

National Aeronautics and
Space Administration

EXPLORE MARS

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NASA Planetary Science Advisory Committee (PAC) Meeting

June 2023

Mars Exploration Program Highlights

Mars Draft Future Plan Released: NASA external stakeholder rollout underway

- Solicited comments from the public
- MEPAG findings express support
- Retreat held to adjudicate comments
- Final Future Plan by end of the CY

Perseverance collected Melyn sample at Tenby

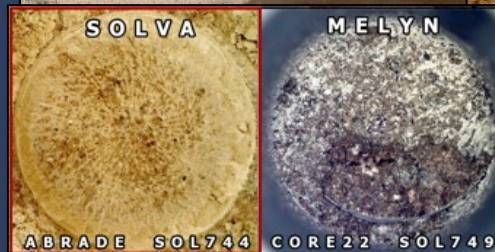
- Currently processing conglomerate sample from Otis Peak

Ingenuity completed its 50th flight on Mars

- The first aircraft on another world reached the half-century mark on April 13, traveling over 1,057 feet in 145.7 seconds. The helicopter also achieved a new altitude record of 59 feet.

Perseverance Lego released in Europe, in US later this summer

15 of 55 MDAP Proposal selected; results posted in NSPIRES



MEP Pre-Formulation Efforts

Sample Receiving Project

Sample Safety Assessment

- Project tiger team established to recommend test protocol, statistical analysis, subsampling strategy; completion in December

Sample Receiving Facility Study

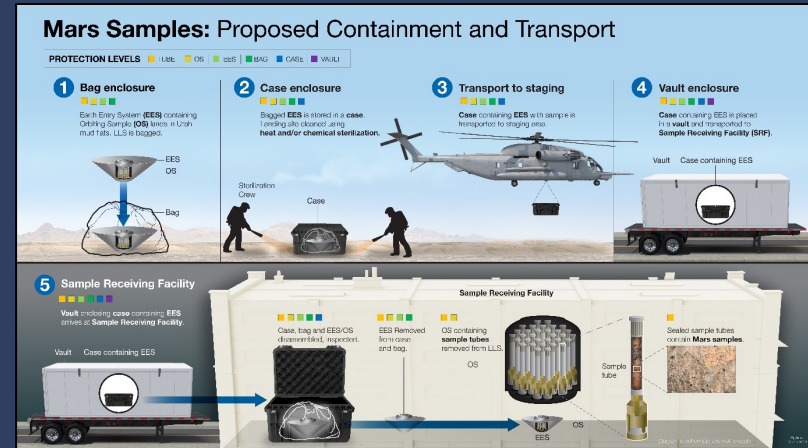
- Phase 2 studying concept designs for modular containment suit-lab and cabinet-line facilities; completion in late-spring 2024

Measurement Definition Team (MDT)

- Terms of Reference signed by NASA & ESA
- >850 people have already expressed interest
- An open call for members will go out before the end of June

Potential Collaboration on ESA's Rosalind Franklin Mission

- NASA participation subject to the availability of U.S. funding
- Proceeding with long lead item contracts to acquire descent engines and restarting production of RHUs
- MOMA reintegration reviews for 2028 launch underway

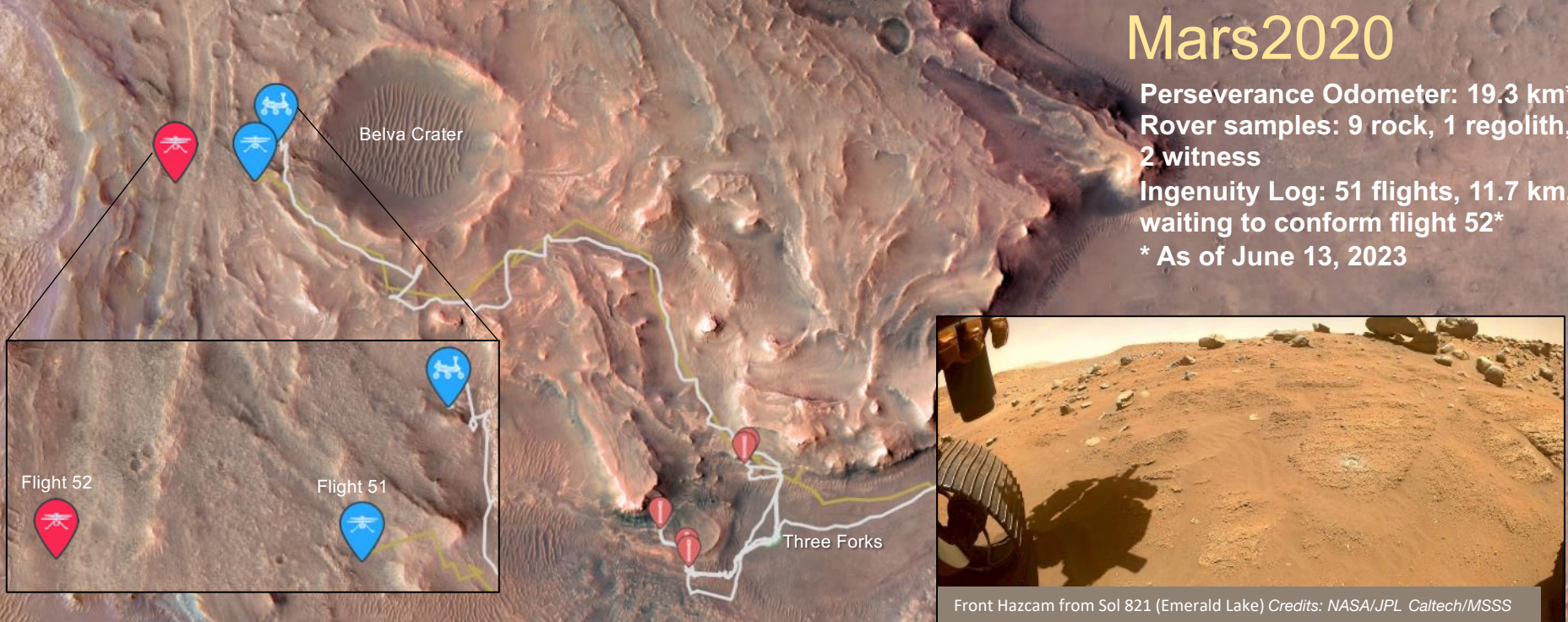


Mars2020

Perseverance Odometer: 19.3 km*
Rover samples: 9 rock, 1 regolith,
2 witness

Ingenuity Log: 51 flights, 11.7 km,
waiting to conform flight 52*

* As of June 13, 2023



- Perseverance explored the 'Onahu' outcrop for over the past 3 weeks after abrading 'Ouzel Falls' indicated interesting conglomerates (crumbly) but worth sampling attempt
- Conglomerate core from Emerald Lake acquired, working on sample processing now
- Ingenuity connectivity to Perseverance limited at current location; flight 52 data (April 25th) not relayed to the rover until Perseverance moves closer to the Ingenuity landing site
- After completing the Upper Fan science campaign, Perseverance will move toward the 'margin unit', the carbonate-bearing rocks located along the inner rim of Jezero

