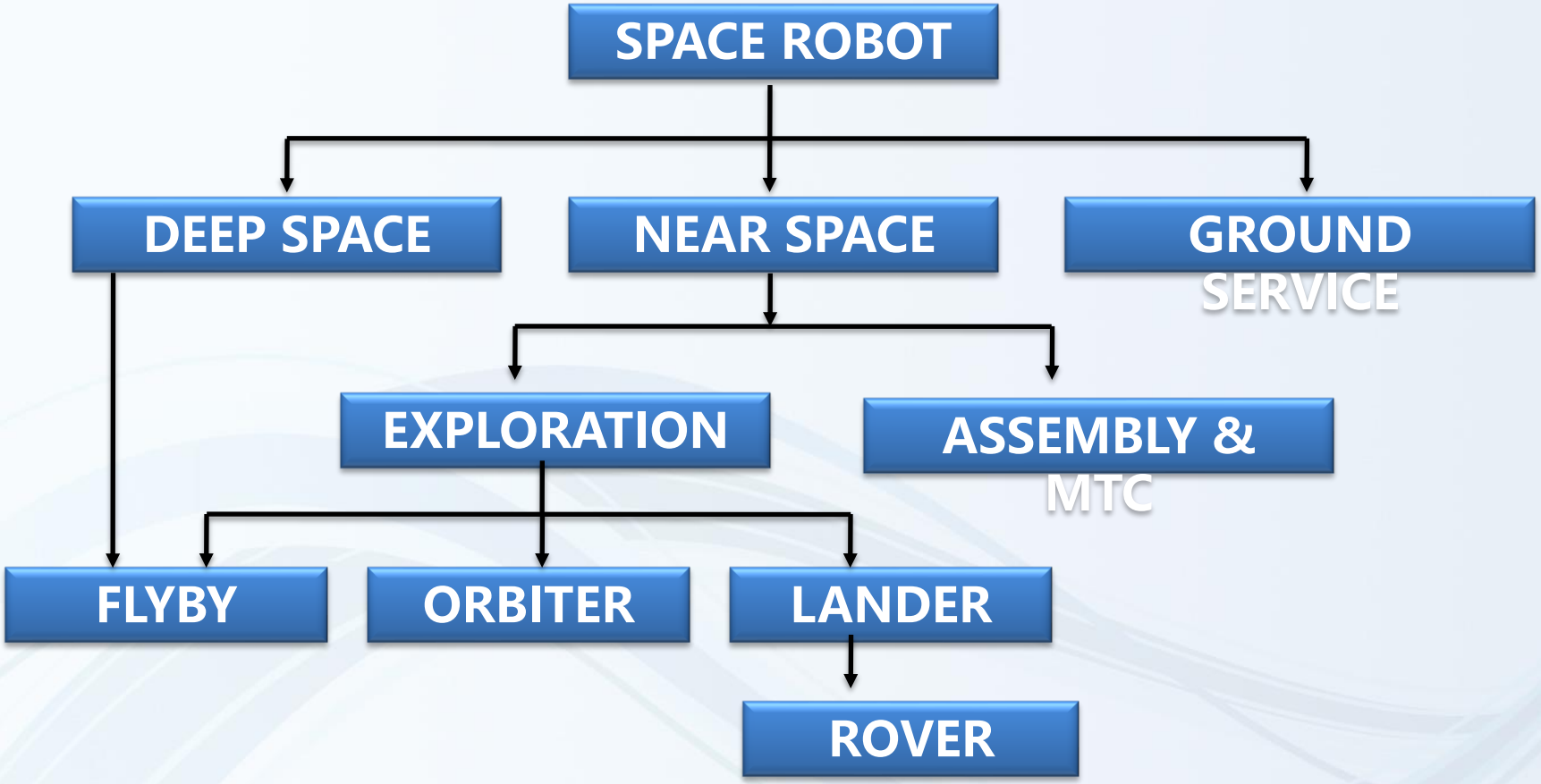
- Space is a hazardous environment
- Access to space is expensive



ADVANTAGES OF USING SPACE ROBOTS

- Robots don't need to return to Earth
- Performs tasks less expensively, compared to humans.
- Robots can operate where people can’t go for long durations

SPACE ROBOTIC MISSIONS



SPACE ROBOTIC MANIPULATORS

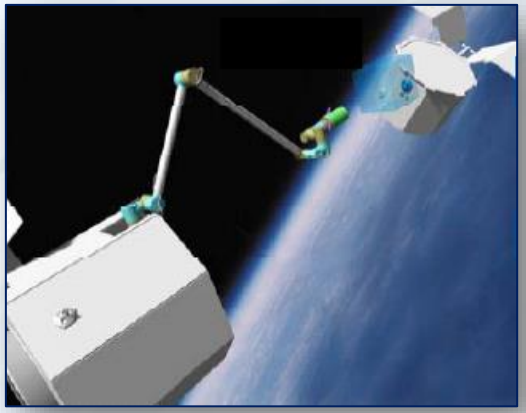
Robot manipulators have been used in space missions

- To perform unmanned experiments
- To assist astronauts in the execution of desired tasks
- To carry out various assembly operations
- To carry docking operations (Satellite Capture & Berthing)
- To carry planetary exploration

