SSE01: Mars Sample Return Project

Crowd Sourcing a Mars Sample Return Mission

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PROJECT SCOPE

NEED

NASA needs a program that will get the public excited about space exploration and willing to support a larger budget while also demonstrating that they are not only still relevant in today's low cost commercial and DIY space industry, but show that they are still the leaders.

GOAL

Build excitement and support for space exploration and the study of Mars by allowing the public direct involvement with the design of the most advanced robotic mission ever attempted.

OBJECTIVES

Have the public completely design a major element of a Mars sample return mission, from initial concept all the way through detailed design.

Return multiple Mars soil and rock samples from several regions of the planet

MISSION

Deliver multiple robotic explorers, designed by the public, to various locations on Mars to collect soil and Rock samples to be returned to earth. Each lander will independently launch its own return vehicle, based off of a 3U CubeSat, which will navigate to earth orbit to be collected by a larger spacecraft. Once collected, the samples will be returned to earth and analyzed in an isolated laboratory.

CONSTRAINTS

Ready for launch by 2024

Chosen concept(s) for "sample collection robot(s)" must come from the general public

BUDGET

$1.5B

SCHEDULE

Kick off - April 2014

Launch - June 2024

Sample Returned - Jan 2026

(More details in Life Cycle below)

AUTHORITY & RESPONSIBILITY

NASA JPL – Manage overall project and own top level requirements for all subsystems, coordinate bringing all components together. Also responsible for design of mars landing system (ie mini sky crane) - ***Expertise – Large scale robotic space exploration***

Quirky.com – Host design concept contests similar to how they currently create new inventions. Concepts for "sample collection robot(s)" will be submitted by the public and voted on by other participants. As the concepts are refined various additional contests could be used to solve specific design issues, like how to package the collected sample. ***Expertise – Crowdsourcing invention***

LocalMotors.com – Manage the crowdsourcing of the design of the "sample collection robot(s)", similarly to how they currently crowd source the design of vehicles like the Rally Fighter ***Expertise – Crowdsourcing vehicle design***

Nanosatisfi – Design of 3U CubeSat return vehicle capable of being grappled by a larger spacecraft and transfer it's sample container**.** ***Expertise – CubeSat design***

University of Michigan – CubeSat propulsion system to return sample to earth orbit. ***Expertise – CAT Engine – CubeSat water propelled plasma thruster***

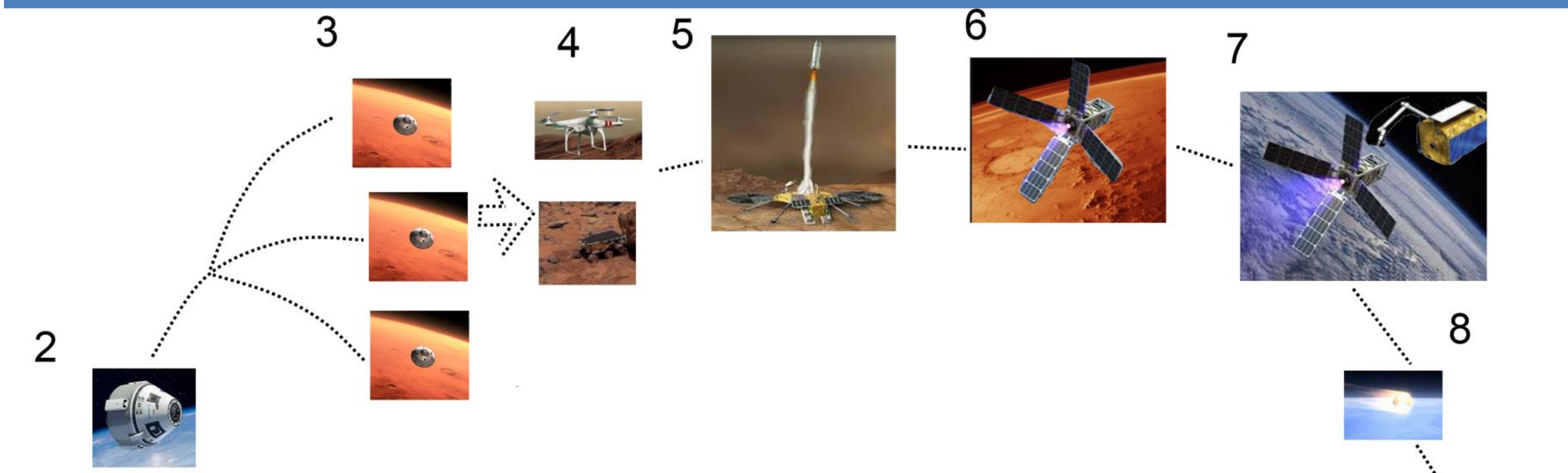
SpaceX – Design of Mars assent rocket. ***Expertise – Low cost, high reliability rocket design***

Other NASA Centers, ESA, JAXA – Various components of the system will be sourced to other space agencies or other NASA centers.

