Jet Propulsion Laboratory
California Institute of Technology

Mars Exploration Program

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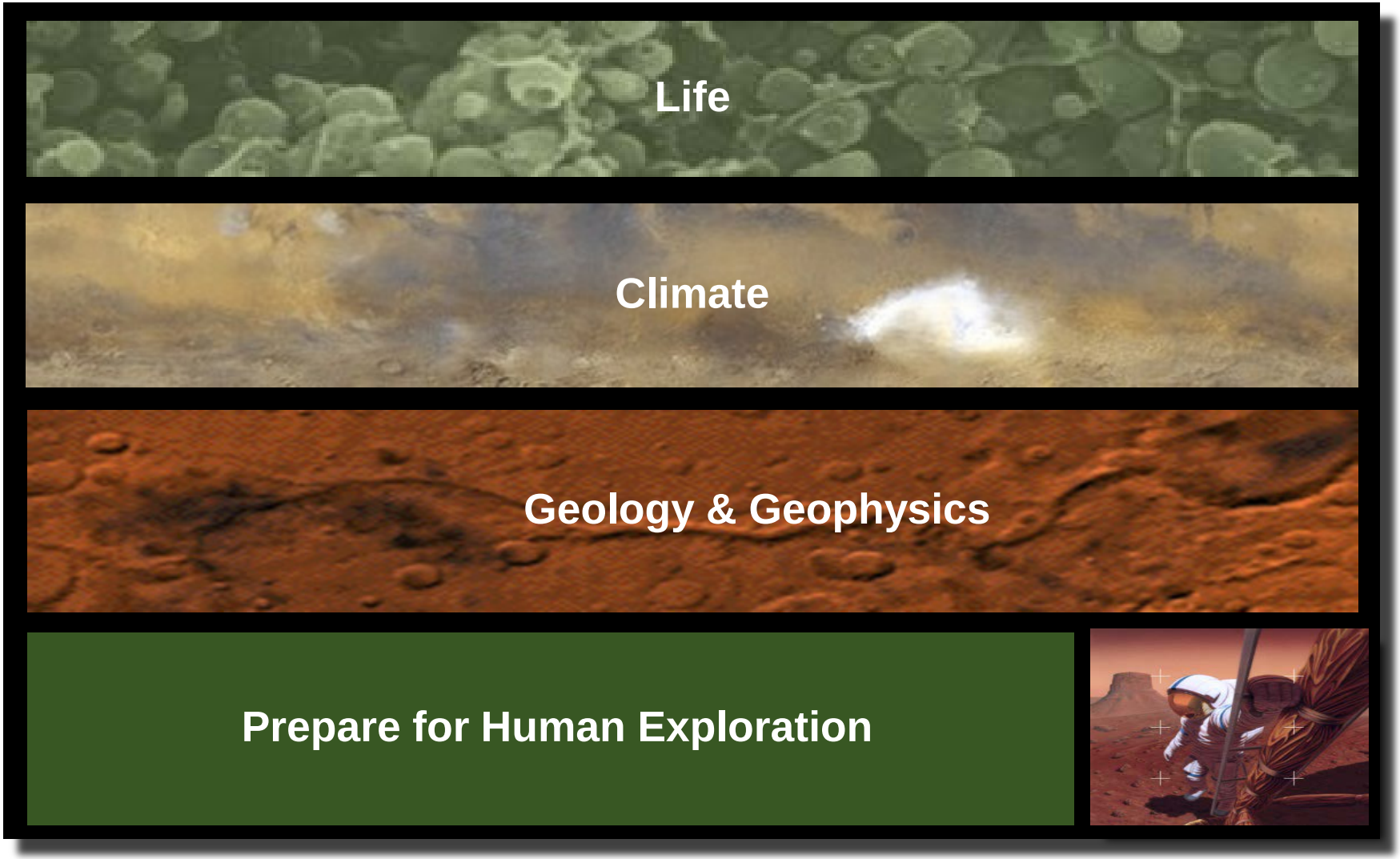
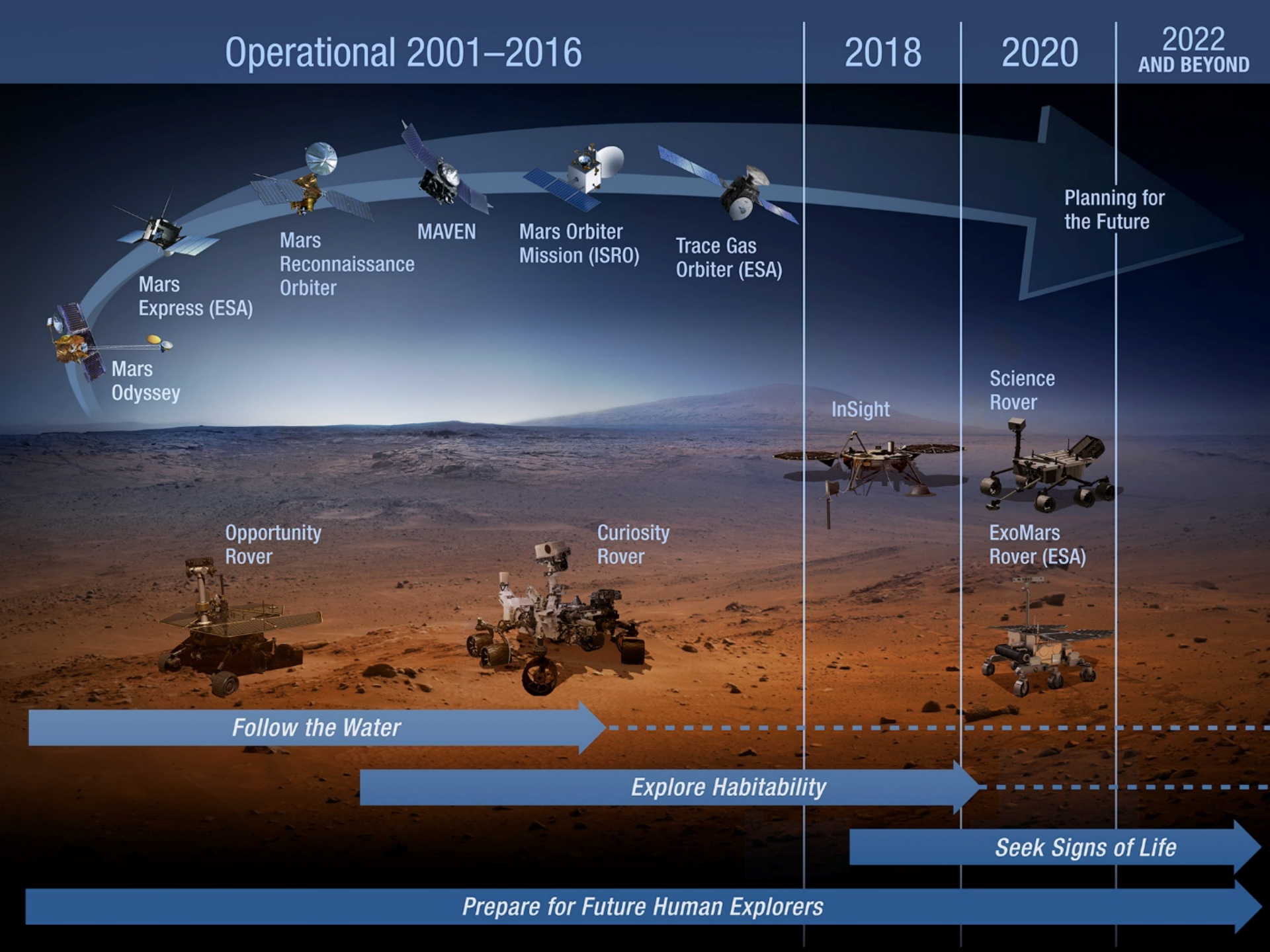
Jet Propulsion Laboratory,