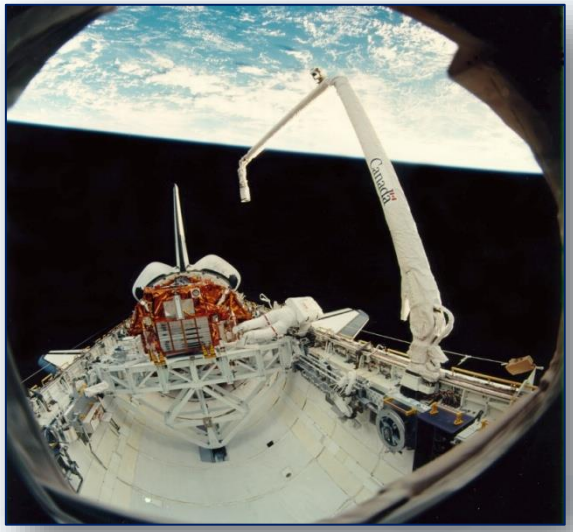
SPACE ROBOT APPLICATIONS

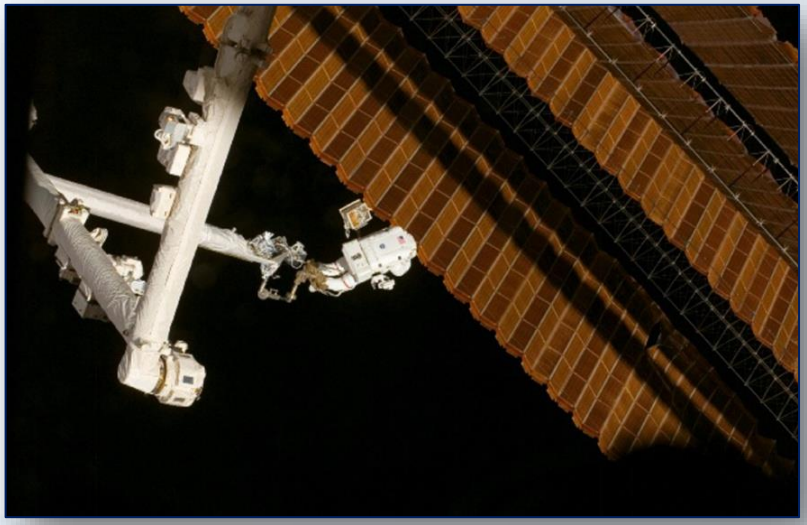
Applications of Robots in space are many

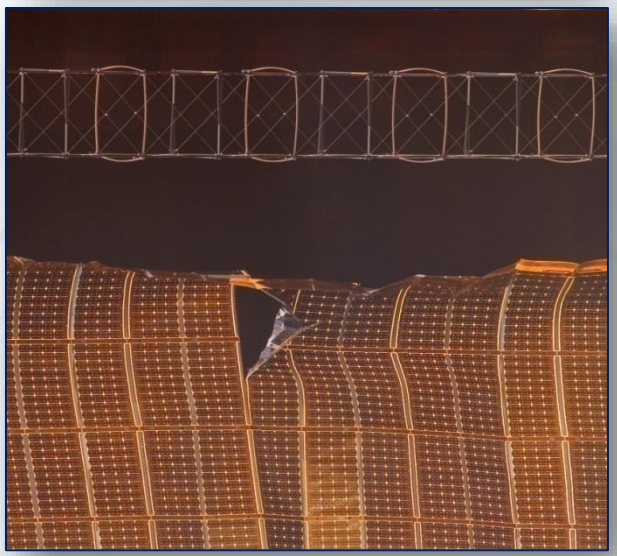
- In-orbit positioning and assembly of modules to Satellites/Space station
- Re-supply of equipment, materials and operations for conducting experiments in space lab
- Maintenance & Servicing : Removal/Replacement of faulty modules/packages
- Shuttle Servicing



ROBOTS FOR REPAIR / SPACECRAFT SERVICING







Damaged solar panel of ISS

DEXTRE(DEXTEROUS MANIPULATOR ON ISS)

ROBONAUT : HUMANOID ROBOT

- A **humanoid robot** is a robot with its overall appearance, based on that of the human body, allowing interaction with made-for-human tools or environments.
- In general humanoid robots have a torso with a head, two arms and two legs, although some forms of humanoid robots may model only part of the body, for example, from the waist up.
- Some humanoid robots may also have a 'face', with 'eyes' and 'mouth‘.

The value of Humanoid Robots over other designs is the ability to use the same workspace and tools.

ROBONAUT : HUMANOID ROBOT

- Robonaut 2 launched in Feb 2011 is the latest generation of humanoid robots.
- It'll be on a platform and spend most of its time submitting to tests that measure how it handled the rigors of space flight and if it can acclimate itself to the space station's zero-gravity environment.
- Initially, Robonaut 2 will operate from a fixed pedestal inside the ISS. Performs simple tasks and acts as an assistant to human operators.
- Its primary mission is to teach engineers how dexterous robots behave in space.

