Perspectives from Lockheed Martin on Mars Exploration Technology and Commercial Partnerships

Planetary Science & Astrobiology Decadal Survey: Mars Panel – 05 January 2021

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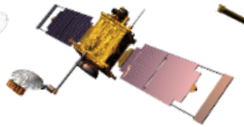
LOCKHEED MARTIN

Leveraging Our Legacy of Planetary Experience

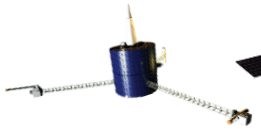

Viking 1 & 2
1976

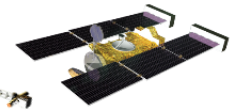

Magellan
1989

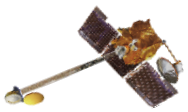

Hubble
1989


Mars Global Surveyor
1996


Cassini Propulsion
1997

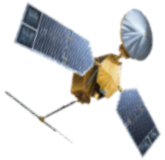

Lunar Prospector
1998


Stardust
1999


Mars Odyssey
2001

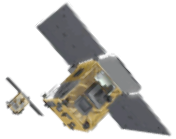

Genesis
2001


Spitzer
2003

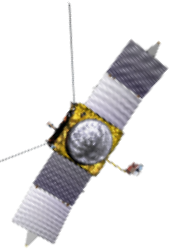

Mars Reconnaissance Orbiter
2005


Phoenix
2007

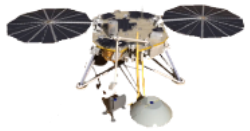

Juno
2011


GRAIL A & B
2011


MSL Aeroshell
2011

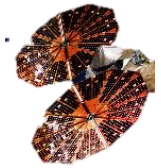

MAVEN
2013


OSIRIS-REx
2016


InSight
2018


Mars 2020 Aeroshell

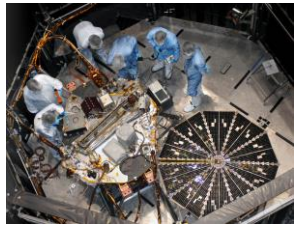

LunIR


Lucy


McCandless

Extending Commercial Space Transportation Business Model

Like space launch, McCandless is a commercially developed, end-to-end space transportation service available to all customers



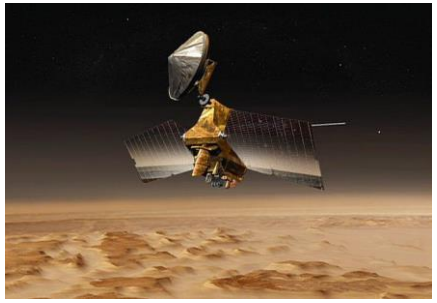
Experienced planetary spacecraft teams and active facilities ready for assembly and test.

McCandless will be flown by the same Lockheed Martin Mission Operations team currently operating 7 planetary spacecraft

The Challenges of Commercial at Mars

All US Mars missions to date are NASA missions

Viking Landers (1975)



Mars Reconnaissance Orbiter (2005)

MAVEN (2013)

InSight (2018)

CLPS Lunar Lander

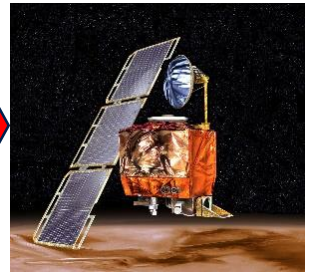
Inserting Small Sat Technologies and Commercial Launch Services approaches

Based on RCA commercial AS-4000 bus & TIROS/DMSP bus

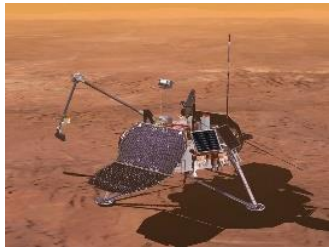
Mars Observer (1992)

Mars Global Surveyor (1996)

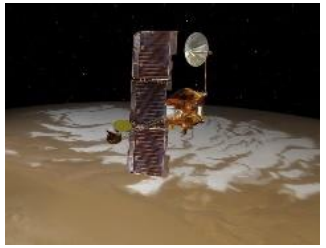
Inserted FBC technologies developed for SSTI (Clark)



Mars Climate Orbiter (1998)



Mars Polar Lander (1999)



Mars Odyssey (2001)

Phoenix (2007)

