

# NASA Mars Exploration Program Update to the Committee on Astrobiology and Planetary Science

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Director MEP  
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# The state-of-the-MEP today

## Our operational assets remain healthy and productive:

- ✓ MAVEN has successfully completed its prime science mission and is now continuing investigations in an extended mission
- ✓ Odyssey, our oldest Mars asset, continues to be healthy and contribute thermal imagery and data relay services
- ✓ MRO continues to provide invaluable reconnaissance imaging and mineralogical mapping, supporting science investigations, rover operations, and exploring potential human landing sites
- ✓ Opportunity continues to provide important ground truth data, recently scaling 30 deg slopes of Knudsen Ridge atop the southern flank of Marathon Valley, to investigate red zones
- ✓ Curiosity continues exploring Gale Crater, generating important insights into Martian chemistry
- ✓ Mars Express continues operating our collaborative deep radar sounder (MARSIS)

## M2020 development on-track and proceeding well:

- ✓ PDR successfully completed Feb 2016
- ✓ Heritage H/W fabrication underway; some delivered
- ✓ Sampling system development labs up and running

## We are meeting our foreign commitments:

- ✓ Our two Electra payloads on the TGO are ready for flight
- ✓ MOMA is proceeding in development for the ExoMars Lander

## Financially, the program is doing well:

- ✓ This fiscal year all our planned activities are funded
- ✓ Earlier this month the President's FY17 budget was released and Mars fared well again, supporting our development, operational, and future mission activities

Overall, the state-of-the-MEP is good

# M2020 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  $\pm 30^\circ$  latitude,  $\leq -0.5$  km elevation
- Curiosity-class Rover

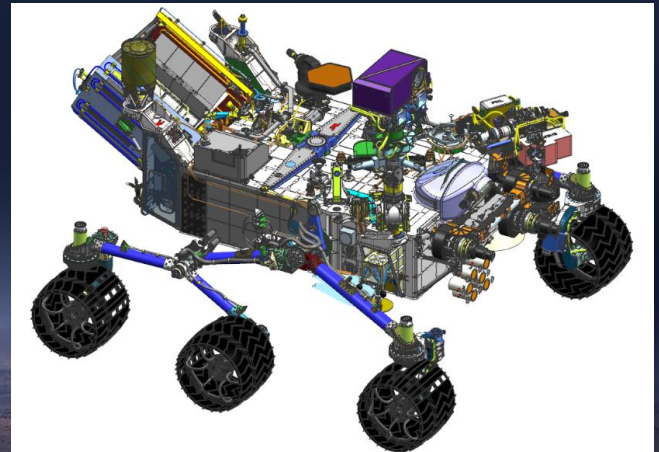
## SURFACE MISSION

- 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

M2020 mission elements

# M2020 Project Status Summary

- The Mars 2020 Project has conducted successfully the lower level instrument, subsystem, and Office level PDR's necessary to provide confidence in a full understanding of the requirements, design response, and associated cost estimates
- Cost estimates for new developments, particularly the instrument payload and SCS, include acceptable financial and schedule margins to support a 2020 launch
- The Mars 2020 Project has conducted successfully the mission system PDR
- Cost performance on heritage HW continues to perform under plan
- Project is progressing on-schedule within cost target



