Mars Sample Return Lander Concept Overview

2nd International Mars Sample Return Conference

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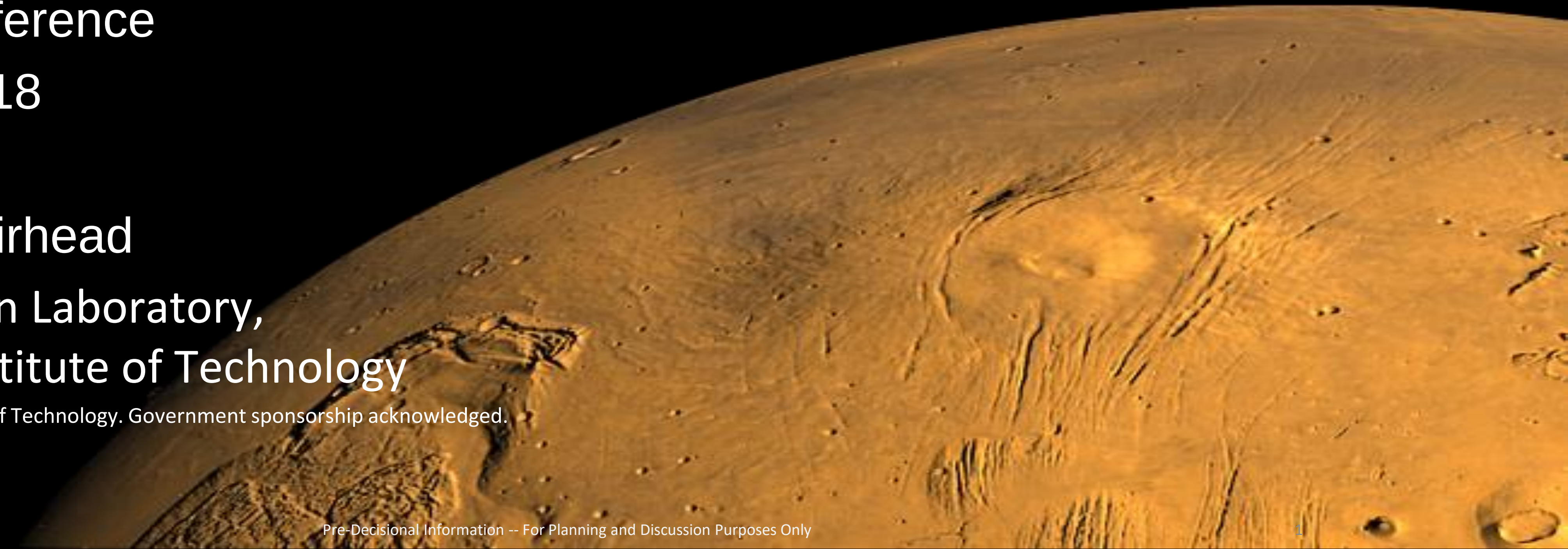
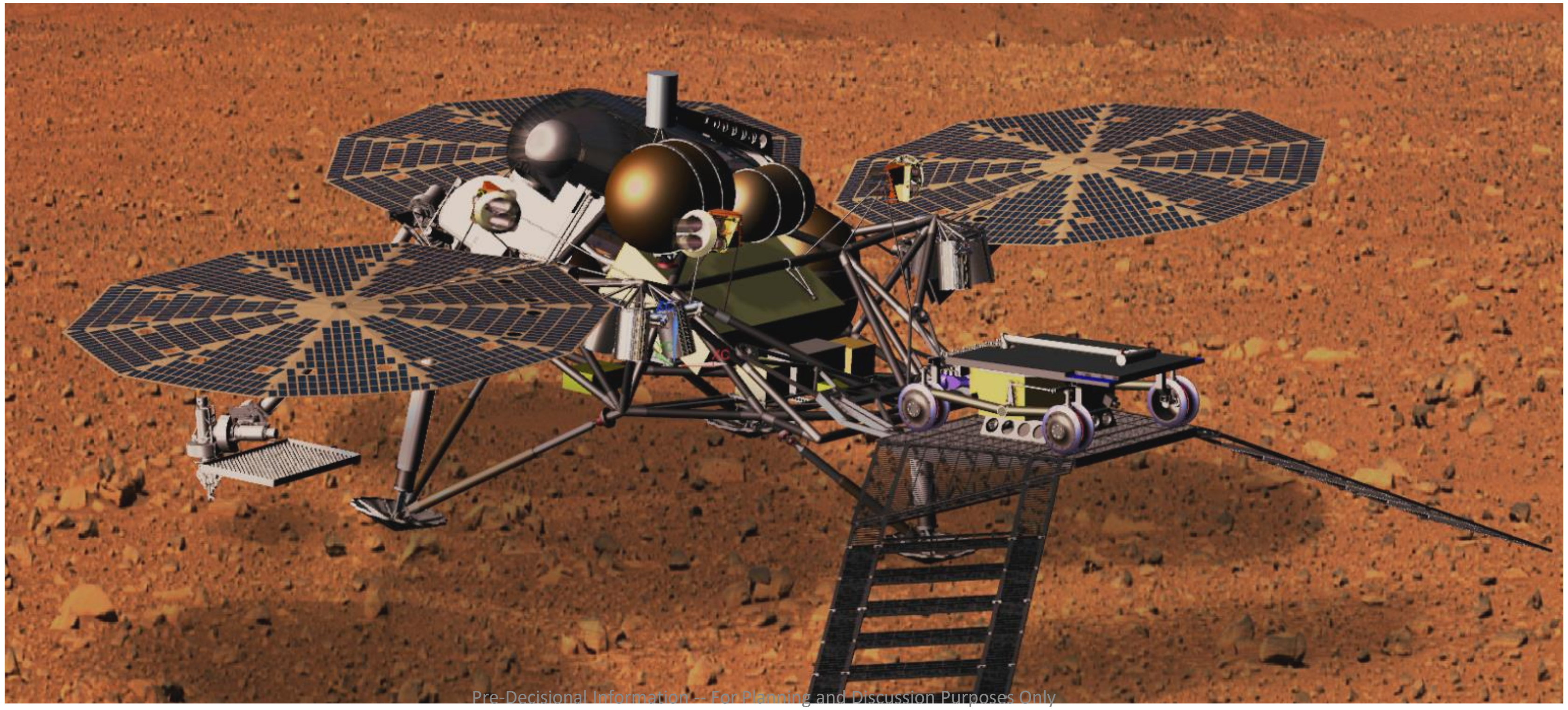


