

Mars Exploration Program Update

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Presentation to Virtual MEPAG Meeting

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Current Status of the MEP

Our operational assets remain healthy and productive:

- All six Mars missions did well in Senior Review and are going forward in extended missions
- Odyssey continues imaging in sunrise-sunset orbit
- MRO continues to provide reconnaissance imaging and mineralogical mapping
- Opportunity has left Marathon Valley
- Curiosity heading up Mt Sharp, soon to exit the Murray Buttes formation
- Mars Express continues

M2020 development on-track and proceeding well:

- Start Phase C June 27, 2016
- Heritage H/W fabrication underway; some delivered
- Sampling system development labs up and running

Foreign partnerships continue to be integral to the success of our program:

- Two NASA Electra payloads on TGO and on the way to Mars
- Prepared to support TGO MOI and EDM landing activities (Oct 19)
- MOMA is proceeding in development, supporting ExoMars delay to 2020
- Strong international interest in participating in potential future MEP activities

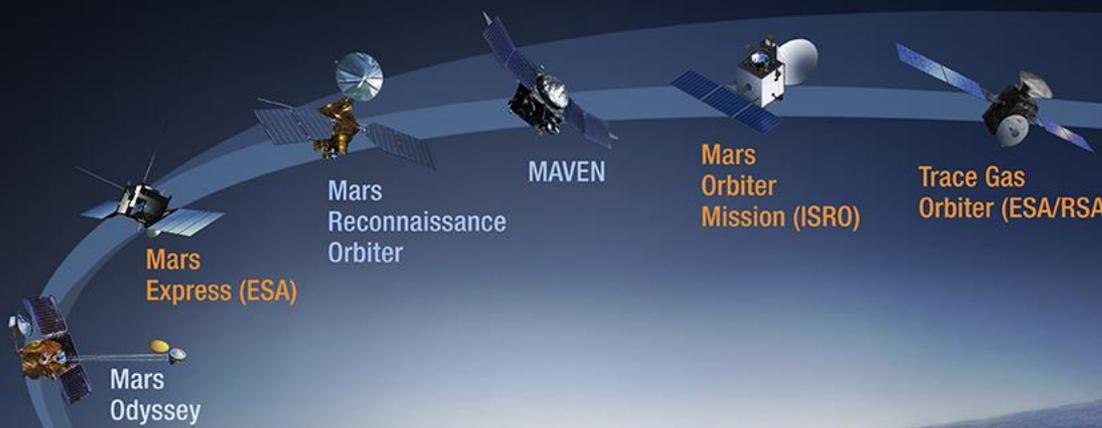
No missions beyond M2020 have yet been budgeted or approved:

Operational 2001–2016

2018

2020

2020s



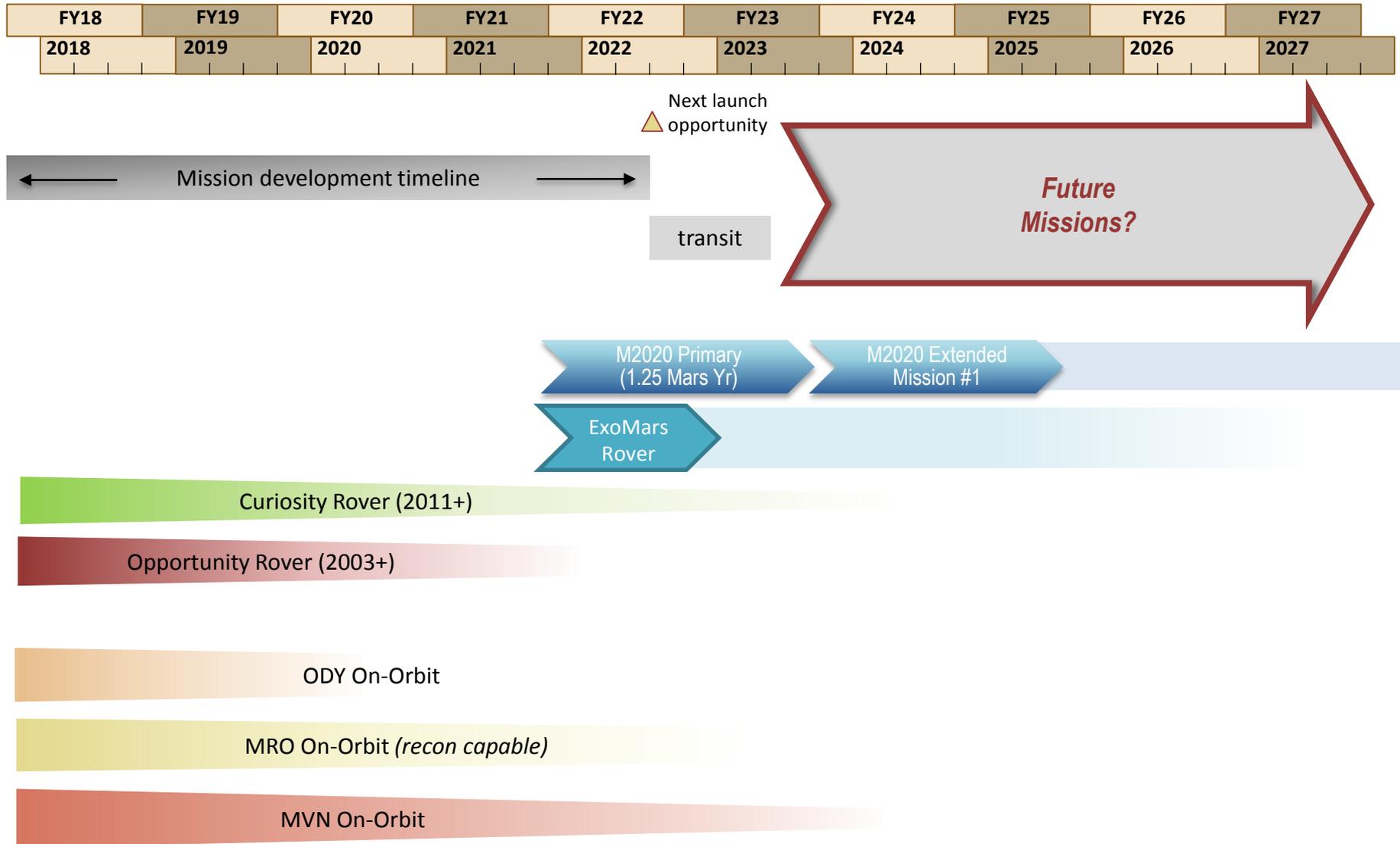
Follow the Water

Explore Habitability

Seek Signs of Life

Prepare for Future Human Explorers

Evolution of MEP Capabilities at Mars



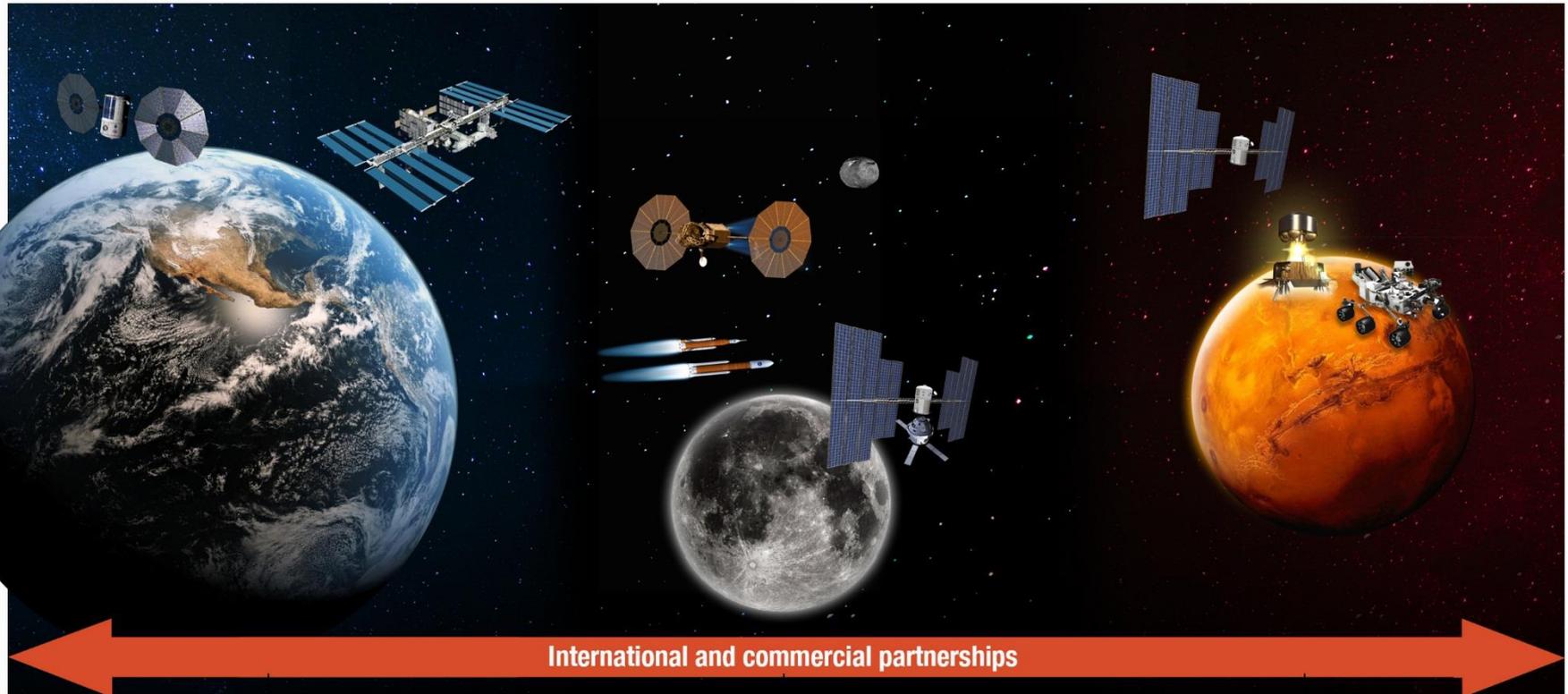
Progress Since Spring MEPAG Meeting

- MEP mission formulation studies are underway for the decade of the 2020s with an orbiter as the logical next step
- Reviewed RFI (July 2014) to survey for new business models for providing telecommunication relay services [NASA buys service from commercial provider]
 - All required some combination of NASA funding for launch, an early deposit, and a guaranteed subscription/lease arrangement to recoup cost and ensure positive ROI
- Reviewed recent planetary orbiter analogs that demonstrated affordability
 - MAVEN
 - Osiris-Rex
- Nearing completion (Jun-Oct 2016) of multiple (5) industry studies exploring potential high TRL heritage system approaches for orbiter spacecraft
 - Industry capabilities, heritage designs, and strategic interests are well suited to meeting orbiter needs
- Received 5 official *Letters of Interest* from potential international partners to contribute to an orbiter mission should NASA proceed to fly one

JOURNEY TO MARS



All elements needed for a human Mars mission are in development now.



EARTH RELIANT

NOW - MID-2020s

- International Space Station operation through 2024
 - Commercial development of low-Earth orbit
- Development of deep space systems, life support, and human health

PROVING GROUND

2018 - 2030

- Regular crewed missions and spacewalks in cislunar space
- Verify deep space habitation and conduct a yearlong mission to validate readiness for Mars
- Demonstrate integrated human and robotic operations by redirecting and sampling an asteroid boulder

EARTH INDEPENDENT

NOW - 2030s & BEYOND

- Science missions pave the way to Mars
 - Demonstrate entry, descent, and landing and in-situ resource use
- Conduct robotic roundtrip demonstration with sample return in the late 2020s
- Send humans to orbit Mars in the early 2030s

Next Steps