Mars Science Laboratory (MSL) Curiosity

Curiosity is headed toward the upper Gediz Vallis ridge, a landform that may record the most recent episode of liquid water on Mount Sharp

- Driven over 30 kilometers and gained over 700 vertical meters on Mount Sharp
- All ten instruments continue to return high-value scientific measurements
- Completed its 38th successful drill-based sampling campaign in May at Ubajara, marking 44 sampling campaigns overall.
- Years in the making, a major software update installed in April enables Curiosity to drive faster and reduce wear and tear on its wheels - just two of about 180 software changes implemented



NASA's Curiosity Mars rover will drive faster and reduce wear on its wheels thanks to two of the new capabilities included with a major software update that was completed on April 7. Seen here is the rover's view of a hill nicknamed "Bolívar," with Gale Crater's vast floor in the upper right.

Credits: NASA/JPL-Caltech/MSSS



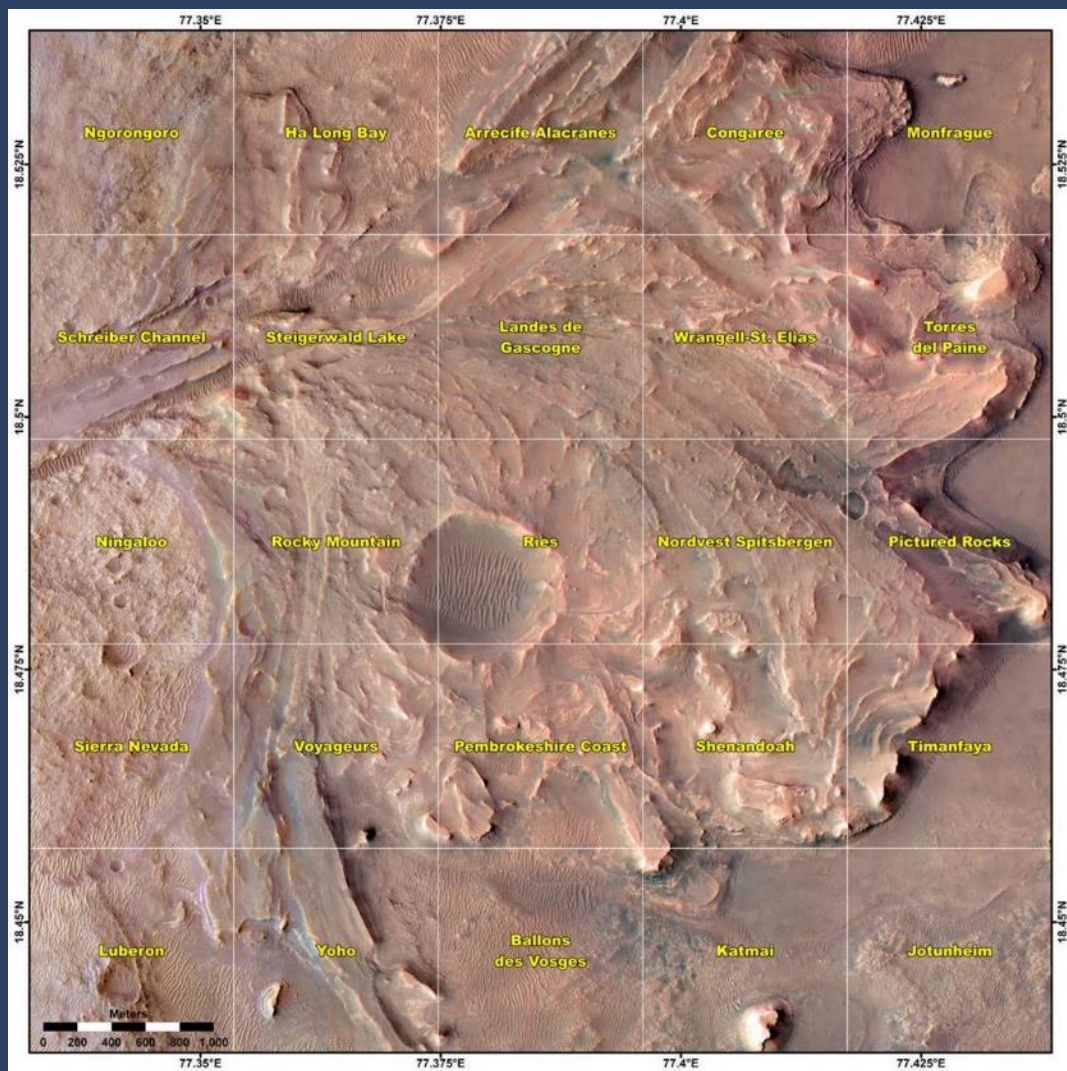
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Perseverance's Quadrant Themes

This map shows various quadrant themes in the vicinity of NASA's Perseverance Mars rover, which is currently in the Rocky Mountain quadrant within the much broader Jezero Crater. Each quadrant is 0.7 miles (1.2 kilometers) on each side.

The Perseverance team chose quadrant themes related to various national parks across Earth, from Shenandoah National Park in Virginia to Jotunheimen National Park in Norway.

The themes help organize the unofficial nicknames that are given by rover team members to different surface features they want to study, such as hills, craters, boulders, and even specific rock surfaces.