MSR Sample Return Lander (SRL) Scope

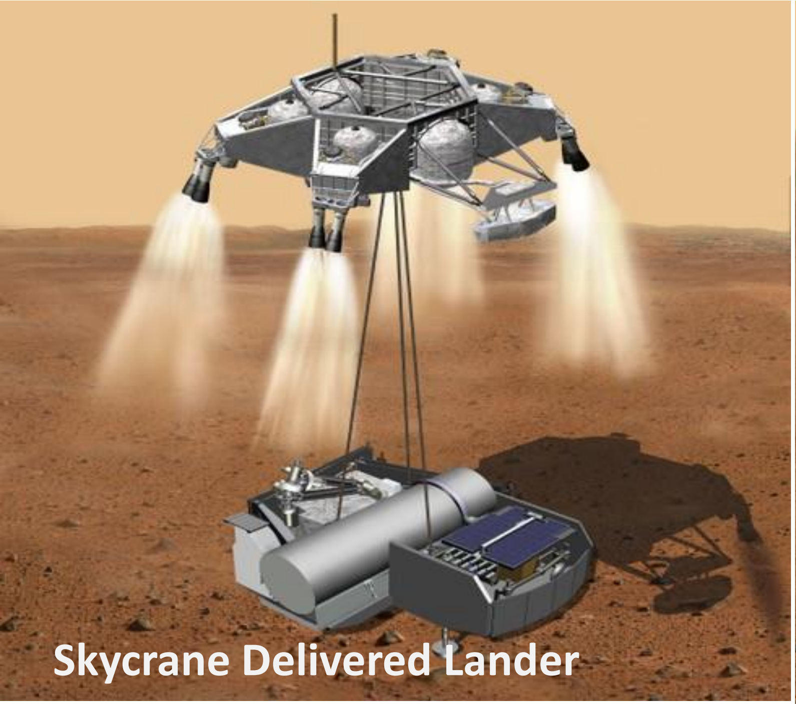
Conduct architecture-level studies to:

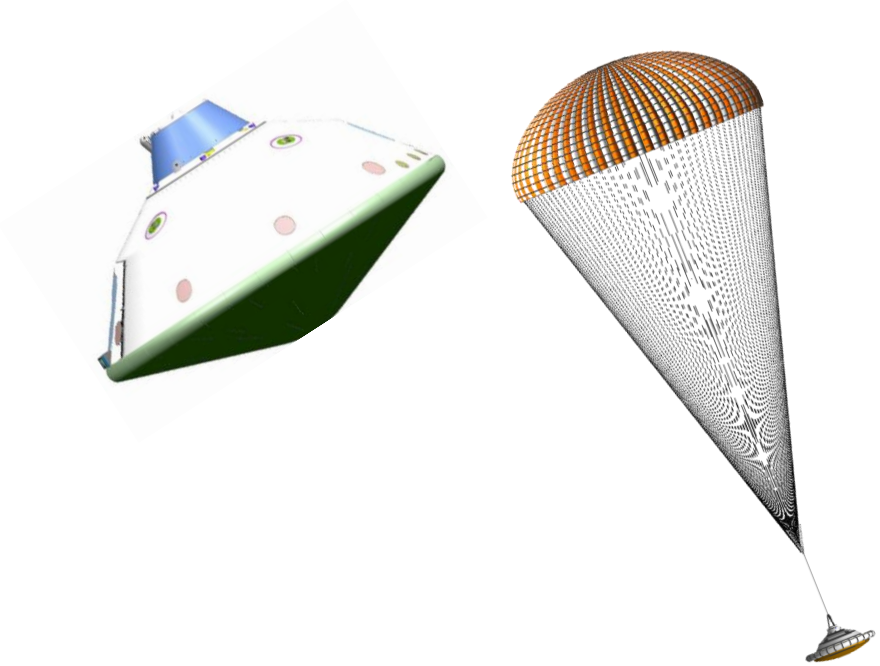
- Acquire sample tubes, package and deliver them to Mars orbit
- Within performance, environmental, planetary protection and programmatic constraints

Cruise Stage & Aeroshell	Descent Propulsion	Lander	Fetch Rover	Orbiting Sample (OS) container	Tube Transfer systems	Mars Ascent Vehicle