California Institute of Technology

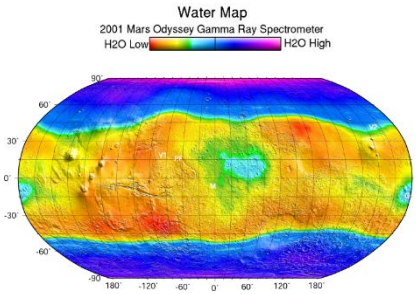
Mars Exploration Program Science Goals



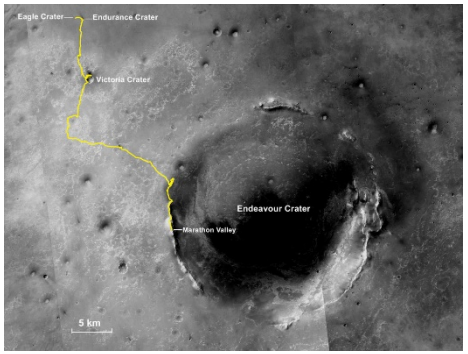

Operational 2001–2016
2018
2020
2022
AND BEYOND
Mars Odyssey
Mars Express (ESA)
Mars Reconnaissance Orbiter
MAVEN
Mars Orbiter Mission (ISRO)
Trace Gas Orbiter (ESA)
Planning for the Future
InSight
Science Rover
Opportunity Rover
Curiosity Rover
ExoMars Rover (ESA)
Follow the Water
Explore Habitability
Seek Signs of Life
Prepare for Future Human Explorers