MEP Orbiters (no change)

Mars Relay Network (MRN)

- MEP successfully managing network activities with aging orbiters that are well into their extended missions
- MRN Health Assessment conducted in July 2022; Only 1 asset (ESA's TGO) expected to be viable into mid-2030; MEP Draft Strategy plan includes focus on refreshing comm relay assets

Odyssey

- Results of propellant investigation now estimates remaining propellant at 4 kg +/- 2 kg, usage 1 kg/year
- Project began its **9th extended mission** in October 2022

MAVEN

- MAVEN operating in all-stellar attitude sensing mode to preserve lifetime of remaining IMU
- MAVEN experienced Safe Mode event due to IMU this past February
- MAVEN achieved its 18,000th orbit in Jan 2023
- Project began its **5th extended mission** in October 2022






MRO

- No safe mode events since Nov 2022
- MRO experiencing approximately 3 safe mode events per year since 2020; no root cause, but events associated with Galactic Cosmic Radiation maxima
- Project began its **6th extended mission** in October 2022






ExoMars/TGO

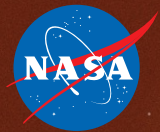
- Continuing to support relay operations for MEP; returning >50% relay data of landed assets

Summary of Mars Relay Network (MRN) Assets

Mission	Agency	Launch Year	Orbit	UHF Relay Payload	Max Return-Link Data Rate
ODY	 NASA	2001	385 km x 450 km 93 deg incl	CE-505 redundant units, quadrifilar helix antenna, 12 W transmit power	256 kb/s
MEX	 ESA	2003	298 km x 10,100 km 86 deg incl	Melacom single unit, patch antennas, 8.5 W transmit power	128 kb/s
MRO	 NASA	2005	255 km x 320 km 93 deg incl	Electra redundant units, quadrifilar helix antenna, 5 W transmit power	2048 kb/s adaptive data rate enabled
MAVEN	 NASA	2013	~200 km x 4500 km 75 deg incl	Electra single unit, quadrifilar helix antenna, 5 W transmit power	2048 kb/s adaptive data rate enabled
TGO	 ESA	2016	400 km x 400 km 74 deg incl	Electra redundant units, quadrifilar helix antenna, 5 W transmit power	2048 kb/s adaptive data rate enabled

Status of Aging Mars Relay Network Assets

Mission		Mission Status
ODY		Fuel usage is ~1 kg/yr, with ~4kg remaining. “All-stellar mode” in use to preserve IMU lifetime. No remaining redundancy in reaction wheel assembly; loss of another wheel would reduce remaining mission lifetime to ~1yr.
MEX		Fuel load extremely low and uncertain. “All-stellar” mode in use to preserve IMU lifetime. Available for emergency relay services for NASA’s landed assets.
MRO		Fuel usage ~10 kg/yr, with ~150 kg remaining. “All-stellar mode” in use to preserve IMU lifetime. X-band TWTA is effectively single-string due to waveguide transfer switch (WTS) anomaly.
MAVEN		Fuel usage ~5 kg/yr, with ~70 kg remaining. Fuel usage planned to allow science and relay operations through 2031. “All-stellar” mode in use to preserve limited lifetime on single remaining degrading IMU.
TGO		Fuel usage is ~8 kg/yr, with >200 kg remaining. All subsystems nominal with full redundancy available. Lifetime extension methods (eg. “all-stellar” mode) under study. Presently returning >50% of relay data from NASA’s landed assets.



National Aeronautics and
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EXPLORING MARS TOGETHER

DRAFT Plan for a Sustainable Future for Science at

Mars
2023 – 2043

Draft for Community Feedback

MEP Planning Team

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PROGRAM CONTEXT

Over the past two decades NASA and the Mars Exploration Program (MEP) have been making progressive steps to better understand the planet and to search for past and present life at Mars through a series of orbiters, landers, and rovers

- Mars Pathfinder *
- Mars Odyssey
- Mars Spirit & Opportunity Rovers
- Mars Reconnaissance Orbiter
- Mars Phoenix
- MSL Curiosity Rover
- MAVEN
- InSight *
- Mars 2020 Perseverance Rover

* Mars Missions managed under NASA's Discovery Program

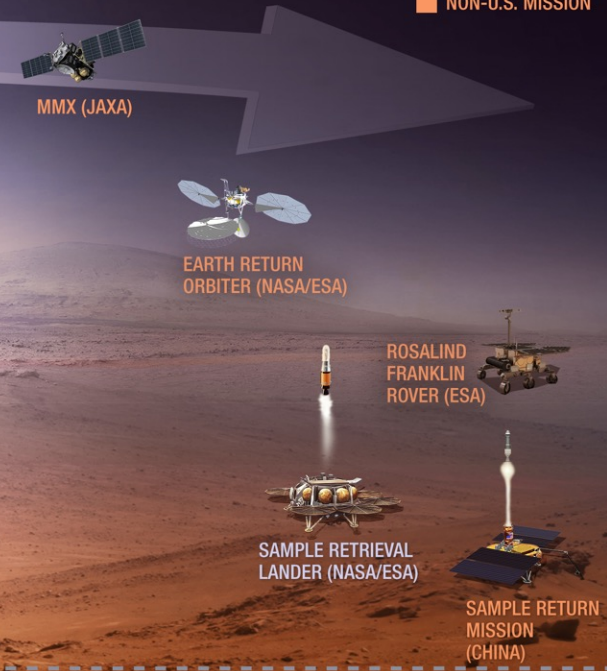
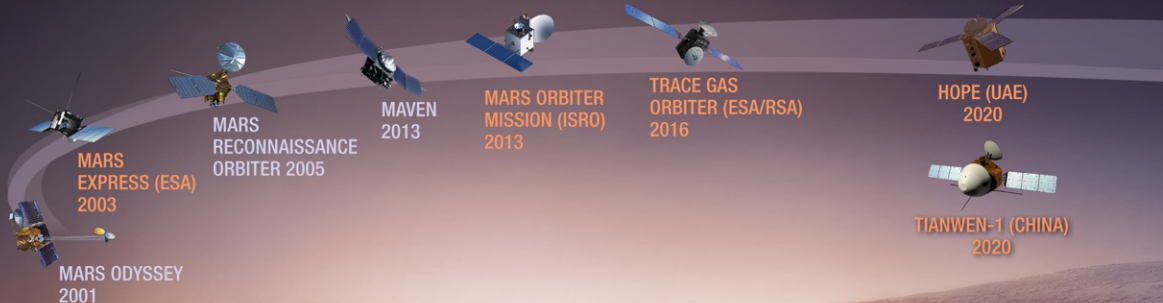
This critical chapter in Mars exploration would culminate in the return of samples to Earth through the planned Mars Sample Return campaign

The Mars Exploration Program is now at an inflection point at which it must adapt to the changing space business environment (i.e., broadening international participation and expanding commercial interest/capability), address critical/aging infrastructure, and prepare for a human presence at Mars