Two Lander Options Under Study

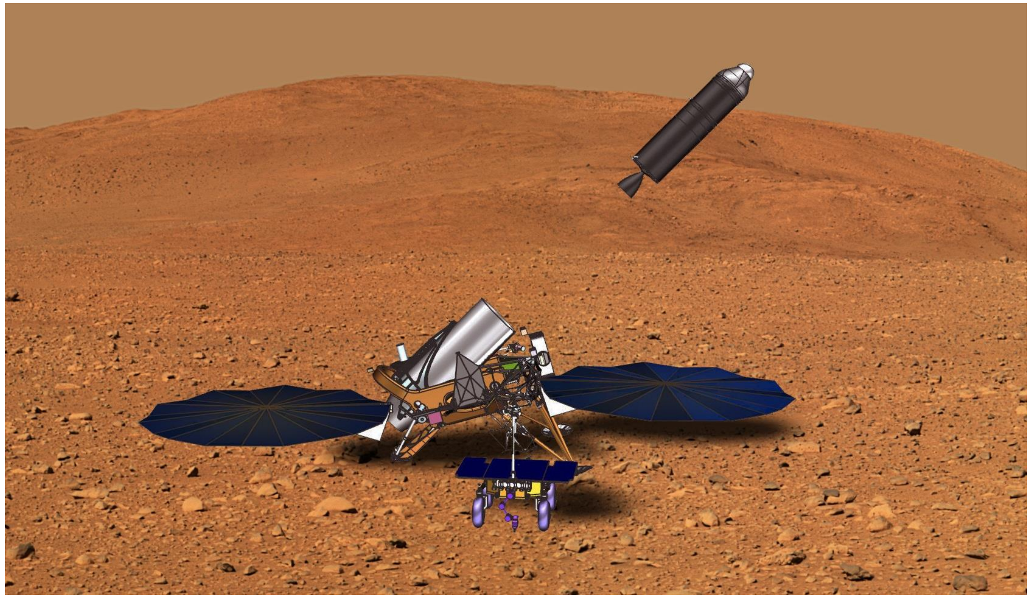


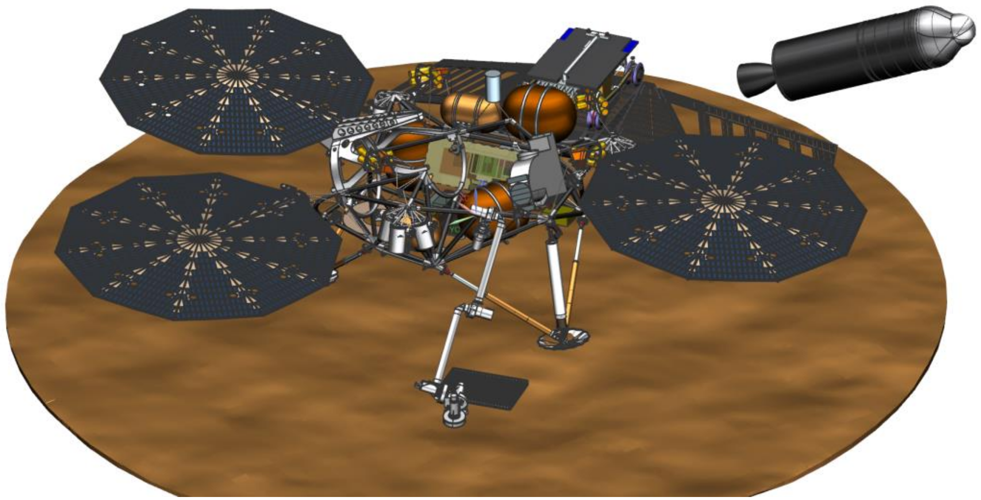


Most of Entry, Descent and Landing (EDL) is common to both:

- EDL through backshell separation, avionics, engines, use of terrain relative navigation (TRN)
- Will likely need augmented EDL capabilities over MSL/M2020 capabilities due to poor Mars opportunity and need for greater landing mass than rovers

Key Trades and Design Studies





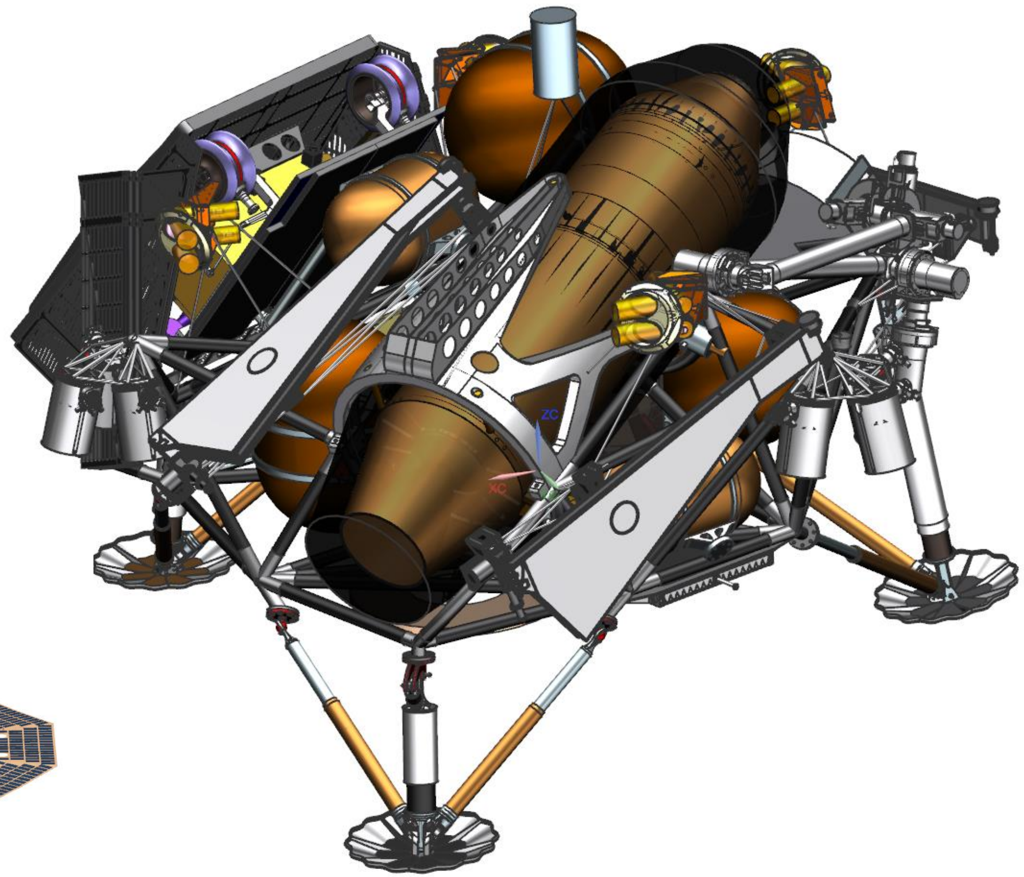
- **Key Trade Studies**
  - MAV : Propulsion technology, performance (including mass), and reliability
  - OS: Tube accommodation, insertion into MAV
  - Planetary protection design and implementation strategies