Mars Exploration Program Milestones

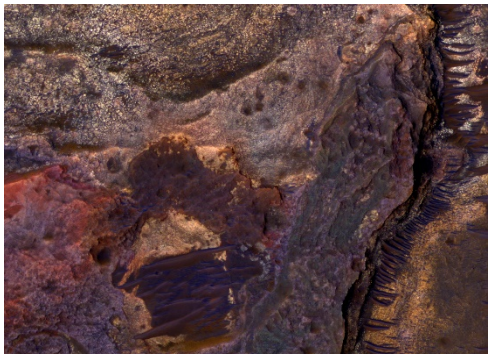
Odyssey: 60,000 orbits



Opportunity: Roved> 26 miles



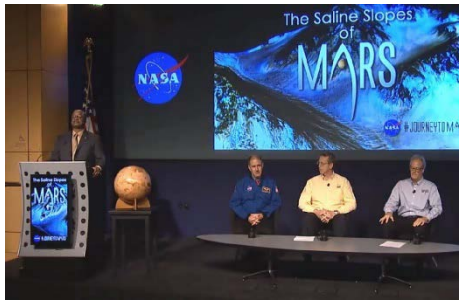
MRO: 10th year since MOI



Curiosity: >3 years since landing

Mars Exploration Program Highlights

RSL Press Conference



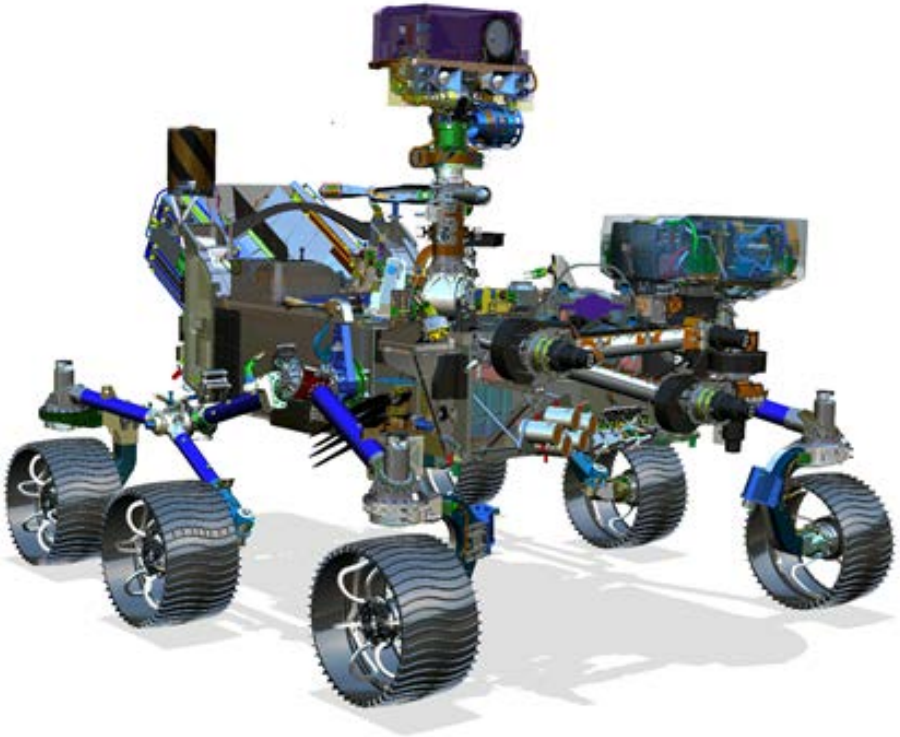
MAVEN Press Conference

'The Martian' Movie

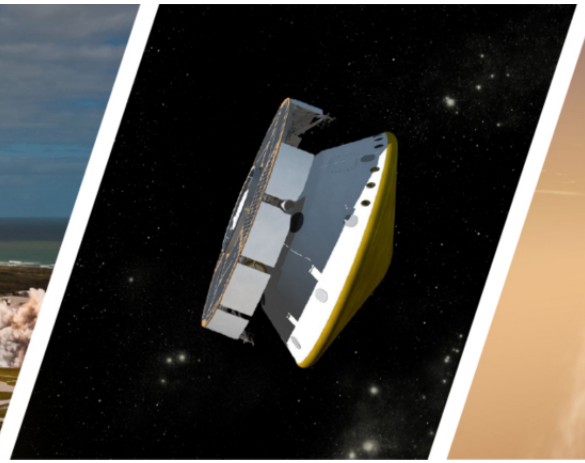
Credits: Twentieth Century Fox

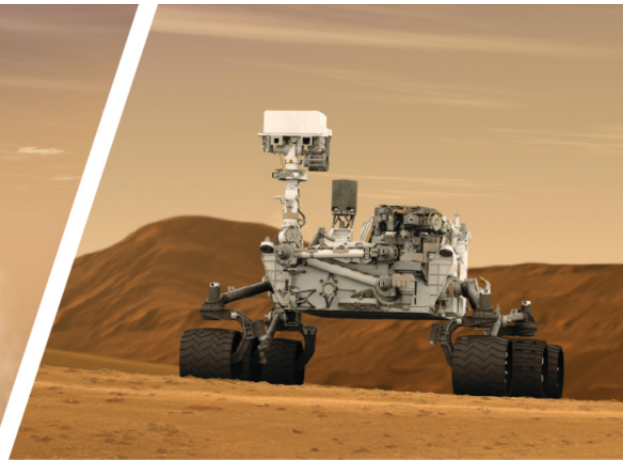
Gale Crater
Press Coverage

Mars 2020



Mission Overview





LAUNCH

- MSL Class/Capability LV
- Period: Jul/Aug 2020

CRUISE/APPROACH

- 7.5 month cruise
- Arrive Feb 2021

ENTRY, DESCENT & LANDING

- MSL EDL system (Range Trigger and TRN baselined): guided entry and powered descent/Sky Crane
- 16 x 14 km landing ellipse (range trigger baselined)
- Access to landing sites ±30° latitude, ≤ -0.5 km elevation
- Curiosity-class Rover

SURFACE MISSION

- 20 km traverse distance capability
- Enhanced surface productivity
- Qualified to 1.5 Martian year lifetime
- Seeking signs of past life
- Returnable cache of samples
- Prepare for human exploration of Mars

Mars 2020 Mission Objectives

- **Conduct Rigorous *In Situ* Science**

  A. **Geologic Context and History** Carry out an integrated set of context, contact, and spatially-coordinated measurements to characterize the geology of the landing site