2001–2022

2024 AND BEYOND

■ U.S. MISSION
■ NON-U.S. MISSION



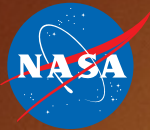
Follow the Water

Explore Habitability

Seek Signs of Life

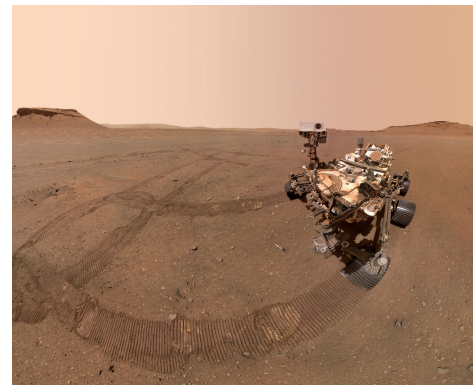
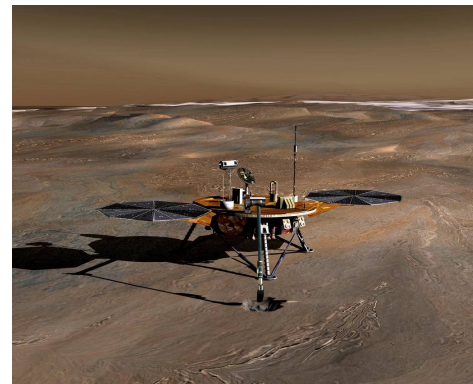
Prepare for Future Human Explorers

Draft for Community Feedback



Highlights of Accomplishments at Mars

- **Odyssey** revealed large subsurface water ice at the poles.
- **Phoenix** lander sampled water directly, as ice and snow, and identified surface chemistry that can permit liquid water brine at modern-day Mars temperatures.
- **Spirit and Opportunity** rovers demonstrated that Mars once had a warmer, watery past. Used air bags for rover landing.
- **Curiosity** has demonstrated that Mars was once a habitable environment, with liquid water, organic materials, and a chemical environment necessary to sustain life as we know it. Used sky crane for rover landing.
- **MRO** has detected active gullies, ice-revealing impacts, and other key geologic features and has significantly enabled subsequent rover landing-site characterizations (e.g., Gale Crater, an ancient crater lake, and Jezero Crater, site of an ancient delta)
- **MAVEN** has provided clues to the loss of water from the Martian atmosphere to space, important to understanding the history of climate and the planet's habitability through time
- **InSight*** has shown us that Mars continues to be a planet that is dynamic, including Marsquakes.
- **Perseverance** is collecting samples from a location that was once water rich for Mars Sample Return, greatly improving the analysis that will be possible to perform on the samples.



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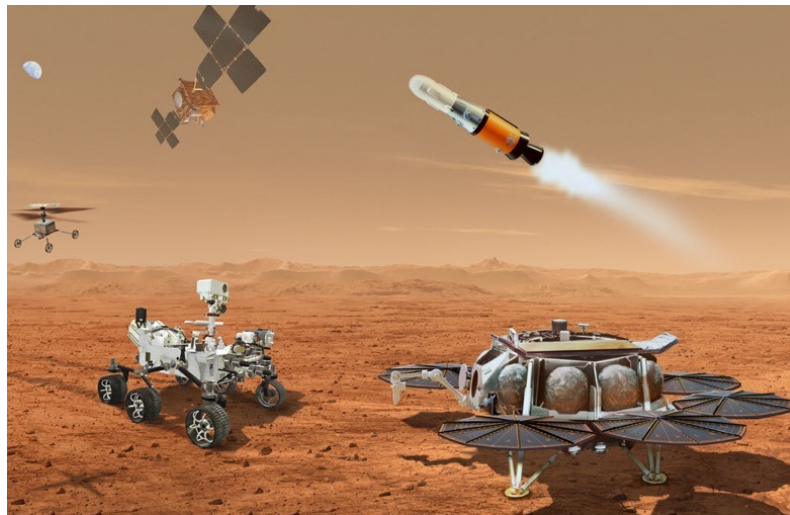
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Mars Sample Return within the Context of the Mars Exploration Program

- Mars Sample Return (MSR)* represents the culmination of the community's highest Mars Exploration priority over the last two decades, as cited in the past three Decadal Surveys.
- MEP has responsibilities on both ends of the MSR campaign:
 - Collecting samples with Mars rover *Perseverance*
 - Curating them at the future Sample Receiving facility.



Artist's Concepts

- While MSR would achieve decadal-class science enabled by the past two decades of MEP exploration, MEP is planning for the next two decades of equally profound scientific investigations with a new strategic paradigm designed to send lower-cost, high-science-value missions and payloads to Mars at a higher frequency.

*The decision to implement Mars Sample Return will not be finalized until NASA's completion of the National Environmental Policy Act (NEPA) process. This presentation is being made available for information purposes only.



“NASA should maintain the Mars Exploration Program, managed within the PSD, that is focused on the scientific exploration of Mars. The program should develop and execute a comprehensive architecture of missions, partnerships, and technology development to enable continued scientific discovery at Mars.”

– 2022 Planetary Science & Astrobiology Decadal Survey

“A Program strategy should be developed before the end of 2022 following the release of the Decadal Survey. The strategy should provide a clear plan of action that includes the overarching science goal for the decade, mission cadence, opportunities for a mix of small, medium, and large missions that increase opportunities for competition and broad community participation including the commercial sector, and that includes a strategy to replenish the communication infrastructure.”

– MEP Program Implementation Review, Standing Review Board Recommendation

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The following presentation provides a draft plan for the future of the Mars Exploration Program (MEP).

The MEP is seeking input to this plan from key stakeholders before finalizing it.

While this is a plan for an SMD program, it requires close coordination with many organizations, including ESDMD, SOMD, and STMD.

The Mars Sample Return program remains the top priority for SMD Mars exploration. MSR is a foundational science mission that would inform future Mars activities.

It is important to note that implementation of this plan is NOT included in the current MEP budget.

Any budget and schedule information presented herein should be considered notional.