- Bring together this summer's industry studies to define the affordable capabilities that could be applied to a Mars orbiter
 - NEX-SAG looked at a wide range of options; time to see what can be supported in the current fiscal climate
 - MEP will continue to include capabilities that might enable possible return of samples by 2030
 - MEP will strive to preserve options for competed payload elements
- Will expand discussions with our potential international partners to map capabilities and desires to the key science and human exploration questions
 - MEP will organize and direct these international exchanges, but will need some participation by the science community's experts
- Bigger Challenge: How to bring together partner interests and ours into an integrated approach:
 - How do we ensure that we fly the right capabilities?
 - How do we continue and expand the participation of US scientists?
 - How do we create more opportunities to participate?
 - How could we have a greater involvement in the development of contributed payloads?
 - How do we bring a diverse group of participants and capabilities into an integrated whole?

MEP Future Mission Studies Construct

- Reality:
 - Progress has been slower than we had hoped - deferred the ORDT
 - Past and present MEP successes have obscured the growing gaps in future capability
 - NASA budget is over-subscribed, affordability is critical
 - Mars exploration is rapidly evolving to a collection of diverse international, and potentially commercial endeavors
 - These could potentially provide elements to MEP missions as well as offering flight opportunities of their own
 - International interest in partnering with NASA remains strong
 - Future MEP missions will likely need to meet a *diverse* set requirements in support of both Decadal science priorities, future human exploration, and partner interests that will evolve over the life of the mission, making the missions strategic in nature
 - MEPAG dealt with some of this in the NEX-SAG study in that they found great synergy between science and human exploration objectives
 - It is likely that a sizeable fraction of any future mission will be contributed/partnered