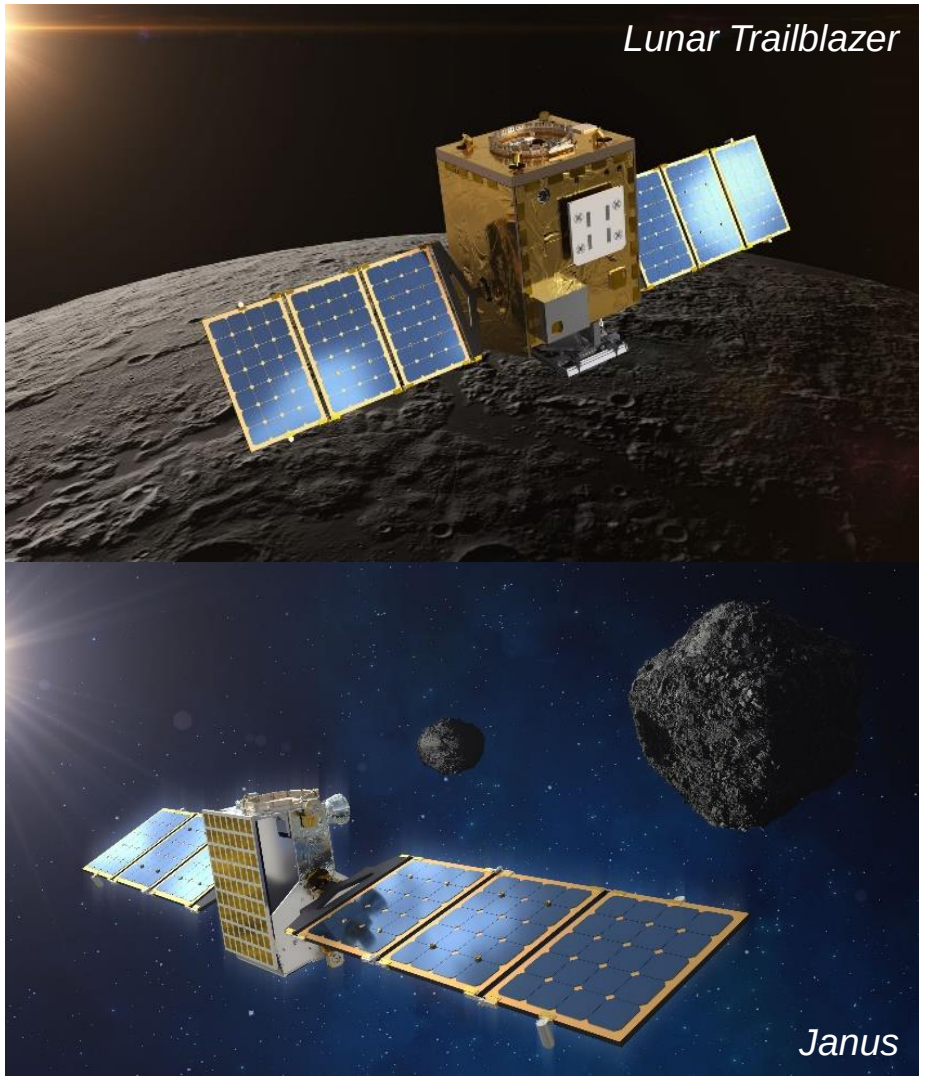
Our Approach to SmallSat Science Missions

Perform **high-caliber** and **achievable** science missions.