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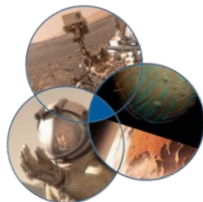
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EXPLORING MARS TOGETHER: MEP FUTURE PLAN, 2023 - 2043

KEY TAKEAWAYS

Mars continues to pose key questions that call for a coordinated program of scientific exploration – three community-responsive science themes for 2023-2043 will guide MEP activities:



- Explore the Potential for Martian Life
- Support Human Exploration of Mars
- Discover Dynamic Mars

Emerging capabilities enable a new era of competitive missions, strengthened infrastructure, transportation opportunities, advanced technologies, and inclusive exploration – MEP will:

- Expand opportunities through frequent, small, low-cost missions to produce impactful science
- Build, strengthen, and maintain critical infrastructure
- Reduce the cost of access to Mars through partnerships, low-cost launch vehicle providers, and new delivery systems
- Develop technologies to enable new capabilities for exploring Mars
- Make exploration more accessible and inclusive to the broader community

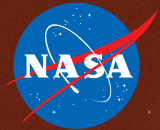
EXECUTIVE
SUMMARY

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1 INPUTS

2 SCIENCE THEMES

3 INITIATIVES

4 ASPIRATIONAL TIMELINE

EXPLORING MARS TOGETHER

2023 – 2043 MEP Future Plan Sections

Draft for Community Feedback



This Plan incorporates inputs from several sources across the planetary science community, Mars science community, and engineering and technology communities.

INPUT

AREAS OF FINDINGS

2023-2032 Decadal Survey

Mars Architecture Strategy Working Group (MASWG) & Mars Concurrent Exploration Science Analysis Group (MCE-SAG)

Keck Institute for Space Studies (KISS) Workshop: *Revolutionizing Access to the Martian Surface*

Low-Cost Science Mission Concepts for Mars Exploration Workshop

Industry Day

Industry Partnering Opportunities - Site Visits

International Mars Ice Mapper Measurement Definition Team (I-MIM MDT)

Human Exploration

Moon-to-Mars Objectives/Recurring Tenets

Mars Sample Return, Mars Life Explorer, International Mars Ice Mapper (I-MIM), Human Exploration, Research and Analysis, Technology, Infrastructure, State of the Profession

Interconnected network of low-cost missions working together to address major outstanding Mars questions, Dynamic Mars, imaging needs, mission classes, competed and low-cost missions

Recommended sustainable architecture to reduce landed Mars costs through efficient operation of multiple assets, leveraging lunar capabilities and partnerships

Viability of small missions, mission concepts, industry partnering

Partnerships to enable access to Mars, including spacecraft/low-cost mission delivery systems and payload hosting; telecom relay, imaging, and weather monitoring

Industry capabilities and partnering interest

Ice science and ice record, reconnaissance, and the need for high-res imaging

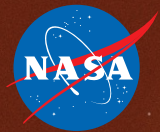
Decadal Survey, Science Objectives for Human Exploration of Mars Workshop, ties to lunar program

LPS-3: Volatiles; LPS-4: Life; SE-3: Core samples of frozen volatiles; SE-5 Remote sensing for human mission planning; RT-1: International Partners; RT-2/RT-9: Industry Partners/Commerce and Space Development: etc.

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SECTION 1
INPUTS

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EXPLORING MARS TOGETHER

2023 – 2043 MEP Future Plan Sections

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High-Level Co-Equal Program Science Themes, 2023 - 2043

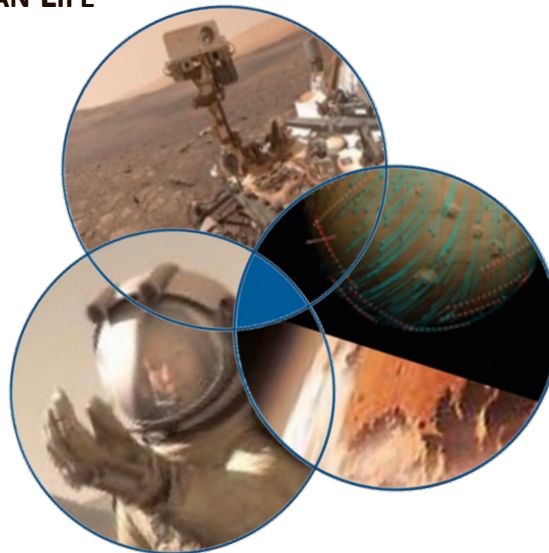
Driven by science, MEP will focus its systemic approach on the following science themes, which draw upon the MEPAG goals of life, climate, geology and preparation for human exploration.

EXPLORE THE POTENTIAL FOR MARTIAN LIFE

Advance the search for past and present microbial life and habitable environments through time, while developing approaches that protect both Mars and Earth.

SUPPORT HUMAN EXPLORATION OF MARS

Make observations that are synergistic with the objectives for human exploration of Mars and prepare for the science that humans will do once there.



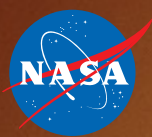
DISCOVER DYNAMIC MARS

Understand the dynamic geological and climatological processes on Mars to illuminate the evolution of the Martian system, our home planet Earth, our solar system, and distant planets around other stars.

SECTION 2
SCIENCE
THEMES

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SCIENCE THEME 1

Explore the Potential for Martian Life

Search for evidence of past or present life on Mars in potentially habitable environments and establish how the Martian environment and habitability co-evolved over time.

1.1 Search for Biosignatures, Past & Present

Determine whether the Martian geologic record has biosignatures and identify areas most likely to capture preserved biosignatures based on what is known about past and current habitability at Mars.

1.2 Understand Temporal and Geographic Patterns of Habitability

Leverage Mars' unique ancient geologic record to understand the extent of habitability and its temporal evolution, the existence of any present-day, subsurface habitable environments (including ice), and how habitable environments on Mars and Earth may have diverged.

1.2.1 Physical Access to the Subsurface

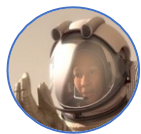
Advance investigations related to subsurface and ice science and access to the ice-rich subsurface as a major programmatic focus, building on water- and habitability-related scientific discoveries of the previous two decades.

1.3 Examine Samples from MSR to Understand Martian Geological & Biological Processes

Study returned samples to understand organic chemistry processes on Mars, what the samples reveal on global, regional and temporal scales, the nature of any biosignatures, and the relationship between Mars' geological and potential biological history.

Planetary protection principles are key across our presence at Mars and upon return to Earth with samples and astronauts, especially as it relates to our search for life.

A focus on potential "special regions" (natural or spacecraft-induced) and the environmental characterization of candidate landing/exploration sites is important to mitigate risks for future human explorers and/or to their astrobiological research.