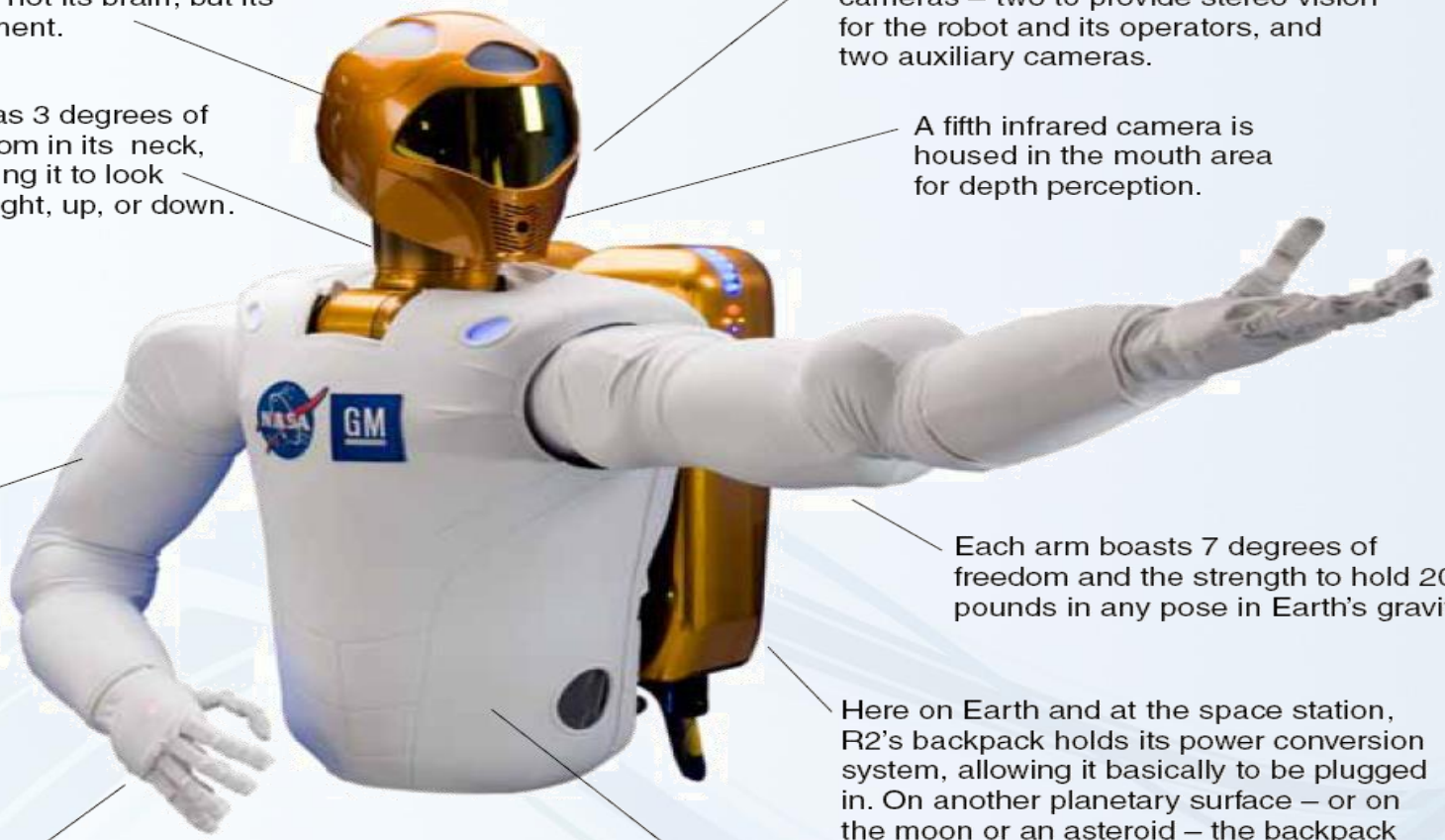
WHAT ROBONAUTS ARE MADE OF

A robot meant to work with humans and use human tools begins to look human-like by default. However, R2's head houses not its brain, but its vision equipment.

Behind R2's visor are four visible light cameras – two to provide stereo vision for the robot and its operators, and two auxiliary cameras.

R2 has 3 degrees of freedom in its neck, allowing it to look left, right, up, or down.

A fifth infrared camera is housed in the mouth area for depth perception.



Each arm is approx. 2 feet, 8 inches long, giving the R2 a total wingspan of 8 feet.

Each arm boasts 7 degrees of freedom and the strength to hold 20 pounds in any pose in Earth's gravity.

Here on Earth and at the space station, R2's backpack holds its power conversion system, allowing it basically to be plugged in. On another planetary surface – or on the moon or an asteroid – the backpack would hold the robot's batteries.

Robonaut 2's hands have 12 degrees of freedom – 4 degrees of freedom in the thumb, 3 degrees of freedom each in the index and middle fingers, and 1 each in the ring and pinky fingers. Each finger has a grasping force of 5 pounds.

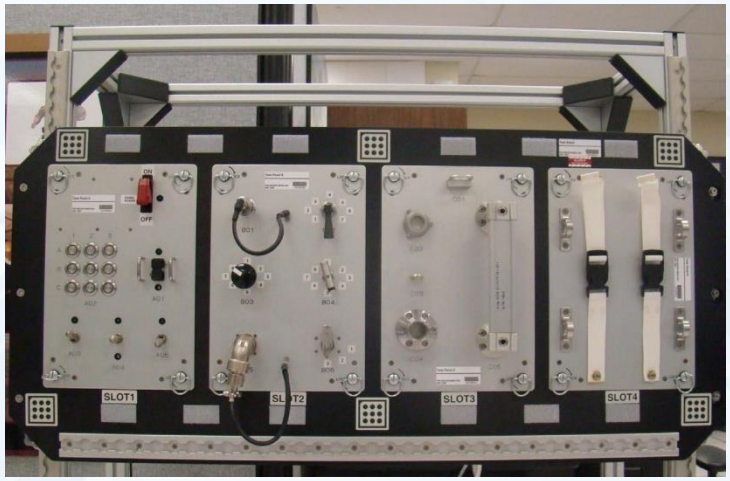
R2 thinks with its stomach – literally. With its head full of cameras, the only place with enough room for a brain is the robot's torso.

ROBONAUT ON INTERNATIONAL SPACE STATION (ISS)

Robonaut On ISS Will help working in

- Micro-gravity
- EMI/Radiation environment
- Crew Interaction

Engage ISS Inspection and Maintenance Community



ISS Modular Task Board for R2 on Space station

ROBONAUT IN SPACE

PLANETARY ROVERS

Objective Of Space/Planetary missions are-

- The space/planetary exploration rovers have robotic capabilities of varying complexity for navigation, science instrument placement onto surface samples, onboard resource management and science data gathering in un known terrain.

- The planetary exploration rovers are expected to go around the unknown terrain in a predetermined way and Characterize the geology and geochemistry of the landing region.