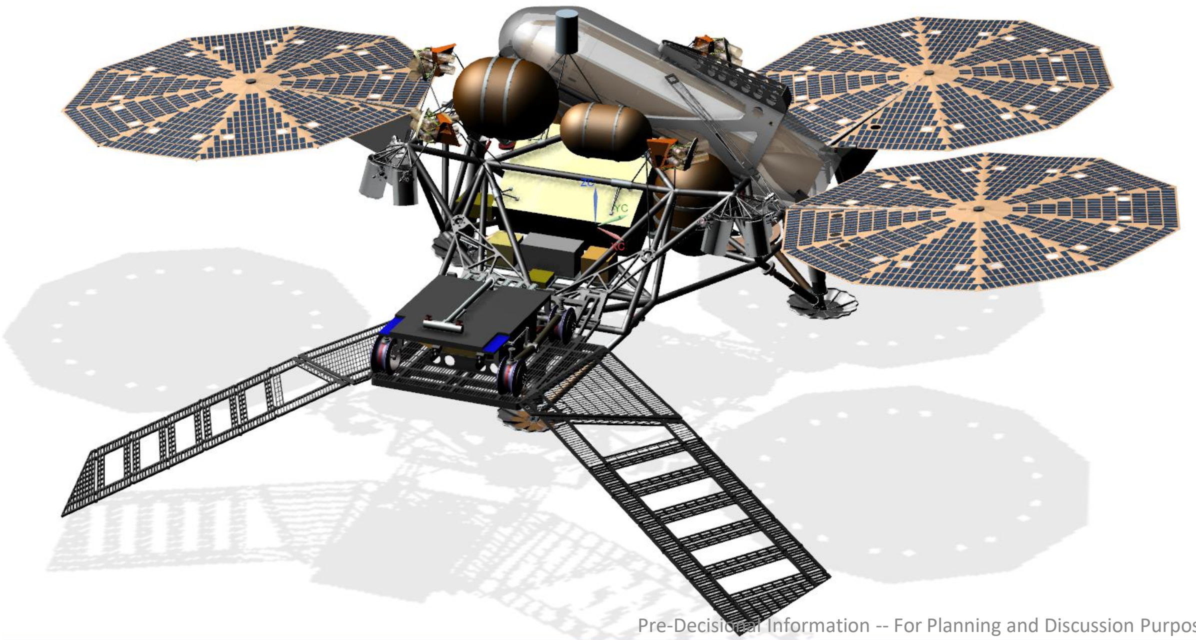
- **Key Design Studies**
  - Accommodation of MAV (400 kg) and Fetch Rover (120 kg) on lander in aeroshell, with volume and mass margins
  - Solar power and thermal design for worst case environments
  - 50cm maximum rock accommodation
  - Augmenting propulsion capabilities for larger divert

Propulsive Platform Lander (PPL) Concept

Design Features and Drivers

- Deployed landing gear on 3 pads
- Truss structure
- MAV at fixed tilt for launch
- Good mass and packaging margins
- Updated thermal and avionics design
- Rover deployed with dual egress ramps