SCIENCE THEME 2 Support Human Exploration of Mars

Make observations that are synergistic with objectives for the human exploration of Mars and prepare for the science that humans will do once there.

2.1 Define Priority Human-Led Science at Mars

Define, with multidisciplinary community input (science, human mission planning), the highest value scientific objectives humans could uniquely advance while traveling to and from Mars and on the surface.

2.2 Characterize Potential Ice-rich Sites for Human Exploration

Scientifically study the environment of candidate ice-rich sites to determine optimal locations for high-priority human-led science, resource potential, and operational feasibility/safety.

2.3 Study Atmospheric Science and Weather for Human Needs

Target investigations of the Martian atmosphere/exosphere sufficient to support prediction of extreme events (e.g., dust storms), human-class landing/launch operations, and a better understanding of how terrestrial microbes released during human operations could propagate in the Martian atmosphere.

2.4 Understand Potential Health and Safety Hazards for Humans (Supporting)

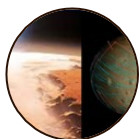
Coordinate with ESDMD to understand mechanical properties (e.g., abrasiveness for suit and hatch seal designs) and breathing hazards to humans (e.g., particle size and potential biological exposures). Supporting biological and physical science objectives in the Moon-to-Mars initiative, develop remote-sensing technologies and obtain data on the Martian environment relevant to human-mission planners in assessing ways to protect and strengthen human health and performance.

2.5 Construct Analogue Missions to Prepare for Expeditions on Mars (Collaborative)

Coordinate with ESDMD to simulate science-driven, robot-assisted expeditions to prepare astronauts and the wide Mars science community on Earth for future interplanetary collaboration in making discoveries “in the Martian field” and in transit. Draw on human lunar activities to feed forward into Mars operational strategies where relevant.

MEP will partner with ESDMD and STMD to collaborate on this theme

Draft for Community
Feedback



SCIENCE THEME 3

Discover Dynamic Mars

Reveal geological and climatological changes through Martian history to understand the evolution of Mars and its potential support of life; conduct interdisciplinary systems-science investigations of Mars and its moons in relation to other planets in our solar system and around other stars.

3.1 Investigate Ancient and Modern Drivers of Change on an Active Planet

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Characterize Geologic Planetary Evolution from Early Mars through the Present

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3.1.2

Understand Early Environmental Change through the Stratigraphic Record

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3.1.3

Determine Recent Climate Evolution through the Study of Volatile Cycles

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3.1.4

Study Dynamic Modern Environments and their Processes

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3.1.5

Characterize Modern Habitability

3.2 Understand Mars as a System through Investigations of the Global Environment

Conduct investigations through orbital, aerial, and landed spacecraft to illuminate the ways in which individual components of the Martian global environment – the atmosphere, hydrosphere, cryosphere, and geosphere – are integrated to make up the Martian system.

3.3 Study the Uniquely Available Geological Conditions on Mars to Conduct Comparative Planetology and Understand “Goldilocks Worlds”

Provide research opportunities that link the uniquely available geological conditions on Mars to fundamental understanding of comparative planetology.

These elements are directly responsive to the primary MEPAG goals of life, climate and geology

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2023 – 2043 MEP Future Plan Sections

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SECTION 3
INITIATIVE
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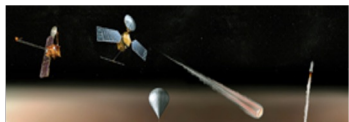
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Program Initiatives for the Future of MEP



INITIATIVE 1

EXPAND OPPORTUNITIES TO EXPLORE MARS THROUGH COMPETED, LOWER-COST, MORE FREQUENT FLIGHT OPPORTUNITIES



INITIATIVE 2

STRENGTHEN AND BROADEN INFRASTRUCTURE AT MARS TO ENABLE A DIVERSE SET OF MISSIONS & NEW OPPORTUNITIES FOR PARTNERSHIPS



INITIATIVE 3

INVEST IN KEY TECHNOLOGIES TO ENABLE EXPANDED ACCESS TO, AND SCIENTIFIC UNDERSTANDING OF, MARS



INITIATIVE 4

ENABLE PARTICIPATION IN MARS EXPLORATION FOR ALL COMMUNITIES



Expand Opportunities to Explore Mars through Competed, Lower Cost, and More Frequent Flight Opportunities

Establish a regular cadence of science-driven, lower-cost mission opportunities as a new element of the MEP portfolio to provide rapid and flexible response to discoveries, to address the breadth of outstanding Mars questions, and to enable increased participation by the diverse Mars science community.

SECTION 3
INITIATIVE
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LOW-COST MISSIONS

Targeted or
Discovery-Responsive Science

- Competed small missions at the \$100M, \$200M, or \$300M levels
- Intent: select missions for every Mars launch opportunity
- Considering one-step or two-step processes
- May select multiple smaller missions per launch opportunity
- Draws on experience from COTS/CLPS programs

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MEDIUM-CLASS MISSIONS

Broad Science

- Strategic Decadal-class science
- More complex instrument suites
- New technologies in sample acquisition, mobility, autonomy
- Considering competing either at the mission or instrument level
- Scalable to significant discoveries

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COMPETED PAYLOADS

Leveraging Commercial &
International Opportunities

- Missions of Opportunity
- Potentially competed or directed
- Could be science or infrastructure focused
- Flown on international or commercial missions

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INITIATIVE 2

Strengthen and Broaden Infrastructure at Mars to Enable a Diverse Set of Missions & Opportunities for Partnerships

Enable infrastructure advancements that no one mission could likely achieve alone and that lower the costs and risks of, and increase benefits for, all Mars missions.

SECTION 3
INITIATIVE 5 FOR THE
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EXPLORING
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SCIENCE AND MISSION ENABLING

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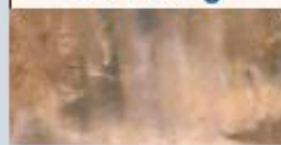
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High-resolution
Imaging



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Global
Meteorological
Monitoring



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Sample Handling
and Receiving



Actively consider opportunities to buy commercial services to address infrastructure

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2.

Ground
Receiving
Networks



I
2.

Data
Infrastructure,
Visualization,
& Analysis



I
2.7

ACCESS
TO MARS

Spacecraft Delivery
(including Rideshares)



I
2.

Payload Hosting
Opportunities



Requirements/implementation approaches coordinated with ESDMD, STMD, and SOMD, as appropriate.