- These objectives can be carried out autonomously on board with sensors, actuators and estimation algorithms which comprises of Autonomous Guidance, Navigation and Control (ANGC).

- Presently the programs goal is to initiate a series of robotic missions to the Moon/ Mars to prepare for and support future human exploration activities.

NEED FOR PLANETARY EXPLORATION

WATER

When?
Where ?
Form
Amount

Look for Life

Understand Climate

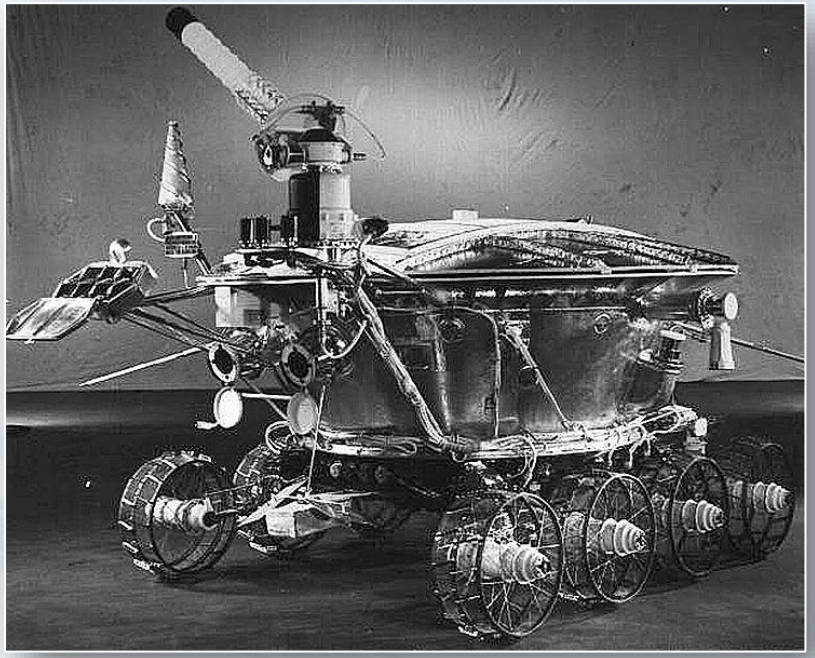
Explore Geology

Prepare for Human Exploration

PLANETARY ROVERS

LUNOKHOD 1

- Lunokhod 1 was a lunar vehicle on eight independently powered wheels and was 2.3 metres (7 ft 7 in) long.
- It was equipped with a cone-shaped antenna, a highly directional helical antenna, four television cameras, and special extendable devices to impact the lunar soil for soil density and mechanical property tests.
- An X-ray spectrometer, an X-ray telescope, cosmic ray detectors, and a laser device were also included.



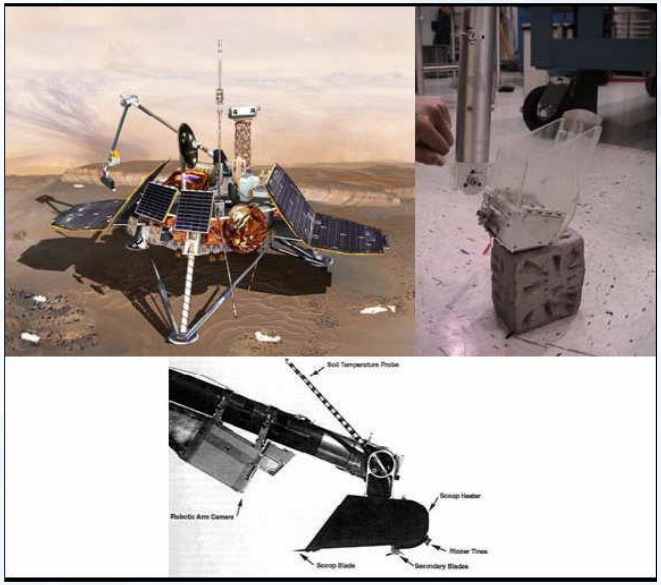
Lunokhod 1 : 1970

PLANETARY ROVERS

VIKING

The sampling mechanism consisted of :

- 4 DOF extendable boom
- Sampling head (4.8 cm) mounted at its end



MARS POLAR LANDER

- The MPL payload consisted of a unique robotic arm of 2.2m length and 4 DOF.
- The end of the arm was mounted with a relatively high capacity ‘scoop’ with a capacity to obtain samples up to 500 cc in one go.

PLANETARY ROVERS

MARS SURVEYOR LANDER 2001 ROBOTIC ARM

The *robotic arm* used for the mission is a light weight black hoe design with

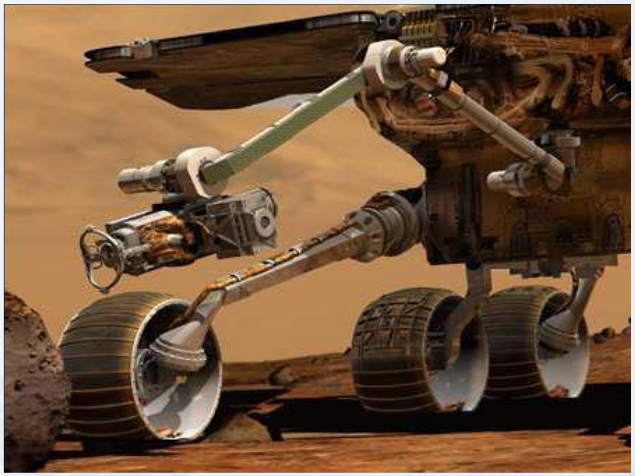
- **4 DOF manipulator**
- **The end effector consisted of a sampling scoop, scraping blades, an electrometer and crowfoot for deployment of the rover.**
- **The arm has the capability to dig and access depths of up to 50cm or more depending on soil conditions.**
- **The Robotic Arm Camera (RAC) is mounted on the forearm for continuous imagery and observation of the landing site and surroundings.**