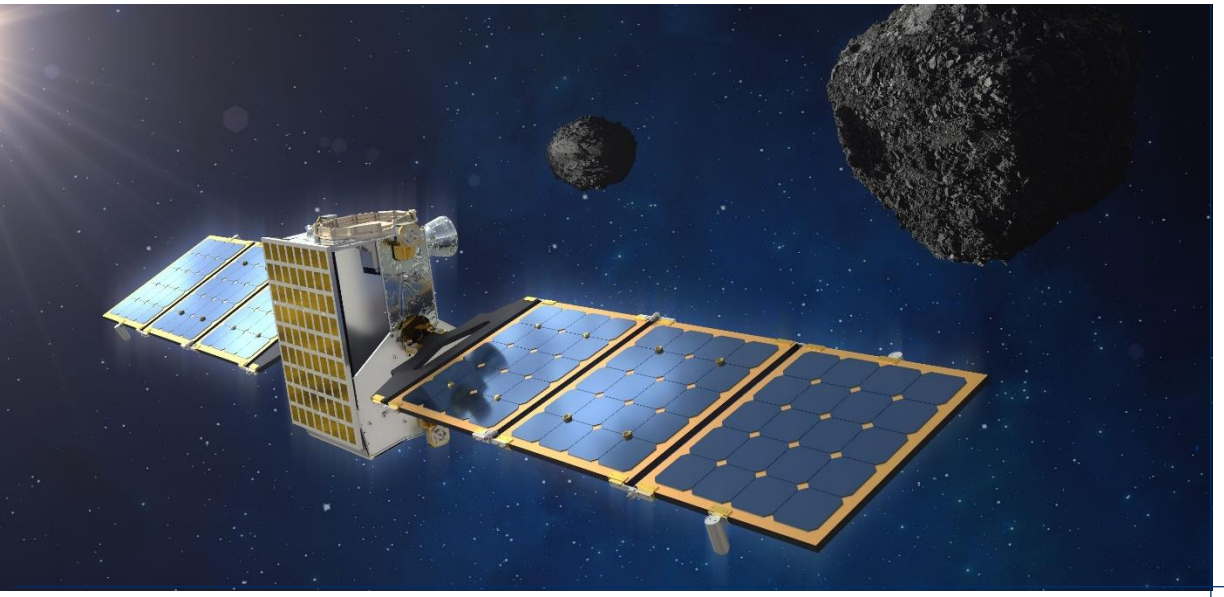
High-caliber: The science goals come first, and we work with the PI to propose and execute the science mission.

Achievable: We help shape the overall mission to fit within the technical, cost, and schedule constraints of a SmallSat or CubeSat science program.

- We embrace a **Class D** risk posture
- We use **commercial-off-the-shelf solutions** wherever possible to avoid driving development cost
- We bring **science support** to proposals and missions, with planetary scientists on Lockheed Martin staff
- We encourage strong **science traceability** to available technical solutions



Janus (SIMPLEx-2)



Program Description

- PI: Dan Scheeres, University of Colorado
- Agency - NASA
- Flybys of two binary asteroid systems.
- Understand the physical evolutionary pathways that drive rubble pile asteroids.
- 2 identical 40 kg spacecraft within SIMPLEx cost cap
- Spacecraft designed, constructed, and operated by Lockheed Martin
- LM managed program has strong cost and schedule performance.
- Instruments: 2 Malin cameras + DVR

Program Status & Key Dates

- Selected as one of three winning SIMPLEx-2 missions in June 2019
- Excellent performance on technical performance margins including successful passage of Preliminary Design Review on 15 July 2020.
- On track for launch as secondary payload with Psyche August 2022
- 4 year mission duration.

LM Science SmallSat Capabilities

- **Architecture:** Two smaller standalone spacecraft providing complementary science observations on independent flybys
- Establishes avionics and software, including testbed hardware
- Bus components sourced from SmallSat- and CubeSat-industry providers
- Janus spacecraft are approx. 50x30x10 cm with 10x10x30 cm thruster platforms ~= 21U in CubeSat terms
- Not built to CubeSat form factor in order to accommodate deep space solar arrays and high-gain antenna

Lunar Trailblazer (SIMPLEx-2)

Program Description

- PI: Bethany Ehlmann, CalTech
- Agency – NASA/JPL
- Low Lunar orbit insertion from IMAP rideshare
- Resolve questions about the character and origin of water in the Earth-Moon system and characterize resources for future landed exploration
- Janus/GRAIL derived spacecraft within SIMPLEx cost cap
- Spacecraft designed and constructed by Lockheed Martin
- Instruments: HVM3 + LTM
  - High-resolution and Volatiles Moon Minerology Mapper
  - Lunar Thermal Mapper

Program Status & Key Dates

- Selected as one of three winning SIMPLEx-2 missions in June 2019
- LM selected as spacecraft provider July 2020
  - Chemical propulsion system chosen over EP solution for orbit insertion
  - LM solution fit within SIMPLEx-2 cost constraints
- PDR October 2020
- On track for launch as secondary payload with IMAP October 2024
- 2 year mission duration.

LM Science SmallSat Capabilities

- **Architecture:** Single standalone spacecraft for dedicated observation
- ESPA-sized spacecraft with SmallSat avionics
- Bus components sourced from SmallSat and CubeSat-industry providers
- Combine with traditional propulsion system for higher ΔV capability
- Propellant and higher-power instrument drive sizing to ESPA volume

Looking Ahead…

SmallSats are capable of “SmallSat science”

- Standalone SmallSats can do lower-cost, riskier missions
- Constellations can give us new types of data
- Early mission formulation is key to success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