Two-Mission Campaign for Mars Sample Acquisition and Return. B. Kennedy, G. Udomkesmalee, P. Backes, A. Trebi-Ollennu, R. Kornfeld, and J. Guinn. Jet Propulsion Laboratory, California Institute of Technology, contact email: bkennedy@jpl.nasa.gov

Challenge: While sample return remains a priority of the science community, the fiscal realities force a re-think of the previously contemplated campaign. The resulting campaign must reduce overall cost while increasing relevancy across NASA's interests.

Proposed Solution: Due to recent technology developments, sampling and caching has been shown to be viable on a MER-class rover [1]. This progress in turn makes a two-mission campaign viable providing NASA with a unique Mars Sample Return (MSR) near-term (2018-2020) mission architecture, which in turn makes a significant step decrease in the cost of the Planetary Decadal survey report [2] proposed three mission MSR campaign. We propose a two-mission campaign that consists of an orbiter launched in 2018 followed by a surface mission launched in 2020. The orbiter would both act as a science asset in its own right as well as playing host to the sample capture and Earth Return Vehicle. As an additional role, it would become a communications relay asset to augment or replace current orbiters. As a bonus, the proposed mission architecture is compatible with foreign collaboration, as required by Planetary Decadal survey report [2] for MSR.

Benefits to NASA and Beyond: The proposed campaign profile has beneficial elements for SMD, HEOMD, OCT, and the United States at large.

SMD: The proposed campaign makes sample return as prioritized by the National Research Council Planetary Decadal Survey a fiscal possibility in the near-term (2018-2020).

HEOMD: As explained in detail below, the descent stage can be modified to provide a secondary soft-landing technology demonstration and the landed descent stage can be used for HEOMD monitoring station. This arrangement will fill Strategic Knowledge Gaps in the Human Exploration of Mars as well as the Mars Exploration Program Analysis Group (MEPAG) Goals, particularly those related to Atmospheric Aspects, Radiation measurements, and Trafficability.

OCT: Inherent in the campaign structure is the demonstration of capture and docking technology that will pave the way for other solar system missions.

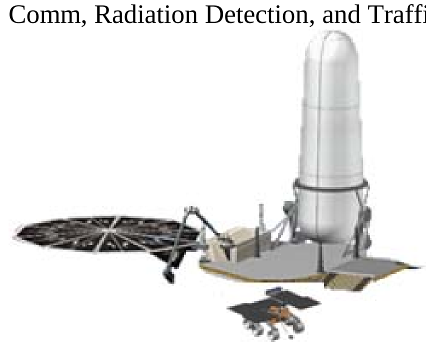
U.S. world relations: As described below, the campaign restores the possibility of NASA collaboration with ESA and other agencies on a significant effort.

Technical and Programmtic Approach:

2018 Orbiter: In 2018, a medium-sized orbiter would be launched to Mars. This orbiter would carry a science payload roughly equivalent to MRO, but on a larger bus consistent with previous MSR architectures [3-5]. Technical and cost risk for such a system should be low due to the high heritage.

The remainder of the bus would be occupied by a Sample Return Module provided by an international partner. This module would itself be comprised of a Capture System, an Earth Return Vehicle, and an Earth Entry Vehicle. When needed, the Sample Return module would pilot itself away from the orbiter in order to rendezvous with the Sample. Because the orbiter would already be in place prior to the injection of the Sample into orbit, the Sample Return Module may have to have orbital change capability greater than the current baseline mission. However, this need could be offset by the observability of the launch of the ascent rocket and the viability of a beacon in the Sample. The technical and cost risk for this element would be supported by the international partner, much as was conceived for the previous campaign [3]. It should also be noted that the campaign structure is also compatible with a completely separate return mission provided by international partners.

2020 Lander: Launched in an MSL-class aeroshell, the lander will rely on an MSL-heritage Descent Stage to reach the surface [3], which would deposit the lander on the surface MSL-style. In order to reach science targets in a timely fashion (see below), precision landing of approximately 5km x 5km will be required. However, unlike the MSL, the Descent Stage would carry fuel margin sufficient to pilot it away from the lander to a soft landing, thus demonstrating soft landing of a significant system, a requisite for human missions to Mars. This ability will require improved control and processing power, which may be anticipated in the normal course of time. Once on the ground, the Descent Stage can begin to operate as ground station as a demo of human mission needs such as Laser Comm, Radiation Detection, and Trafficability.



The lander itself would consist of a MER-class rover and an ascent rocket.

2020 Rover and Sample Acquisition System: A Fast-Driving solar rover would carry a coring drill and a caching system [1]. These would be used over the course of approximately 6 months to collect and store samples. In order to collect samples from a scientifically significant number and range of targets, the rover will need a higher level of autonomy in moving from location to location. The roving and sample acquisition systems uses the heritage and experience from over a decade of surface operations on Mars, from Mars Pathfinder, MER rovers to the Mars Phoenix Lander.

Sample Surface Transfer: Once sufficient sample is collected, the rover wouldl return to the lander and transfer the Sample to the ascent rocket. To minimize system development, the rover arm would be used to make the transfer.

Ascent Rocket: The small ascent rocket would be erected, then launched, preferably when observable by the orbiter. In order to minimize the orbital change required by the Sample Return Module, the ascent rocket launch tower will be pointable, and its exact vector and the timing of the launch will be calculated to optimize the fuel use by the Sample Return Module. The ascent rocket would launch the Sample into a circular orbit of 500 km+/- 100 km and less than 1 degree of inclination.

Orbital Sample Transfer: The ejection of the Sample from the ascent rocket and the capture by the Sample Return Module would be along the lines of the current campaign [3].

Summary: With technological advances well within reach, a two-misson campaign is possible. The elimination of the third mission and reduction of the assumed durations of the remaining mission will result in significant cost savings, thus making a sample return program viable as a prime objective. In addition, other goals of NASA and the United States can be realized.

References:

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