

A STRATEGIC FRAMEWORK TO SUPPORT SCIENTIFIC COMMUNICATIONS FOR MARS SAMPLE RETURN SCIENCE: OVERVIEW AND STATUS.

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Introduction: The joint NASA/ESA Mars Sample Return (MSR) Campaign is a cornerstone of both agencies' long-term scientific exploration strategy that would revolutionize our understanding of the history of Mars, the Solar System, and the potential for life beyond Earth. In 2023, findings from an Independent Review Board (IRB-2) emphasized the need for clear and compelling communication of MSR's scientific and strategic value to Congress, the scientific community, and the public [1]. In response, NASA's Science Mission Directorate's MSR IRB-2 Response Team (MIRT) acknowledged the critical need for strengthening and enhancing strategic communications to ensure mission success and public support [2].

Addressing MSR Science Communications Challenges via a Strategic Framework: The Mars Sample Return Campaign Science Group (MCSG) [3] established the Strategic Communications Working Group (SCWG), tasked with creating a strategic framework comprising six plain language Work Products (WPs) to enhance MSR Science communication efforts [4]:

WP-1: Science Value Proposition: Articulates the high-level scientific benefits of MSR, emphasizing, among others, transformative discoveries that might bridge fundamental knowledge gaps in our understanding of the cosmos, the powerful legacy of sample curation for science advancements in future generations, and technical readiness for future human exploration to Mars and planetary science missions to more distant planetary bodies.

WP-2: Plain Language MSR Science Objectives: Simplifies the highly technical MSR-Sample Receiving Project (SRP) Science Objectives [5] to facilitate and reinforce understanding among non-specialist and

decision-making audiences of the relevance of the mission to NASA's and ESA's long-term scientific exploration strategy.

WP-3: Plain Language SRP Science Questions: Complements the Science Value Proposition (WP-1), breaking down high-level science questions that frame the SRP Science Objectives (WP-2), providing rationale for the key measurements that have been defined by the NASA and ESA appointed international Measurement Definition Team (MDT-1) [6], emphasizing the critical importance of the MSR Sample Analog Collection in supporting engineering and technology development for the SRP [7], and bringing to light how each sample collected by the *Perseverance* rover has been meticulously selected to address these high-level science questions.

WP-4: Critical Sample Science Findings: Highlights unique discoveries from previous sample return missions and sample science in general to underscore the unparalleled value of direct sample analysis. This effort also emphasizes the transformative potential of the Mars Sample Return (MSR) mission to provide a comprehensive understanding not only of Mars' geological and environmental history, but also foundational insights into the early history of the Solar System and the potential for life on Mars. By leveraging a carefully curated set of 30 samples, MSR offers a level of scientific depth and rigor that will advance planetary science for decades to come, which is unattainable through less targeted "grab-and-go" mission designs.

WP-5: Recommendations for NASA and ESA Leadership: Proposes strategies to unify communication and public engagement efforts across the agencies to amplify the reach of MSR Science communications.

WP-6: Visualizations of MSR SRP Science: Creates compelling visual materials that connect the Science Value Proposition (WP-1) with the SRP Science Objectives (WP-2), emphasizing the critical science questions (WP-3) that the MSR Sample Collection has been meticulously curated to address (Figure 1).

These WPs aim to align accessible and impactful messaging across stakeholder groups, bridge gaps in understanding, and foster an appreciation of MSR's scientific impact.



Figure 1. "Bring Them Home": Inspired by the poster for the 2015 film *The Martian* [8], this visualization places the stakeholder in the role of the hero, and frames the Mars Sample Return Campaign in a cinematic and relatable narrative. The dramatic tagline serves as the "Call to Adventure" [9], evoking urgency and a profound sense of responsibility for the hero to embrace their pivotal role in bringing samples back to Earth and unlocking their promise of groundbreaking discovery.

Responding to Updates in MSR Architecture: Though it is outside the SCWG's statement of task to communicate specifics of MSR mission architecture [4], it is nonetheless important to communicate how MSR Science is affected by changes to mission architecture. To this effect, on January 7th, 2025, NASA Administrator Bill Nelson and Associate Administrator Dr. Nicky Fox announced two possible options for a revised MSR mission architecture that would enable a simplified, faster, and less expensive return of 30 MSR samples to Earth, all while minimizing risk. These options include:

- 1) Leveraging the high-heritage Sky Crane entry-descent-landing (EDL) system previously utilized for the *Curiosity* and *Perseverance* rovers (estimated costs \$6.6 - \$7.7 billion).

- 2) Engaging commercial capabilities such as heavy lift vehicles landers (estimated costs \$5.8 - \$7.1 billion).

Both options would include a redesigned landing platform to carry the Mars Ascent Vehicle (MAV) to the surface of Mars, replacing solar panels with a radioisotope power system. This change has important implications for MSR

Science: The enhanced power and heat capabilities of the radioisotope system ensure continuous operation of critical instrumentation during the extended Martian dust storm season, reducing mission downtime and preserving the integrity of sample retrieval operations. By lowering risks associated with dust accumulation and power interruptions, the radioisotope system also enables greater reliability in planetary protection protocols during the sample transfer process, ensuring pristine sample containment for Earth return.

Opportunities and Next Steps: Mission architecture updates often capture significant media and public attention, making it more critical than ever to capitalize on these opportunities to emphasize that, by design, the science is neither sacrificed nor diminished. Instead, these updates are aimed at safeguarding the scientific integrity while creating new opportunities for discovery.

MCSG, in partnership with NASA, ESA, and the broader science community, are uniquely positioned to leverage these moments to communicate the enduring value of MSR Science. By framing pivotal moments such as architecture changes as catalysts for scientific advancement, we can align our science priorities with those of influential non-expert stakeholders. In the coming months, MCSG will be seeking community feedback on the MSR Science Strategic Communications Framework. We look forward to your contributions.

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