  B. **In Situ Astrobiology** Using the geologic context as a foundation, find and characterize **ancient** habitable environments, identify rocks with the highest chance of preserving **signs** of **ancient** Martian life if it were present, and within those environments, seek the signs of life

- **Enable the Future**

  C. **Sample Return** Assemble rigorously documented and returnable cached samples for possible return to Earth

  D. **Human Exploration** Facilitate future human exploration by making significant progress towards filling major strategic knowledge gaps and…

  Technology …demonstrate technology required for future Mars exploration

- **Execute Within Current Financial Realities**

  – Utilize MSL-heritage design and a moderate instrument suite to stay within the resource constraints specified by NASA

These are a thoroughly integrated set of objectives to support Agency's Journey to Mars

Spacecraft Build Approach

Launch Vehicle
- KSC/Launch Services Program procurement

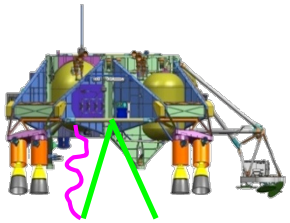
MMRTG
- DoE procurement to industry

Science & Exploration Technology Investigations
- Source per proposals via AO selection

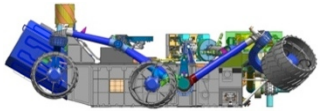
MEDLI2
- NASA Centers (LaRC, ARC, and JPL)

- Built in-house at JPL
- Lowest cost and risk per make-buy study and industry RFIs