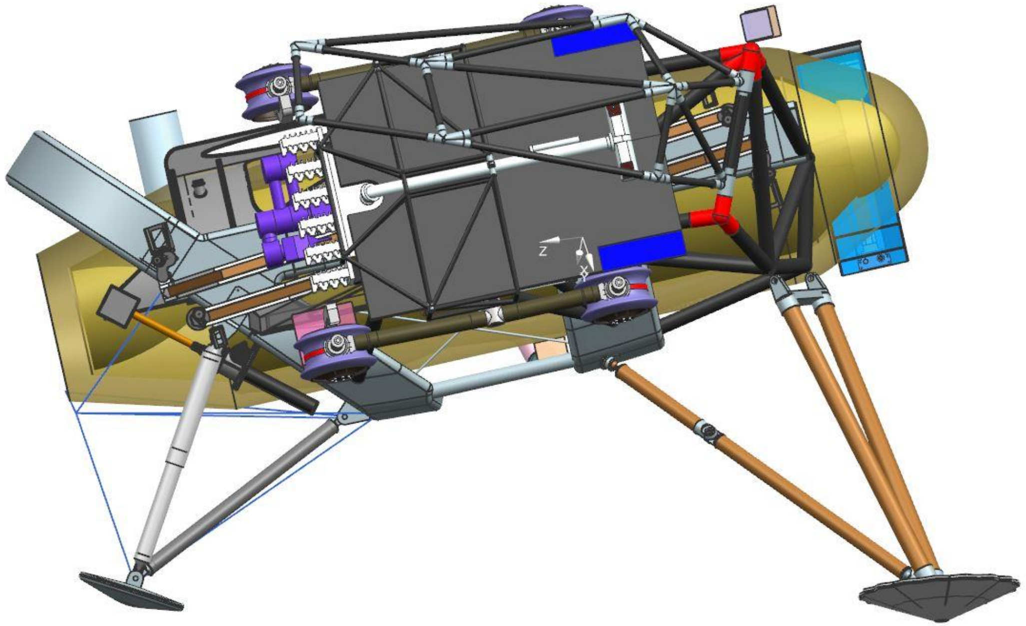


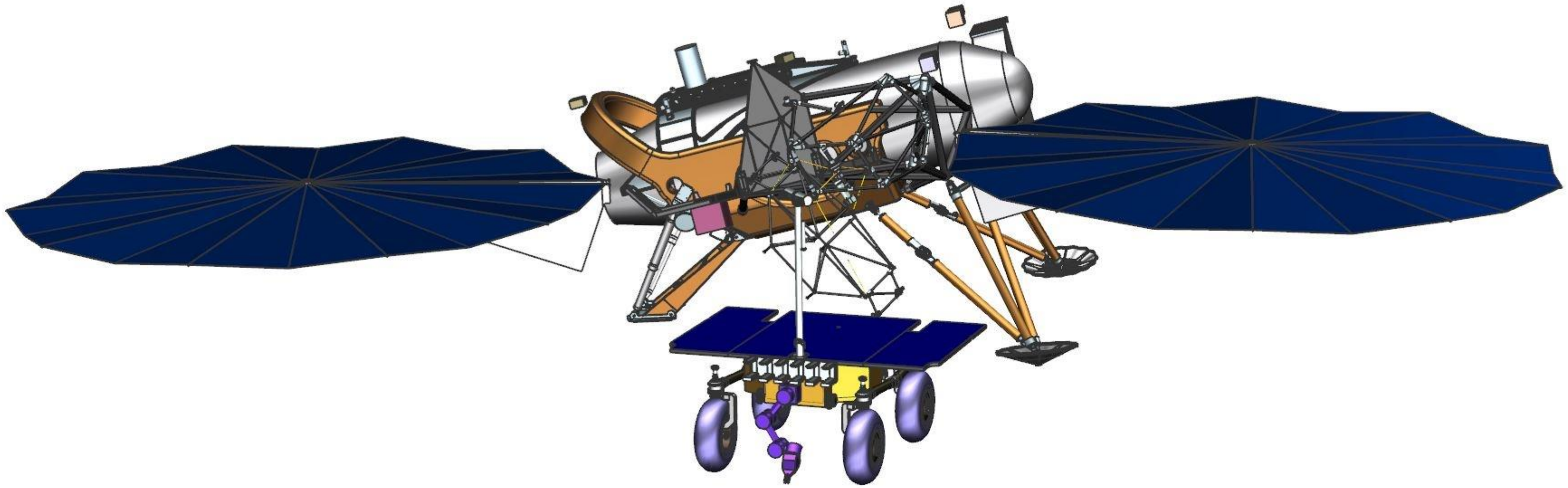


Skycrane Delivered Lander (SDL) Concept

Design Features and Drivers (still in progress)