PLANETARY ROVERS

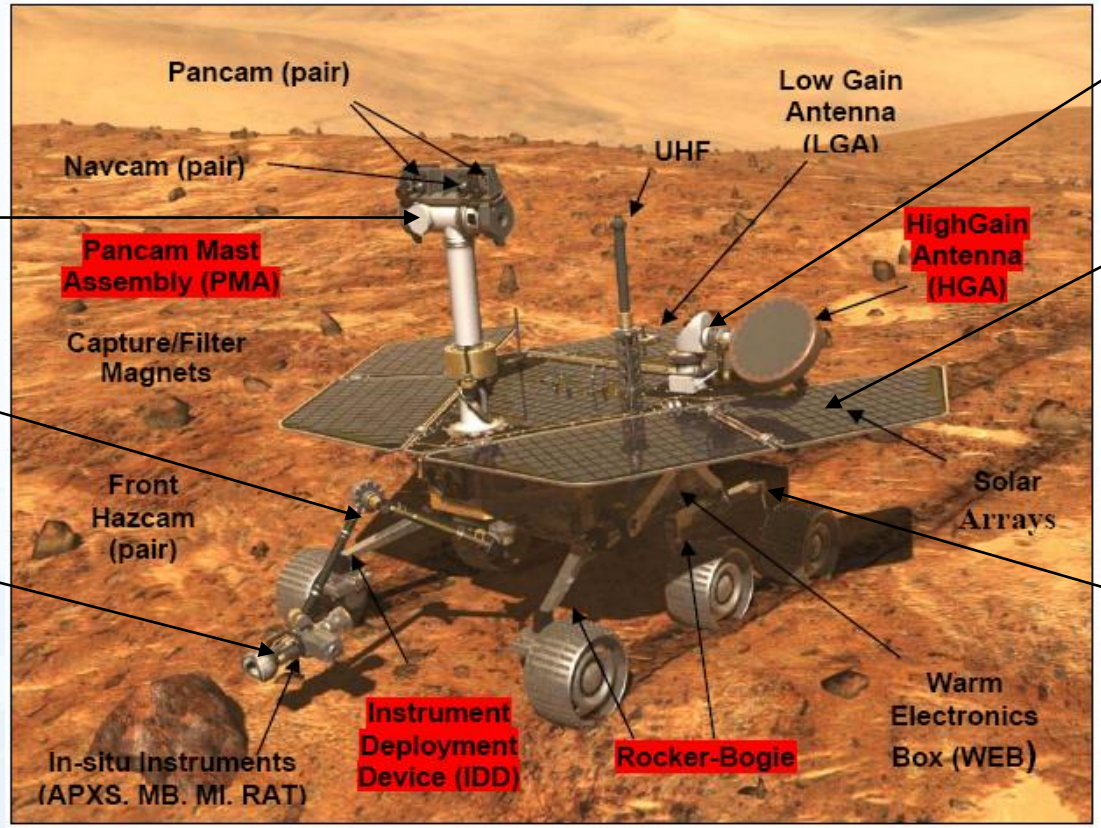
MARS EXPLORATION ROVERS (MER) , 2003

- The rover's arm is called the Instrument Deployment Device (IDD) and is used to hold and maneuver the scientific instruments to the required positions with respect to rock and soil for analyses.

- The arm has three joints with five geared motors, 5DOF and a total reach of 90 cm to give it its motion capability.



INTERPLANETARY ROVER

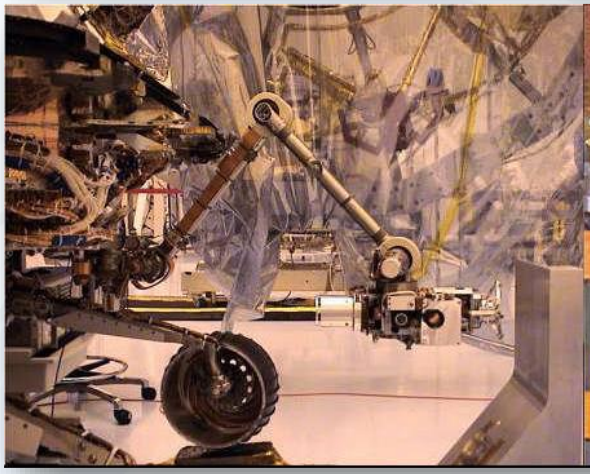


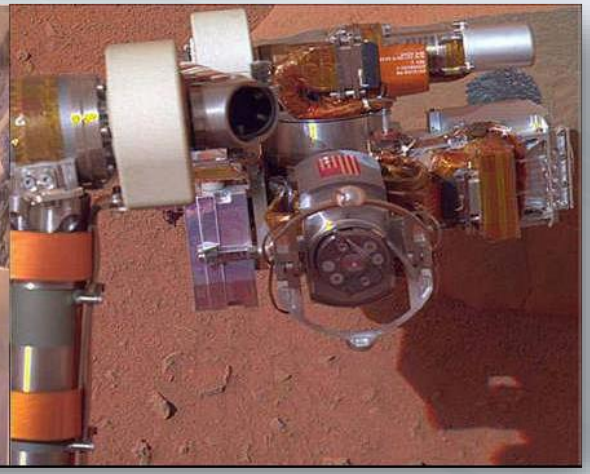
SALIENT FEATURES:

- Autonomous/ Semiautonomous mode of operation
- To survive loads during flight, cruise, landing & environment of Moon/Mars
- To travel unstructured terrain
- To position/pick instrument samples from surface for scientific experiments