- Built by Lockheed-Martin/Denver
- Procure as sole source—most cost effective



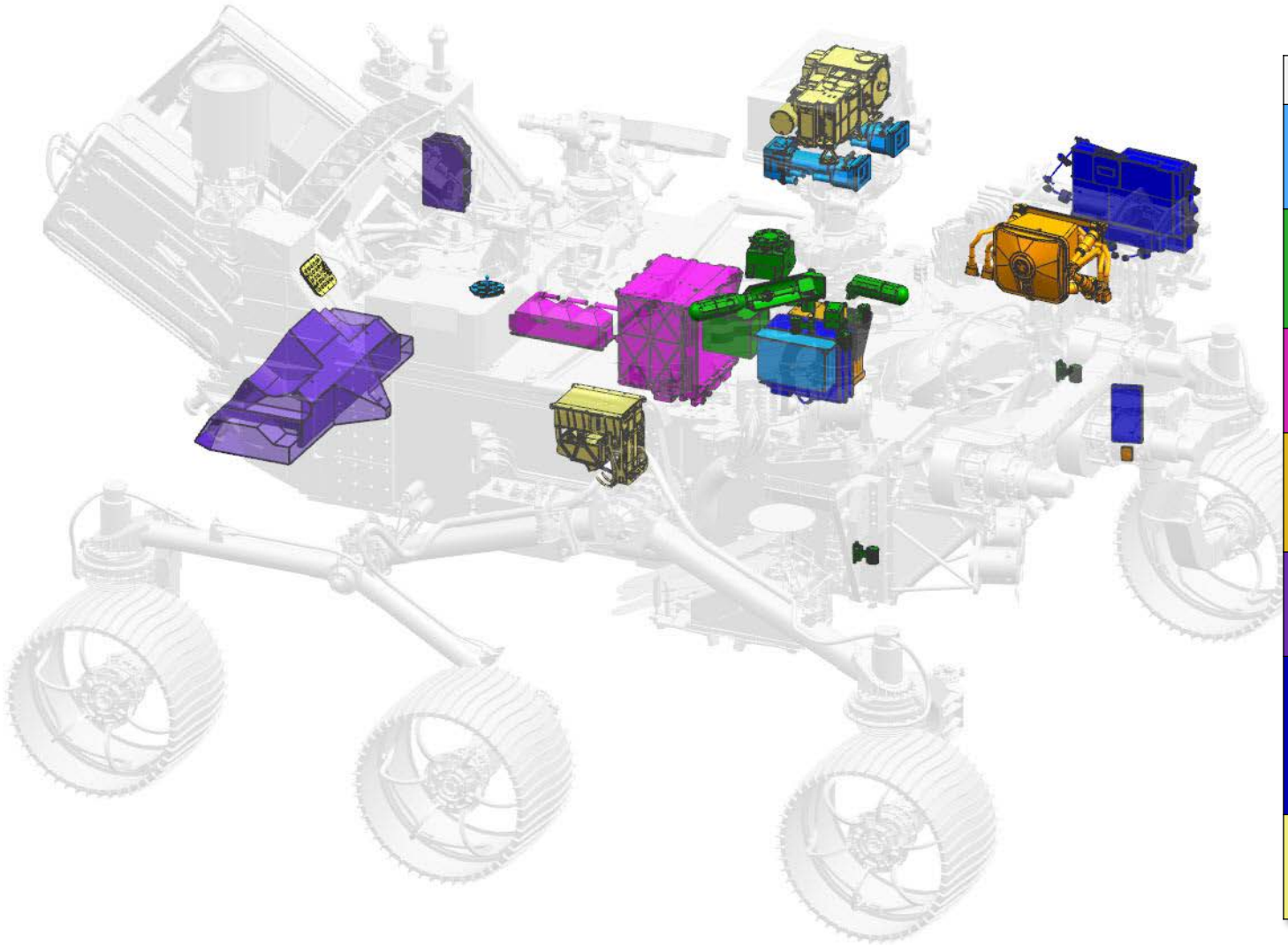
- Built in-house at JPL
- Major industry subcontracts/components
- Rebuild in-house due to criticality of EDL and rover interface



- Built in-house at JPL
- Major industry subcontracts/components
- Spanish contributed High Gain Antenna
- Rebuild in-house due to complexity of vehicle, residual hardware, criticality of EDL and rover interface, operations experience

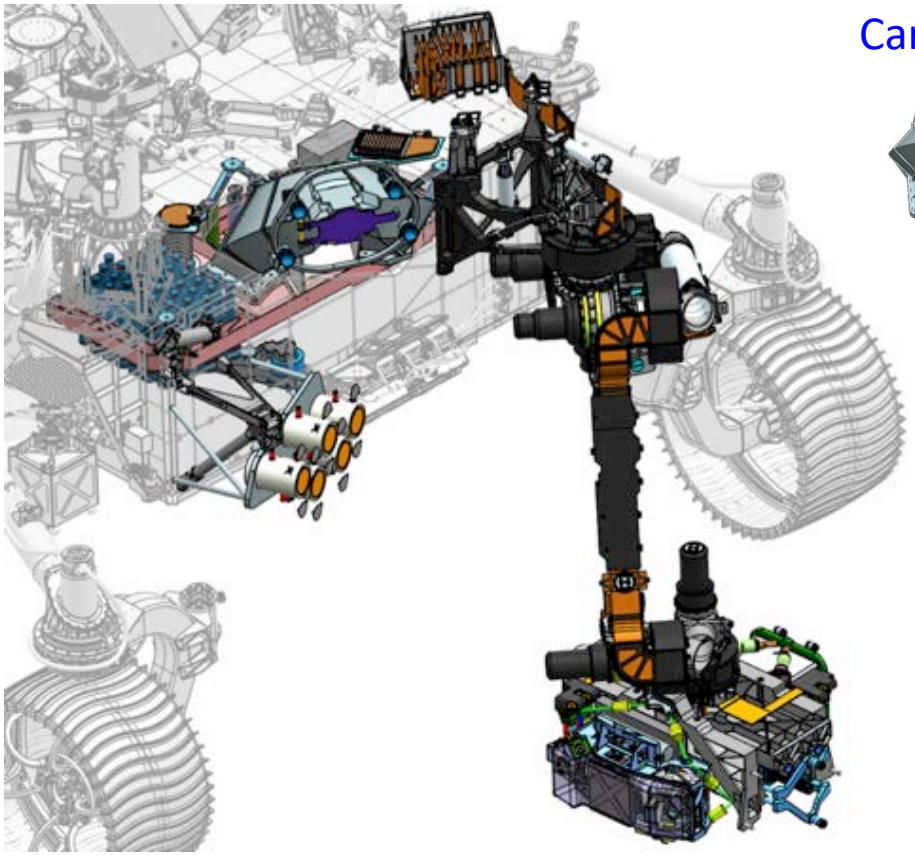
- Built by Lockheed-Martin/Denver
- Procure as sole source—most cost effective