INITIATIVE 3

Invest in Key Technologies to Enable Expanded Access to, and Scientific Understanding of, Mars

Provide continuing improvement in the capabilities of robotic science- and human-enabling missions that collectively enhance US leadership in Mars exploration, lower the costs of all Mars missions, and build upon the developments and experience of Earth and the Moon-to-Mars initiative.

SECTION 3
INITIATIVE 3
S FOR THE
NEXT TWO
DECADES

I
3.1

**Entry/Deorbit, Descent,
& Landing Systems and
Surface Access**

I
3.2

**Aerial Mobility,
In Situ Surface Mobility,
& Autonomy**

I
3.3

**Revolutionary Subsurface
Access up to
Hundreds of Meters**

I
3.4

**In Situ Sample Handling,
Pre-Processing, and Analysis
& Returned Sample Handling**

I
3.5

**In Situ Remote Sensing and
Search for Evidence of Life
Measurements**

I
3.6

**Direct to Orbit, Direct to
Earth, and Proximity Link
Telecommunications**

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Activities to be planned in coordination with STMD



INITIATIVE 4

Enable Participation in Mars Exploration for All Communities

Develop MEP initiatives that support NASA's goals to train, sustain, and retain a qualified and diverse workforce, to develop scientific and technical literacy, and to foster a more inspired and informed society.

SECTION 3
INITIATIVE 4
S FOR THE
NEXT TWO
DECADES

I
4.0

Establish Inclusive DEIA Leadership

Ensure Involvement of Under-Represented
Communities in Development of Data-
Driven Methods to Measure Progress

I
4.1

Ensure Inclusivity in MEP

Involve and Support Under-Represented
Communities in MEP Internships, Mission
Teams, & Leadership Training
Opportunities

I
4.2

Enhance the State of the Profession

Assess MEP Demographics,
Provide Career Opportunities, and
Build a Culture of Inclusivity

I
4.3

Create Opportunities for Public Participation in Mars Exploration

Enable Direct Participation in Exploration
through Immersive Technologies

I
4.4

Create New Models for Community Collaboration

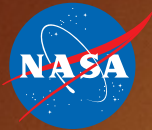
Build upon Emerging
Synergistic Capabilities with
New Public/Private Partnerships

I
4.5

Respect Role in the Stewardship of Mars for Humanity

Be Mindful of Responsibilities in
Exploring Mars "For All Humanity"

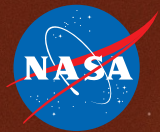
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Near-term Activities

As implementation of this plan is not funded, the program may begin precursor activities within existing program resources:

- Explore opportunities for commercial services to address infrastructure needs
- Award study contracts to industry to better define potential public-private partnerships
- Engage the international community on potential partnerships and hosting opportunities
- Commission a National Academies study to identify science objectives for human campaigns to Mars
- Invest in technologies to expand access to Mars and improve scientific understanding of the planet
- Develop a draft Announcement of Opportunity for the first Low-Cost Mission opportunity
- Initiate work to enable broader participation in the Mars community



National Aeronautics and
Space Administration

1 INPUTS

2 Science Themes

3 INITIATIVES

4 ASPIRATIONAL TIMELINE

EXPLORING MARS TOGETHER

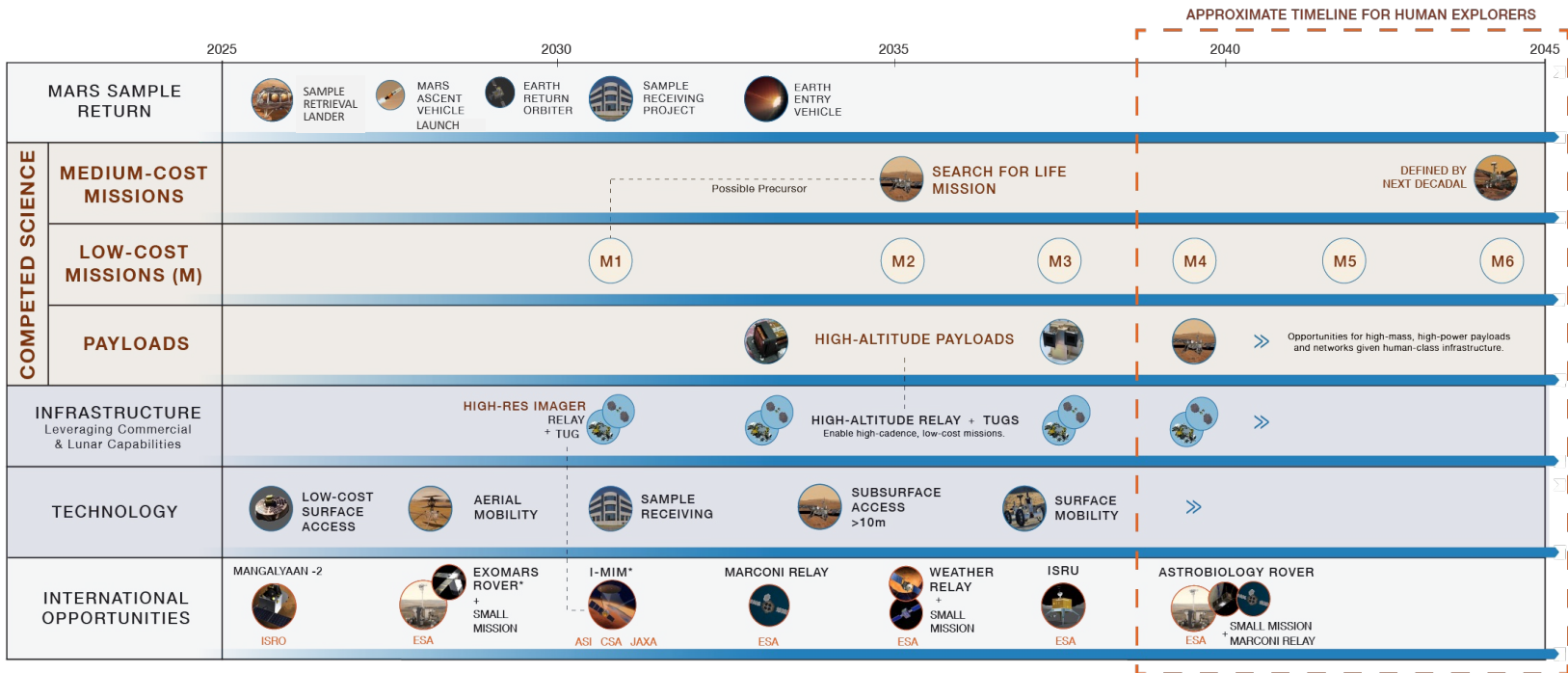
2023 – 2043 MEP Future Plan Sections

Draft for Community Feedback



Aspirational MEP Timeline

SECTION 4 Aspirational Program Timeline



* Launch Dates Fixed

This timeline should be considered hypothetical.