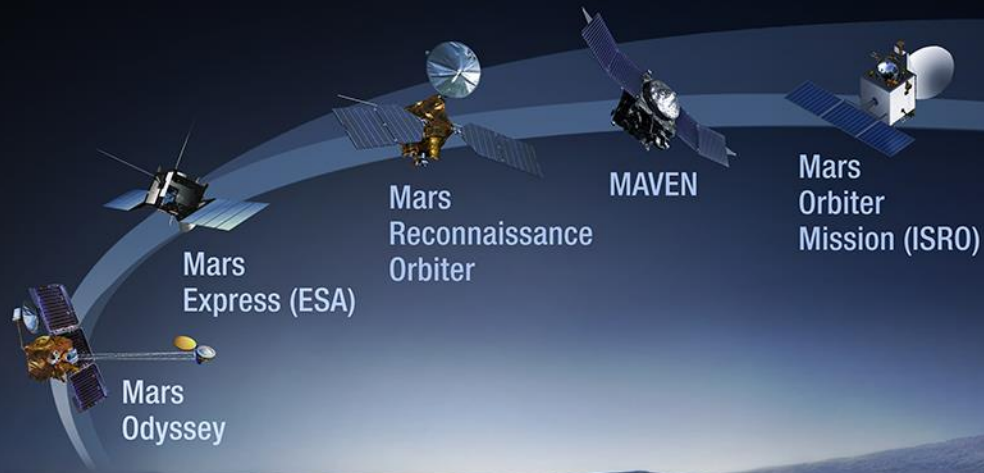


Operational 2001–2015

2016

2018

2020



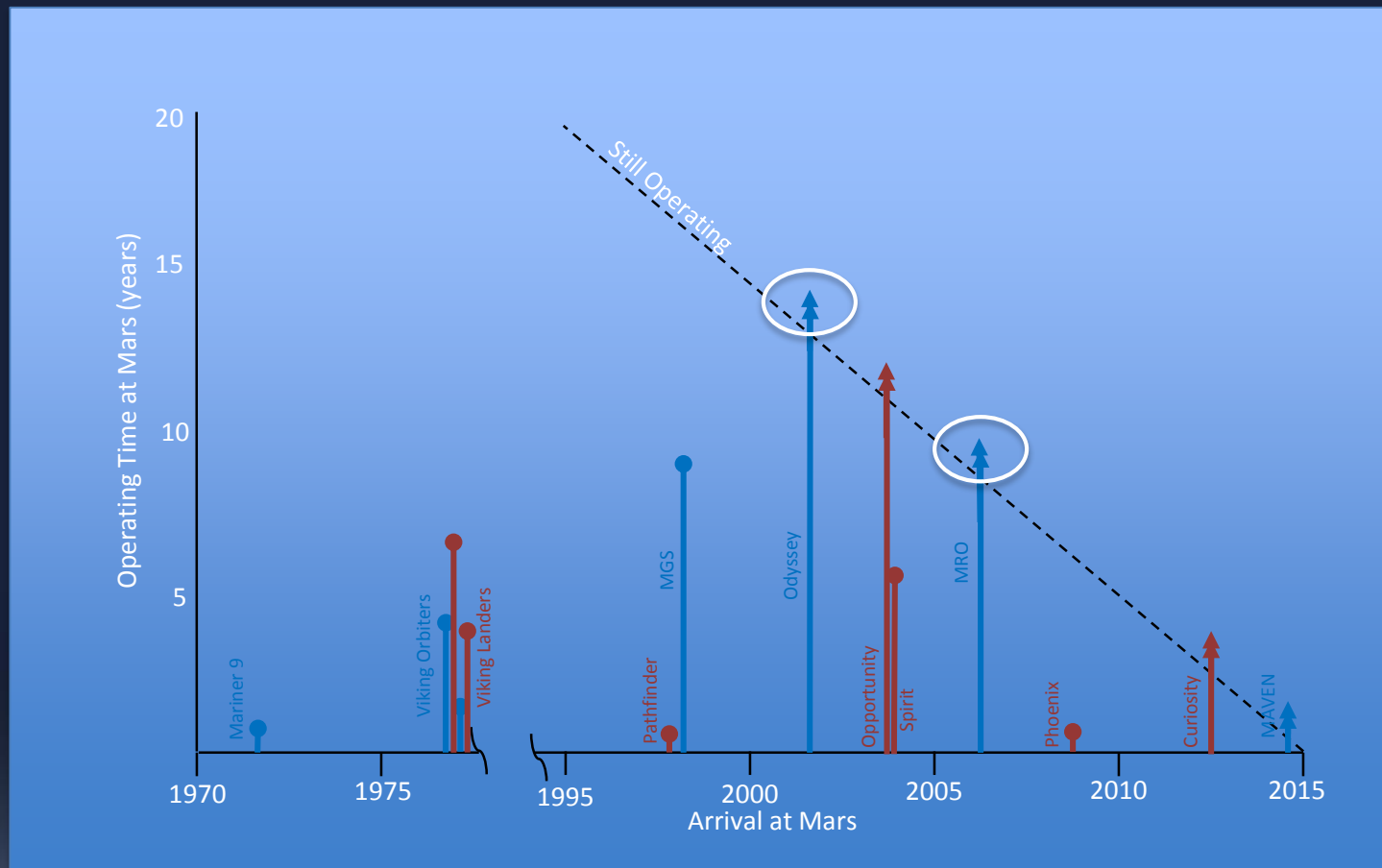
*Follow the Water*

*Explore Habitability*

*Seek Signs of Life*

*Prepare for Future Human Explorers*

# Operating At and Around Mars



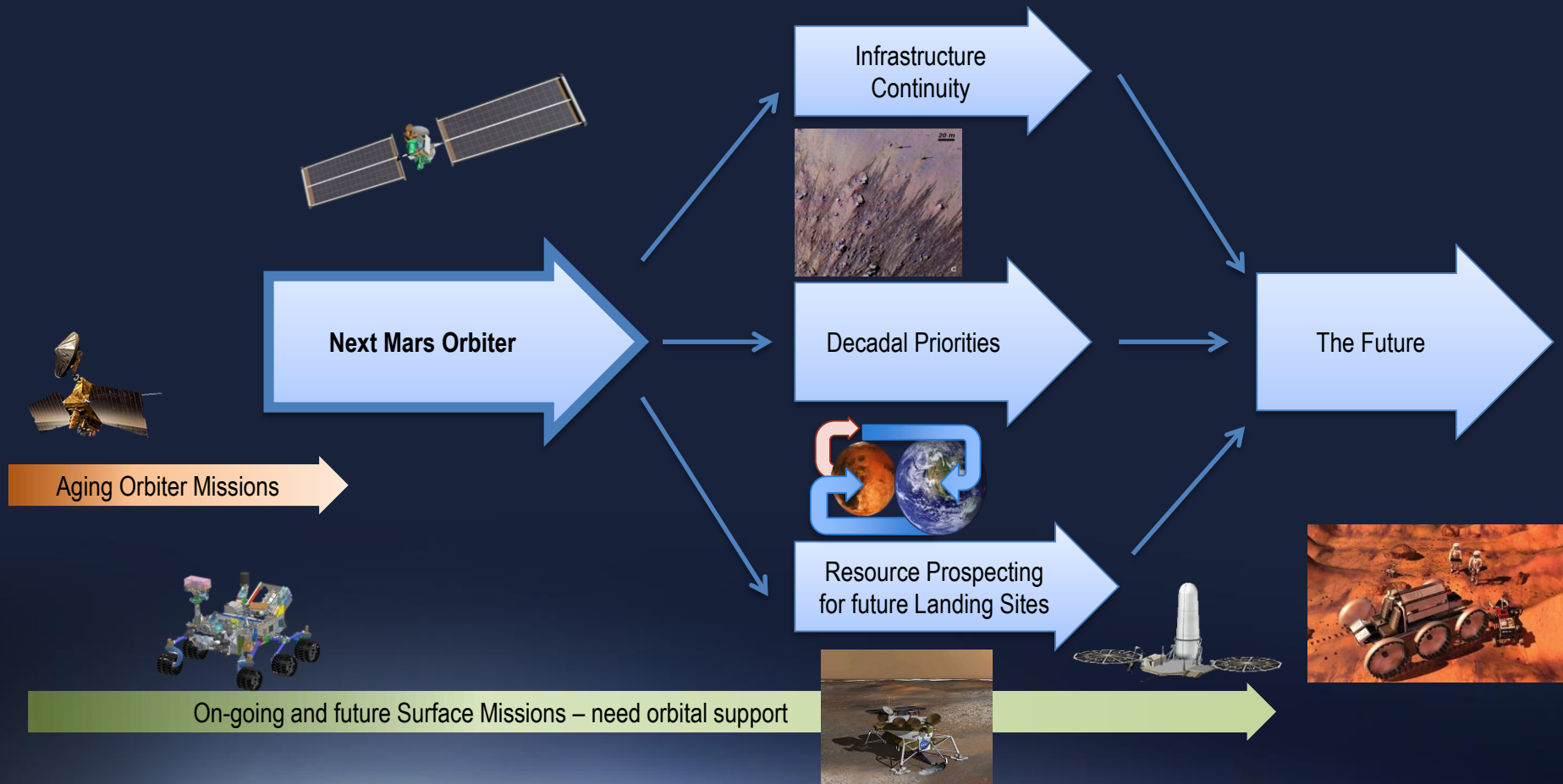
**MEP has operated successfully and with longevity, but our infrastructure is aging, placing the decade of the 2020s at risk**

# Strategic View Forward

- US National Research Council (NRC) Planetary Science Decadal Survey (2012) gave the highest priority to “elements of the Mars Sample Return Campaign”
- The Mars 2020 mission and its payload begin this process with the characterization of a site and the careful selection and documentation of a suite of samples acquired and encapsulated for return
- The President’s NASA Budget Request for FY2017 provides \$10M to begin early work on a future Mars orbiter missions beyond 2020 – with an emphasis on emplacing the infrastructure for the next decade