PLANETARY ROVERS

Robot arm on
Mars Exploration Rover



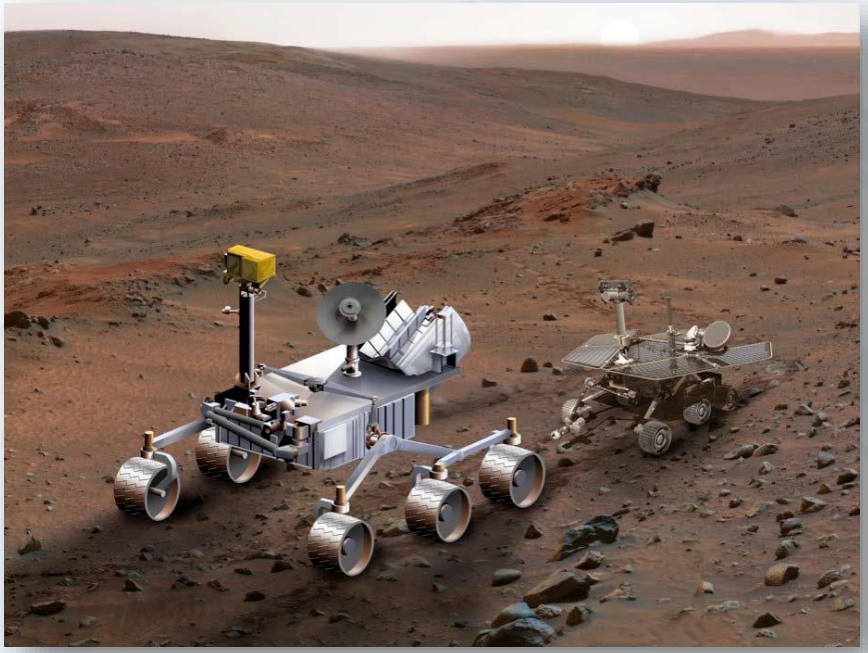


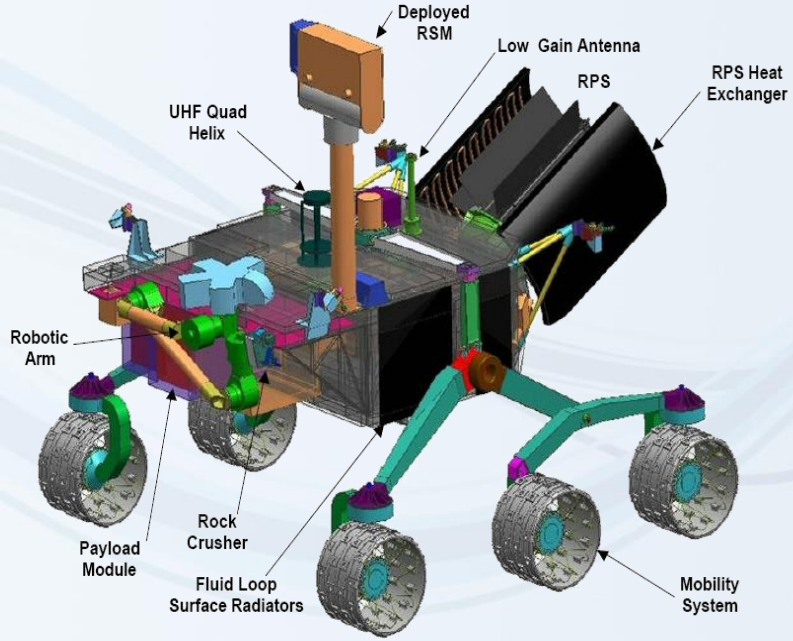
“Sampling” System (L) MER Instrument Deployment Device (R) RAT on MER Arm

PLANETARY ROVERS

MARS SCIENCE LABORATORY

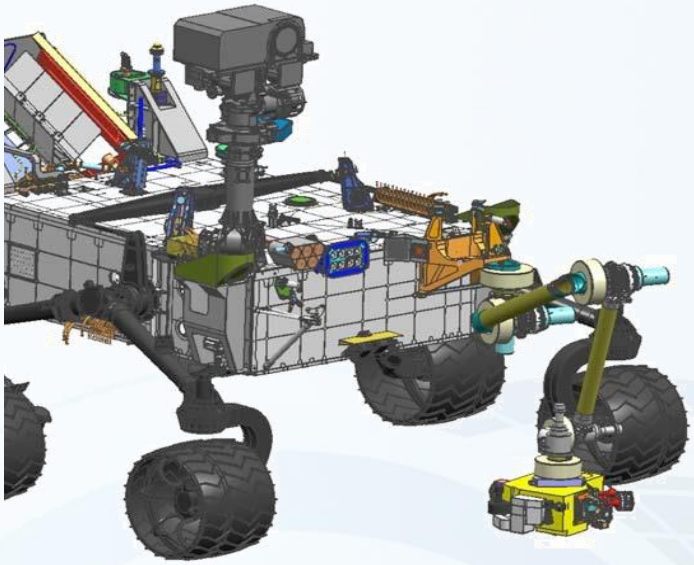
MSL will have a six-wheel rocker-bogie mobility system, and like the MER Opportunity and Spirit rovers, it will have a mast with pointable remote-sensing science instruments and an arm capable of placing science instruments in contact with the Martian surface.