Mars 2020 Payload Family Picture

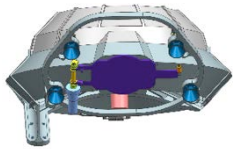


Instrument Key
Mastcam-Z Stereo Imager
MEDA Mars Environmental Measurement
MOXIE In-Situ Oxygen Production
PIXL Microfocus X-ray fluorescence spectrometer
RIMFAX Ground Penetrating Radar
SHERLOC Fluorescence and Raman spectrometer and Visible context imaging
SuperCam LIBS and Raman

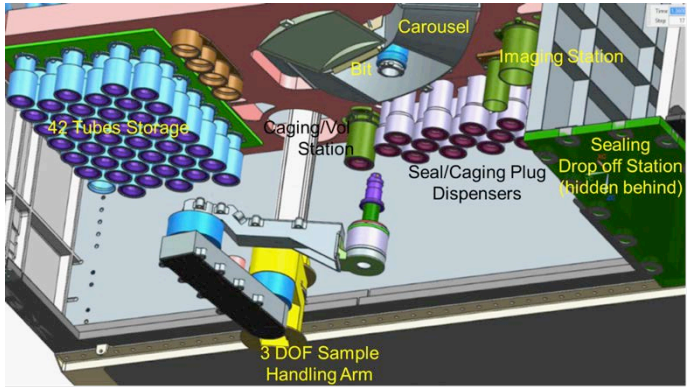
Sampling & Caching Subsystem

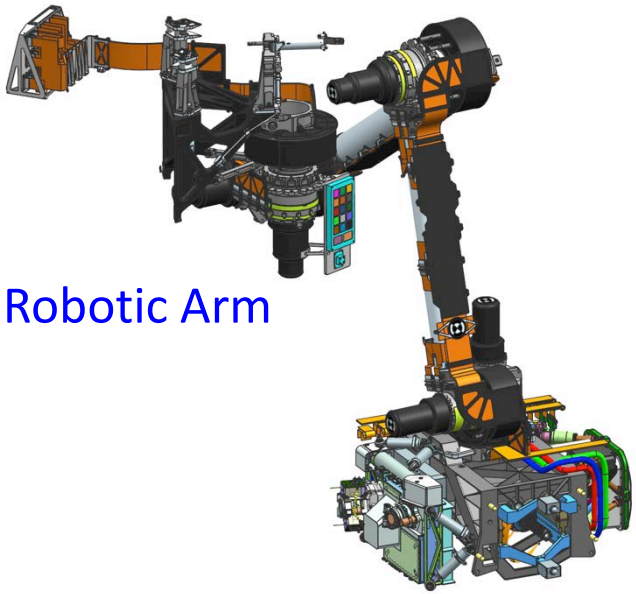


Bit Carousel



Caching Assembly





Robotic Arm

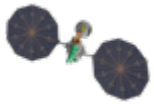
Turret w/ corer

Integrated Campaign for Mars in the 2020's

Mars 2020

- ISRU Prototype
- EDL Instruments
- Sample Acquisition
- In Situ Science
- Habitable Conditions
- Ancient Life

Mars Orbiter 2022



- Resource Survey
- Landing Site Selection
- Optical Comm/Relay
- SEP
- Rendezvous
- Remote Sensing Instruments

Round-Trip Surface to Surface

- Dust Toxicity
- EDL Evolution/ Instruments
- Mars Ascent
- Surface Navigation
- Returned Sample Analysis