**MEP planning strives to integrate these realities into a viable plan for the future**

# Next Orbiter Can Provide Capabilities that enable Many Future Pathways



**Timely Renewal and Enhancement of Infrastructure is needed to Support Future Missions**



# Desired Orbiter Capabilities

## Renew and Update Aging Communications Infrastructure

- Essential to the future of Mars exploration; Laying the foundation for missions to come, while supporting ongoing missions in the early 2020's

## Provide Continuity of High Resolution Imaging

- Scientific Investigations for Landing Site Certification

## Essential Orbital Support for Sample Return

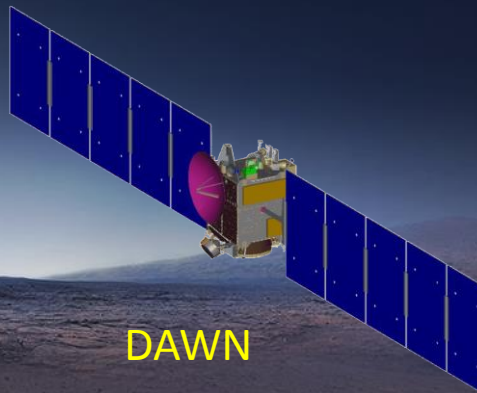
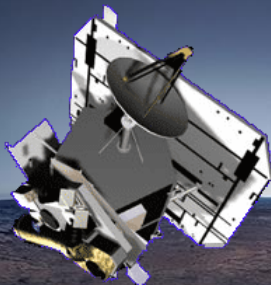
## Potential Resource Prospecting for future Landing Sites and Exploration planning

## Continuity of Relevant Remote Sensing

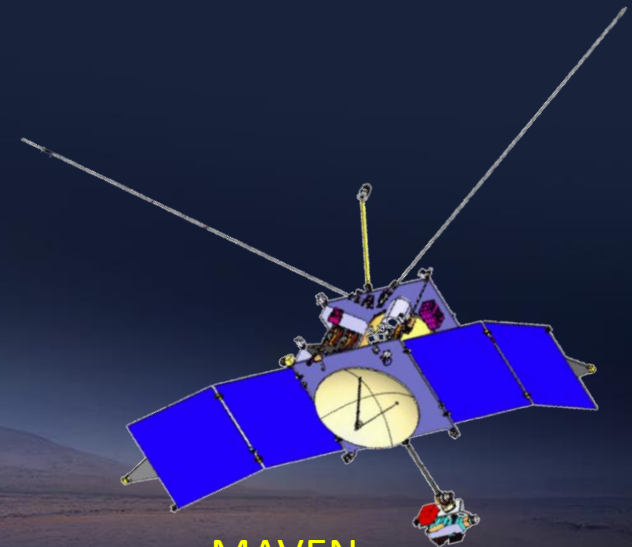
# Building from a Modest (Discovery-Class) Core Vehicle

- Many examples exist of architecturally flexible and adaptable spacecraft capable of supporting this mission
  - Provide Core Technical Functionality
    - Capable of Operating in Deep Space
    - Long Lifetime
    - Autonomous Operations
    - 3-axis pointing for imaging and communications
  - Adaptable to Solar Electric Propulsion, providing mission flexibility
    - Lowest cost launch vehicle
    - Increased mass delivery capability
    - Return to Earth capability

Deep  
Impact



DAWN



MAVEN

MARS

2/17/16

# Notional Orbiter Project Lifecycle Planning Timeline

FY 16		FY 17							
Pre-A		Phase A	Phase B	Phase C		Phase D		Phase E	
▲	▲	▲	▲	▲	▲		▲	▲	▲
MCR	P/L AO	SRR/MDR	PDR	CDR	SIR		Launch	Arrival	Science Orbit

**Phase A start in 2017 is essential, given that an orbiter arriving at Mars at the earliest opportunity would join Odyssey in its 22<sup>nd</sup> year of service and MRO in its 18<sup>th</sup>**

# Next Steps – Path to Orbiter Phase A

## Establish Partnerships

- Communication with iMEWG and MEPAG communities
- Explore potential International & Commercial Partnerships

**by May 2016**

## Prepare for MCR

- Establish baseline project architecture
- Establish key partnerships
- Refine technical trades
- Conduct ORDT, identify opportunities to openly compete selected instrumentation

**Summer 2016**

## Concept Refinement

- Detailed spacecraft studies, assess available aerospace capabilities
- Proceed with Phase A implementation

**Fall 2016+**

ORDT (Objectives & Requirements Definition Team)



# View from our Journey to the Foothills of Mount Sharp

\* WOW! \*



*"compliments of Curiosity rover - Sept 2015"*