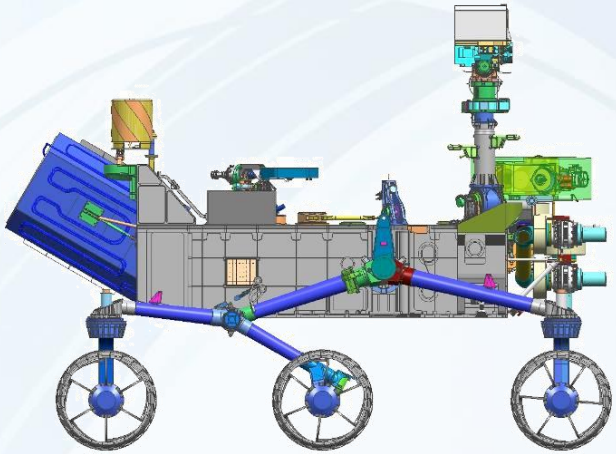


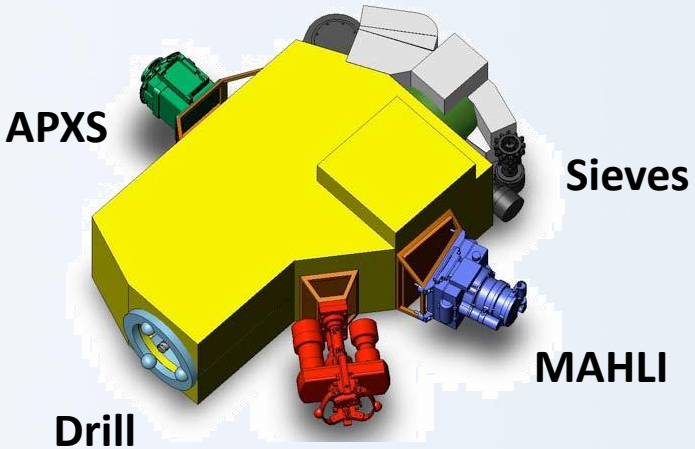


PLANETARY ROVERS

Two-Meter Robotic Arm







PLANETARY ROVERS

OTHER ROVERS

Japan's first explorer to land on the moon would consist of an unmanned lander, a lunar rover equipped with robotic arms and a data-relay satellite

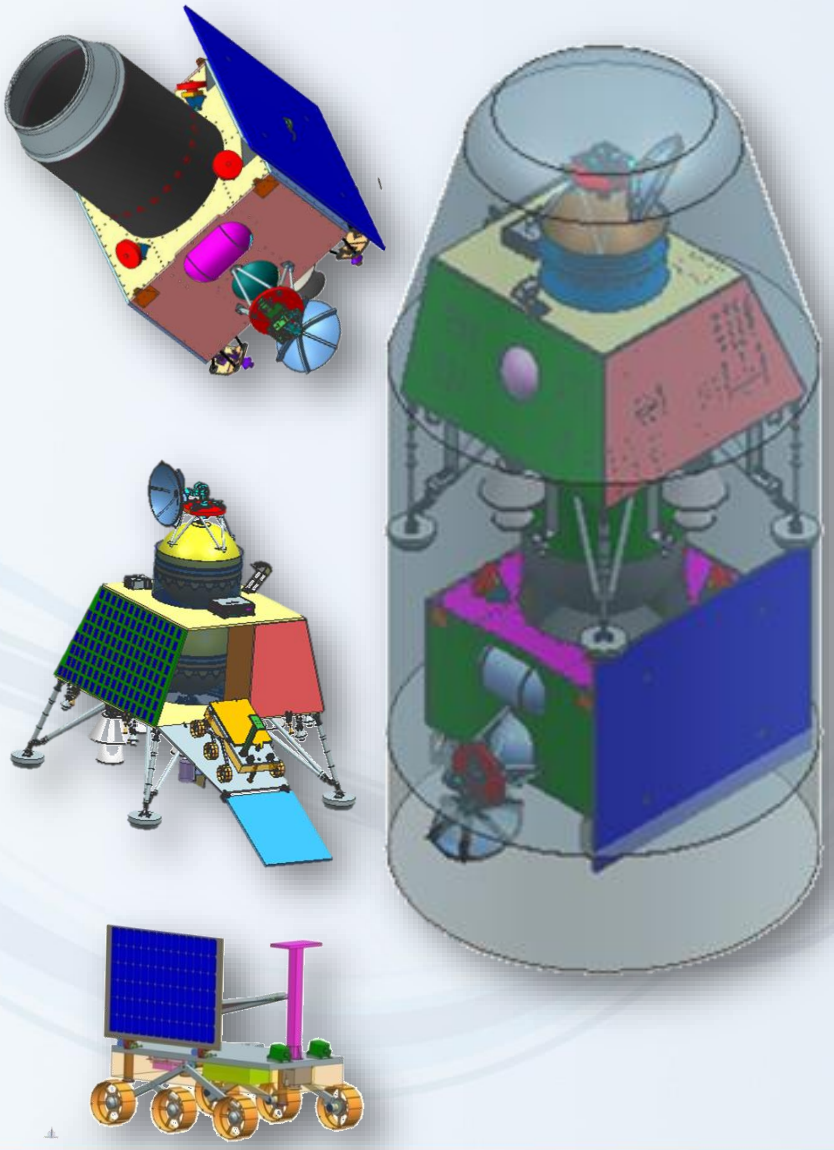
CHANDRAYAAN-2 ROVER

Rover mission objectives:

- Mobility activities on low gravity & vacuum of Moon surface with Semi-Autonomous navigation and hazard avoidance capability
- Elemental analysis of the lunar surface near the landing site with the