Exploration Precursors

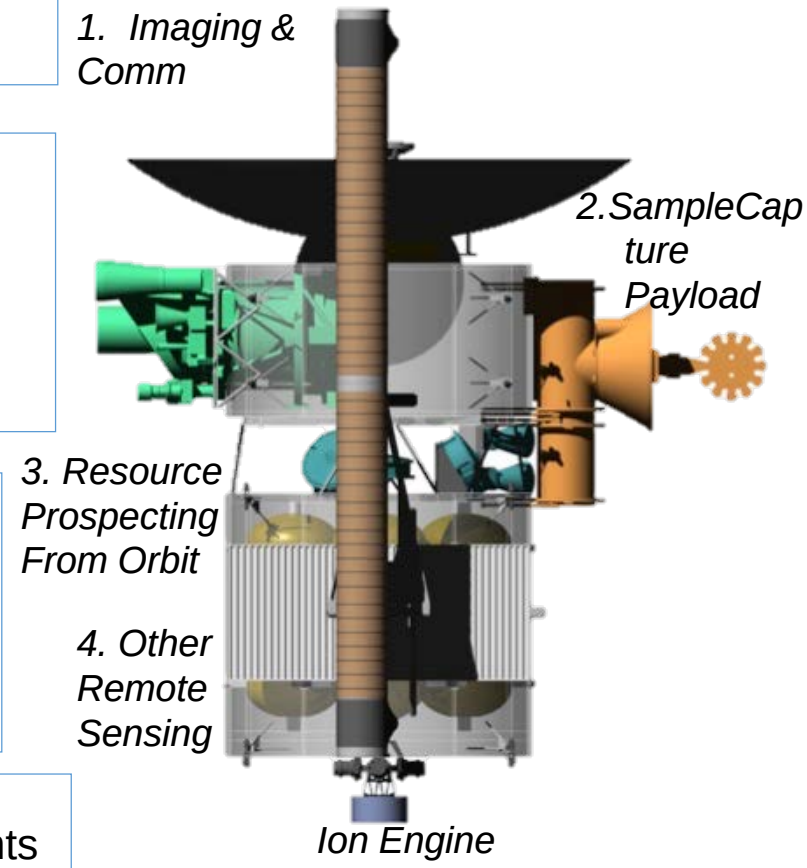
- ISRU Production
- Surface Power for ISRU
- Rad/ECLSS Validation
- Increased EDL Mass & Precision
- Science Instruments

Robotic precursors fulfilling the Mars Sample Return objective intrinsically inform strategic exploration planning by providing invaluable flight experience

Pre-Decisional Information -- For Planning and Discussion Purposes Only

Multi-function Future Mars Orbiter Concept

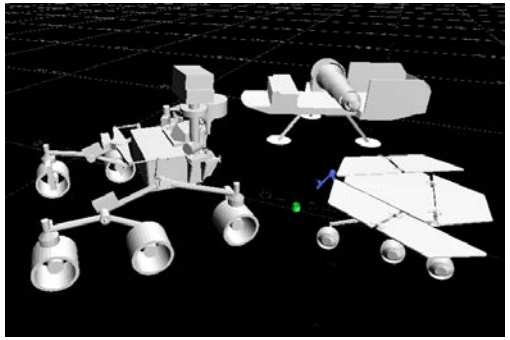
1. Infrastructure for Continued Exploration	-Continued Landing site recon imaging to support future missions -High Direct-to-Earth data rates and proximity links
2. Orbital Support for Mars Sample Return	Sample rendezvous and capture capabilities, including sample containment
3. Resource Prospecting	Sources of H_2O: Subsurface Ice & Overburden characterization, State & concentration of hydrated minerals at the surface
4. Remote Sensing	Atmospheric & other measurements for science



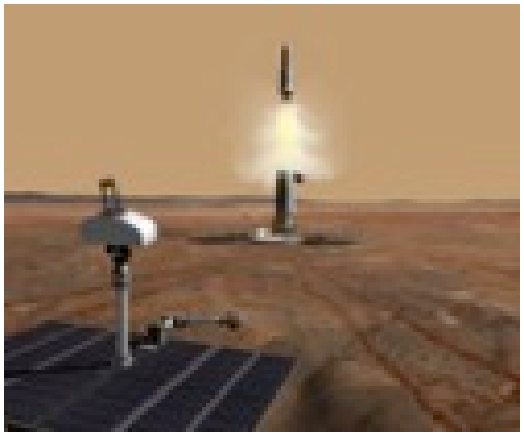
(Notional Spacecraft Configuration)

Pre-Decisional Information -- For Planning and Discussion Purposes Only

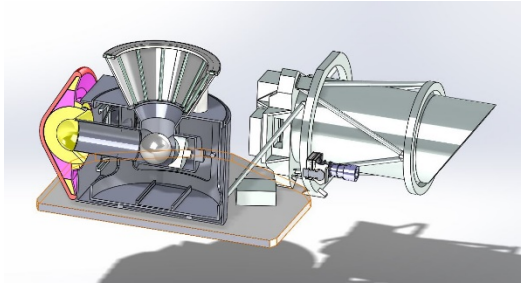
Current Technologies Under Development: Portfolio is focused on technologies for Potential Mars Sample Return