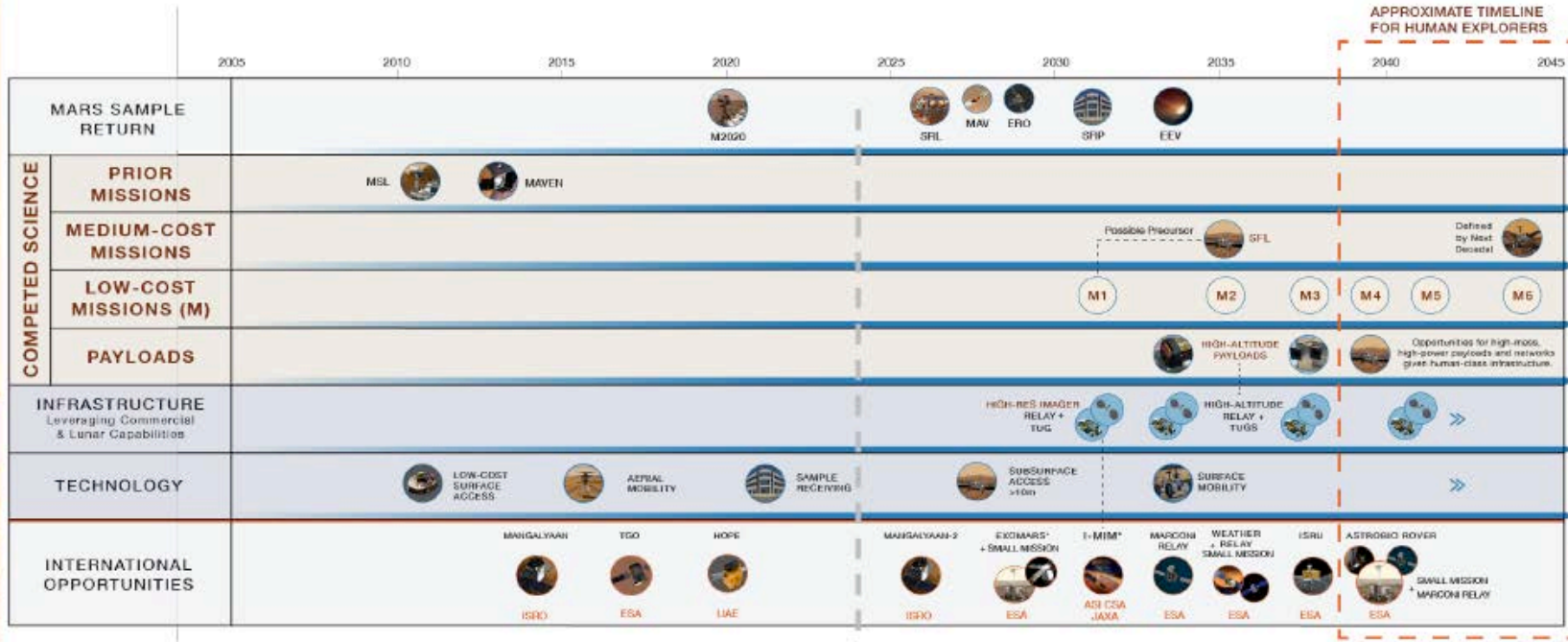
There is flexibility to adjust the phasing of activities if and when funding becomes available to adjust implementation and to respond to discovery.



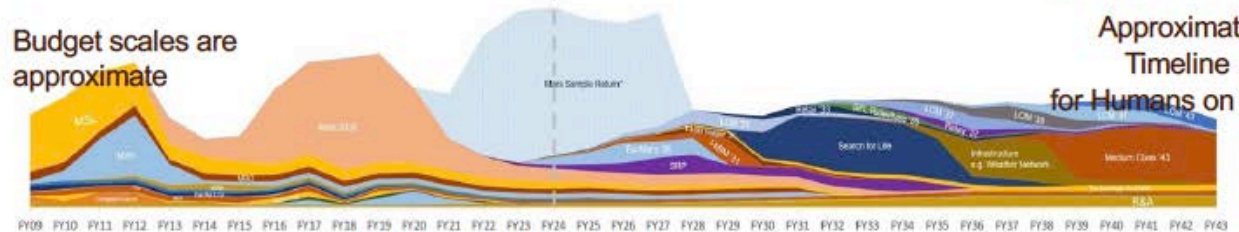
A Sustainable Budget Following MSR

SECTION 4
Aspirational
Program
Timeline

FY09 – FY43
DRAFT



Budget scales are approximate



Approximate
Timeline
for Humans on Mars

EXPLORING
MARS
TOGETHER



Summary of Plans

Priorities prior to the launch of MSR

- Achieve the objectives of the MEP Program of Record, including development of the Sample Receiving Project
- Collaborate with ESA on the ExoMars Rosalind Franklin Mission
- Seek low-cost opportunities to address critical infrastructure needs (particularly communications relay and high-resolution imaging)
- Continue investments in key mission-enabling technologies, especially those enabling the search for life and subsurface access
- Develop public/private partnership arrangements, reinforce existing international partnerships, and explore new opportunities with established and emerging space organizations

Priorities following the launch of MSR

- Implement a sustainable portfolio of low-cost competed missions, medium-class missions, infrastructure and technology investments, and missions of opportunity
 - Content and schedule are variables to be managed against a sustained budget level and maximizing science return
 - Focus on smaller, lower-cost missions, partnerships, and missions of opportunity allows the program to be more agile and responsive to discoveries
- Implement science that is supportive of, and synergistic with, humans at Mars



National Aeronautics and
Space Administration

We welcome your feedback!

Send comments/questions to: **HQ-MEP@mail.nasa.gov**

Eric E. Ianson
Director, Mars Exploration Program

EXPLORING MARS TOGETHER

DRAFT Plan for a Sustainable Future for Science at Mars

2023 – 2043

Draft for Community Feedback

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