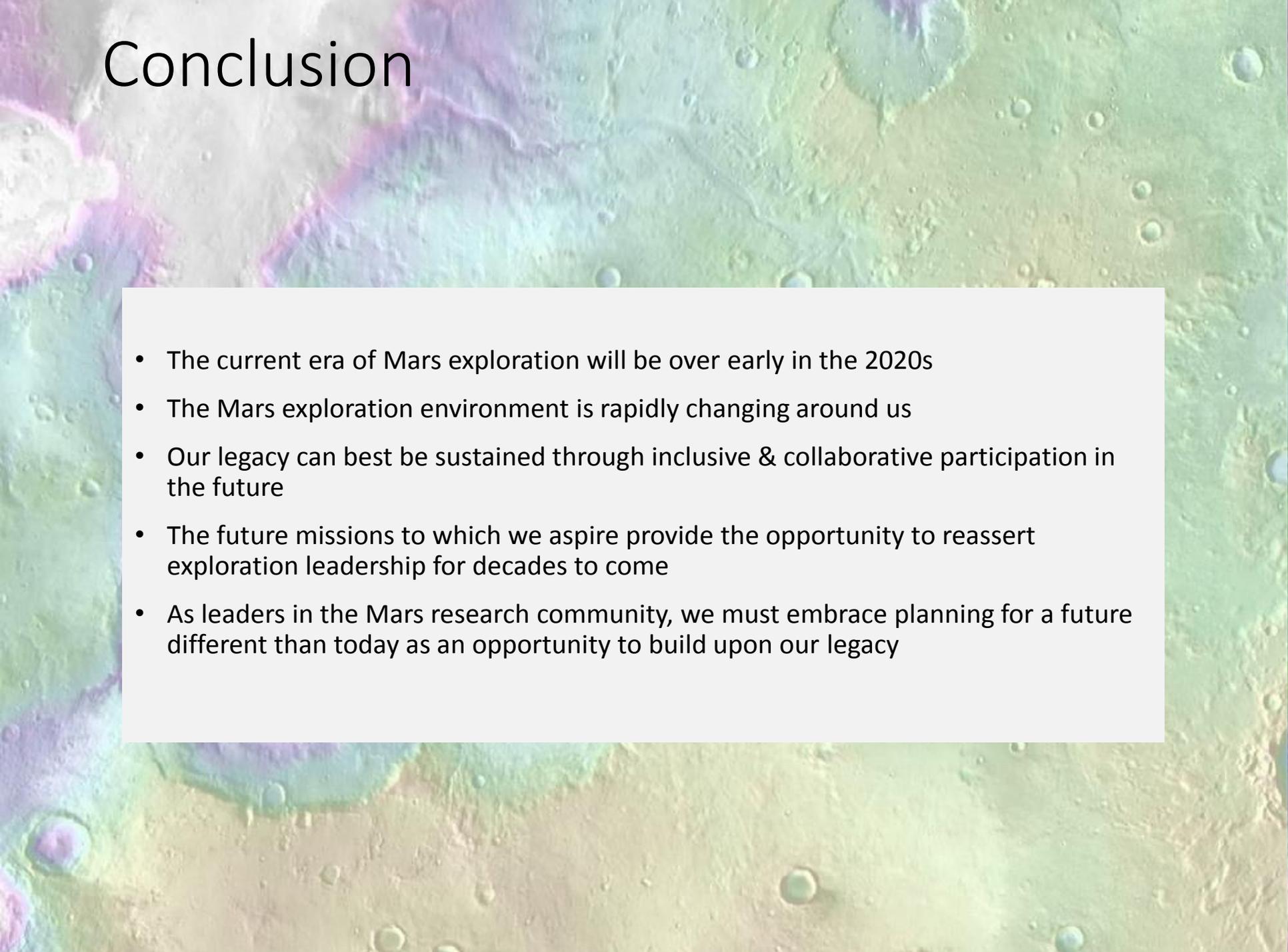
Exploring Options for Fostering Integration in a Collaborative Environment

- Our legacy is that payload providers largely control the utilization of their instruments, however, in a strategic mission context we must devise the means to integrate both payload development and science operations across a diverse set of interests
- Request MEPAG assistance in exploring new operational models that (1) embrace the needs of a diverse community of potential stakeholders and (2) would broaden potential participation as the mission evolves over time
 - Identify ways to tightly integrate instrument development teams across national and corporate boundaries
 - Investigate the idea of a strongly integrated approach to the conduct of mission science, ranging from expanding the participating science program to operating a future orbiter mission more openly as a *facility*

One Option: Facility Operation

- Facility operation opens participation to the broadest spectrum of participants. What might this look like?
 - All observers propose investigations with one or more instruments and specific S/C capabilities (open community)
 - MEP controlled/funded entity reviews proposals and awards observing time and resources (including funding) based on merit. Mission led by a Facility Science Team selected via competition (potentially with term limitations).
 - Something akin to what Astrophysics and Earth Science are already doing, but at a different scale
 - Facility Science Team composed of discipline & interdisciplinary scientists, with membership open to all partners
 - Partner provided instrument observations & data distribution governed by MOU consistent with the facility operation model
 - Strategic operations (eg; MSR support) directed by the program

Conclusion



- The current era of Mars exploration will be over early in the 2020s
- The Mars exploration environment is rapidly changing around us
- Our legacy can best be sustained through inclusive & collaborative participation in the future
- The future missions to which we aspire provide the opportunity to reassert exploration leadership for decades to come
- As leaders in the Mars research community, we must embrace planning for a future different than today as an opportunity to build upon our legacy