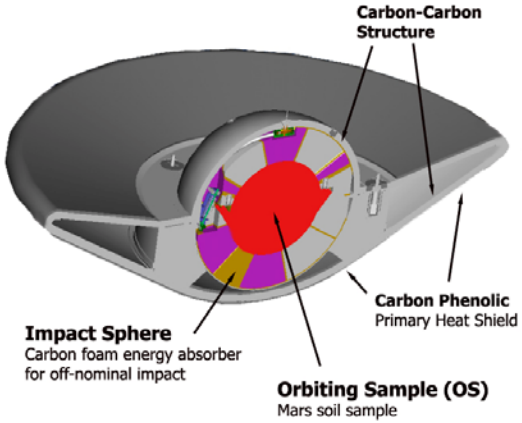
1) Sample Retrieval & Sample Transfer on Mars Surface



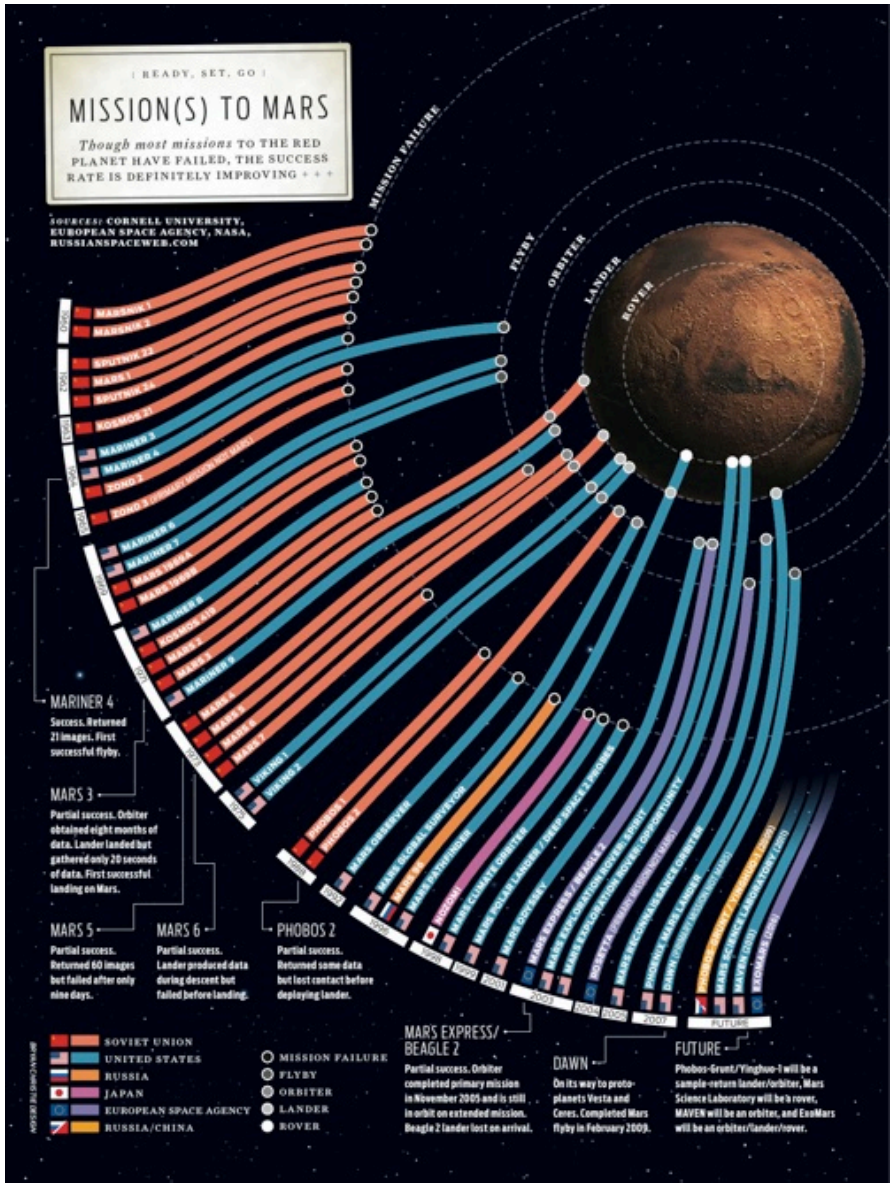
2) Mars Ascent Vehicle – Launching the Samples into Mars Orbit



3) On-Orbit Sample Capture & Transfer



4) Safe Return of Samples – Assured Containment

Backup

It’s Not Easy Being Red