- Deployed landing gear on 3 pads
- Truss structure
- MAV requires tilt-up for launch
- Rover deployed by robotic crane over range of touch down area
- Updated thermal and avionics design
- Working to meet landing mass constraint with margin





Orbiting Sample (OS) Container Concept

- Hold desired number of samples
  - Tubes are inserted by Sample Transfer Arm on lander
  - OS then must be assembled & launched to orbit by MAV
- Hold samples securely through launch to Earth landing
- Support maintaining samples within environmental constraints
  - Sample temperature < +30 ºC
  - Keep magnetic fields < ½ mT at sample
- Accommodate rendezvous and tracking by visual wavelength cameras on orbiter
  - Sufficient albedo to be detected in Mars orbit
  - Non-spectral surfaces

Sample Tube

Assembled Test Article

Disassembled Test Article

Mars Ascent Vehicle (MAV) Concept

Mission Objectives

- Launch from all candidate M2020 landing sites
- Inject OS into >350 km altitude orbit, > 25 deg inclination (< 1deg. dispersion)

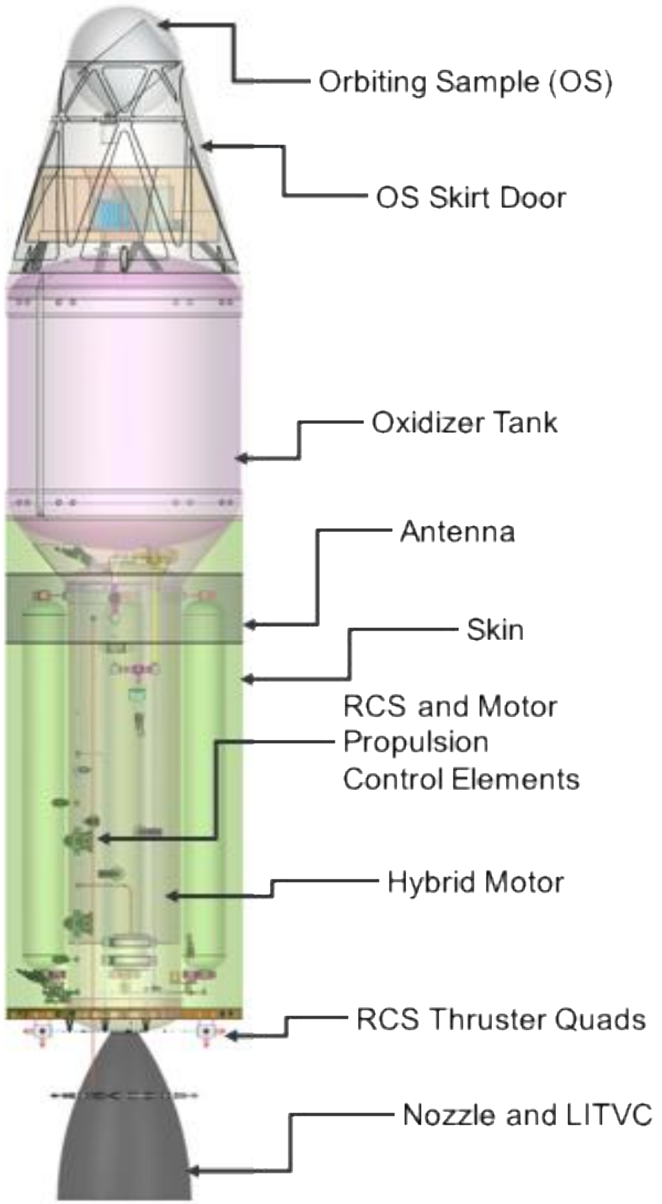
Technology Development Status

- Numerous options have been studied in the past
- Currently, two contractors are working to demonstrate performance of a single stage to orbit hybrid propulsion technology concept
  - Including ignition and stable combustion for the mission duration and a single restart
  - Both are achieving ignition with augmented combustion energy sources