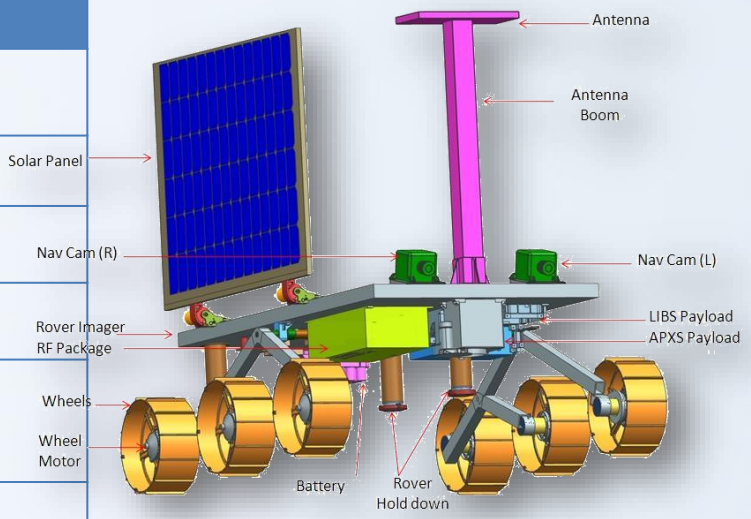
  Laser Induced Breakdown Spectroscope (LIBS) and Alpha Particle Induced X-Ray Spectrometer (APXS) payloads onboard Rover

This mission will be a precursor and technology demonstrator for future missions

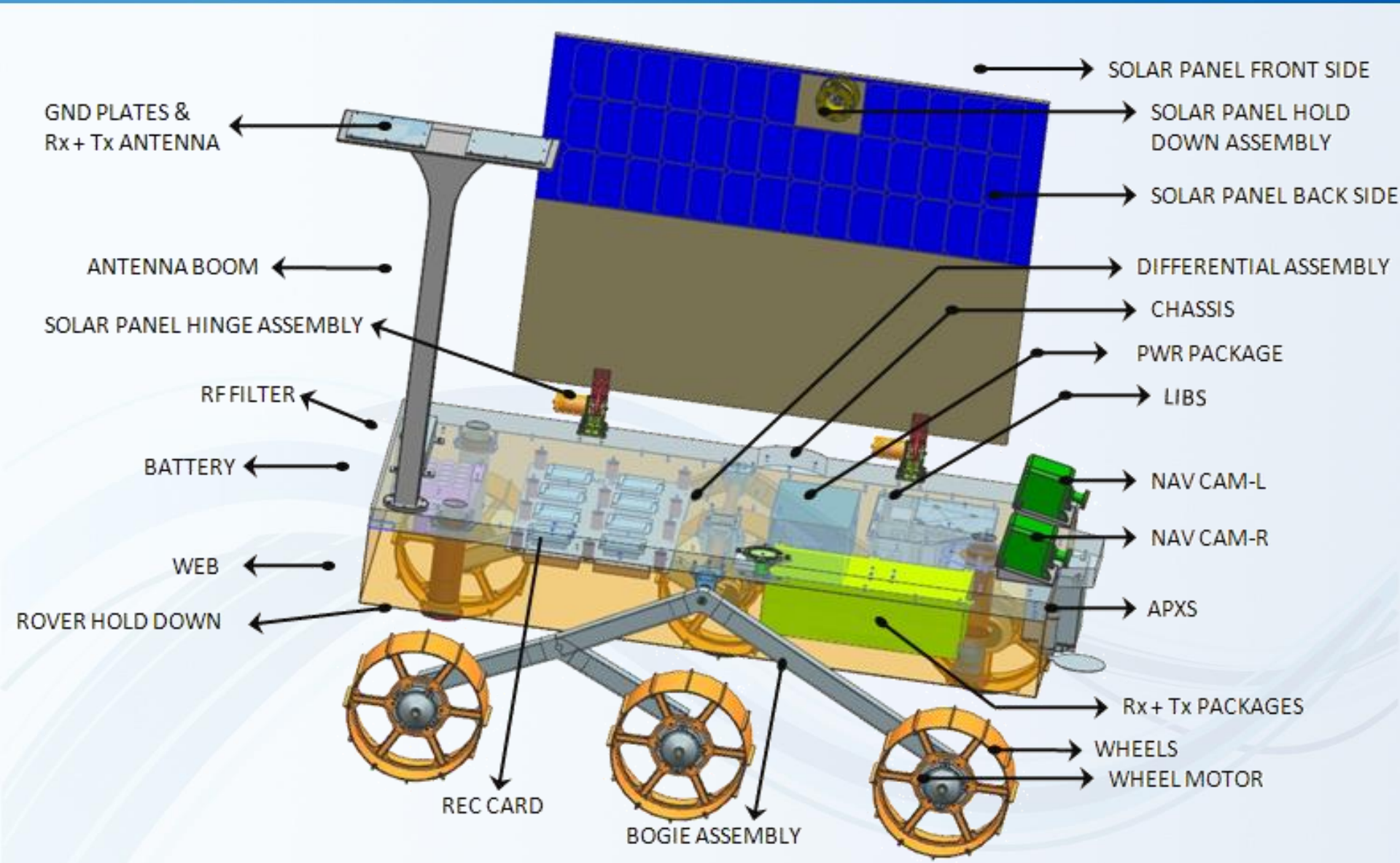


ROVER TECHNICAL SPECIFICATIONS

Parameters	Rover
Chassis WEB size	850 x 450 x 100 mm
Mass	25 kg
Life of the Mission	1 Lunar Day
Nominal velocity	1 cm / sec
Obstacle climbing capability	50 mm (max)
Power	Solar Array 40 Watts
Communication	From LC/OC: S-Band 2kbps To LC/OC: S-Band64/10kbps
Sensors	Navigation camera for determining ground topology
Payloads	LIBS(Laser Induced Breakdown Spectroscope) APXS(Alpha particle Induced X-Ray Spectrometer) Rover Imager (RI)



SUBSYSTEMS OF ROVER



CONCLUSIONS

- Certain activities have to be necessarily done by Robots.
- Space science & exploratory missions have used robots to a greater extent. There are endless activities that are to be pursued using Robots in near future.
- Today, India has carved its own place in Robotics R & D activities.
- To conclude Robotics have to stay and in future, we will have intelligent robots where even human beings find it difficult to pursue certain operations.

THANKS