Key Trade Studies in Work

- Overall vehicle design to meet Mars mass and volume constraints
- Thrust vector control
- Design for environments

Current hybrid concept
300-400 kg Gross Liftoff Mass



Fetch Rover Concept

Mission Objectives

- Acquire sample tubes from the Mars surface
- Surface mission duration: 210 sols max
- Average traverse distance required: 150-250 m/sol

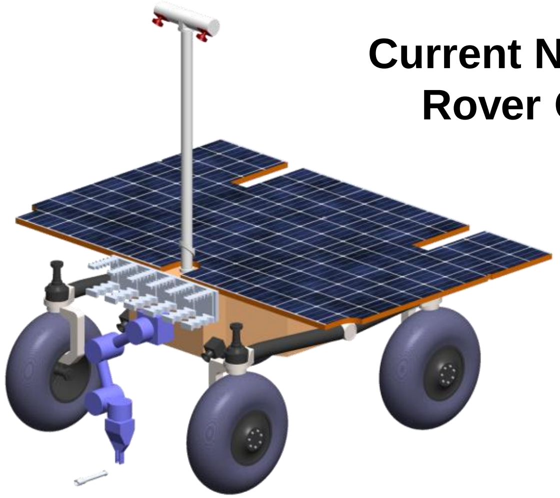
Key Specifications (based on NASA design)

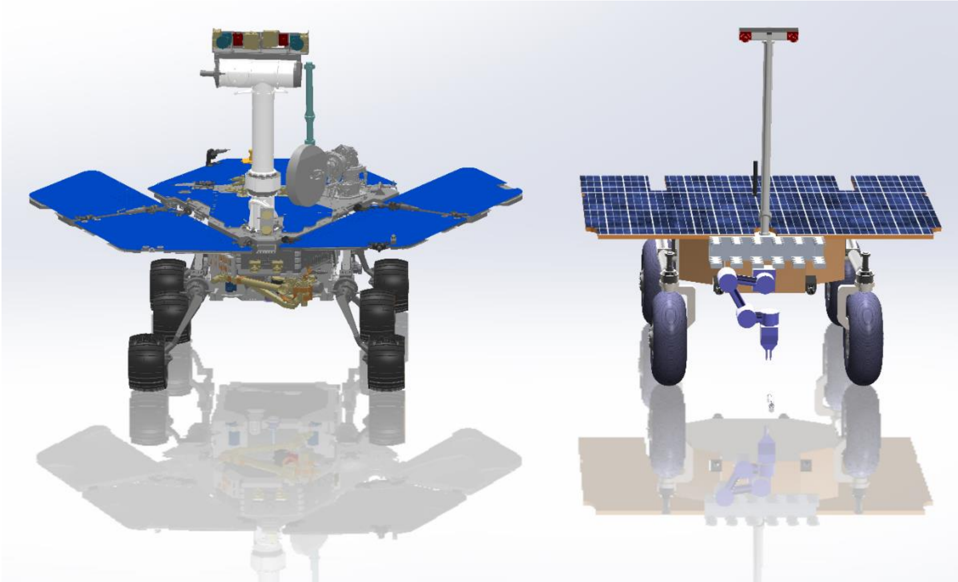
- Rover Mass: 120 kg (Not to Exceed)
- Stowed Volume: ~1 m^3
- Power Architecture: Solar powered, 1.5 m^2
- Navigation: Image processing to support autonomous driving
- Telecom: UHF relay to orbiters

M2020 Delivery

- M2020 as fetch was studied, concluded that that option is feasible and that most robust mission approach is to maintain both fetch rover and M2020

Current NASA Fetch Rover Concept





Scale is roughly 2/3 of MER

Plans for 2018

- Complete current lander design studies and update mass, Spring, 2018
- Continue hybrid testing leading to a Status Review in Spring, 2018
- Continue OS design studies and tube transfer
- Support potential international partner design studies for Fetch Rover