ASSUMPTIONS

With enough participants and a little oversight, the general public is capable of conceptualizing and designing a state of the art space vehicle as good as an experienced NASA team.

CONCEPT OF OPERATIONS



1. Launch the lander, “sample collection robot”, and return vehicle, on a multistage rocket

2. From low earth orbit, payload is sent on a trajectory that will go to mars

3. Split off into multiple landers that will soft land on mars using a mini sky crane

4. One “sample collection robot” will be in each lander – Design TBD by public

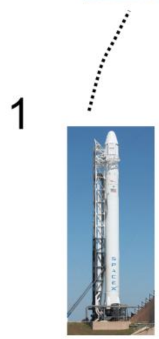
5. Samples will be loaded into 3U CubeSat return vehicle (one at each lander) and launched into Mars orbit

6. CubeSat CAT thruster will navigate back to earth

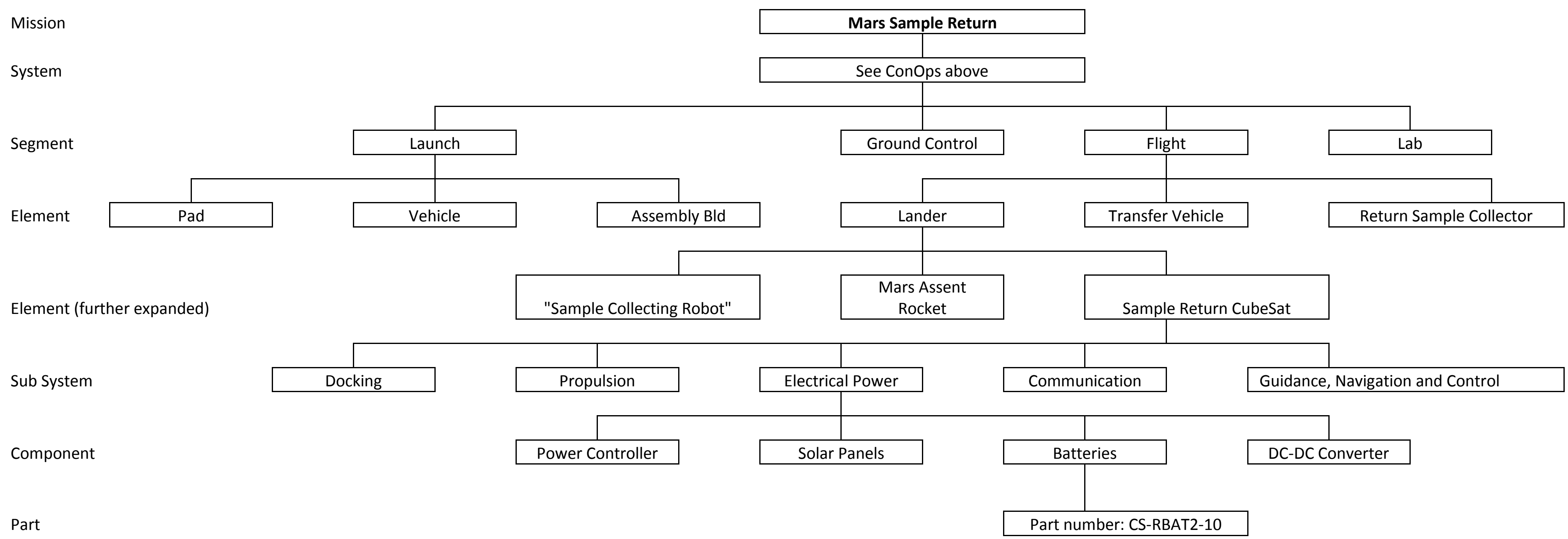
7. CubeSat collected in earth orbit and sealed in welded reentry vehicle to prevent contamination

8. Reentry and ocean recovery

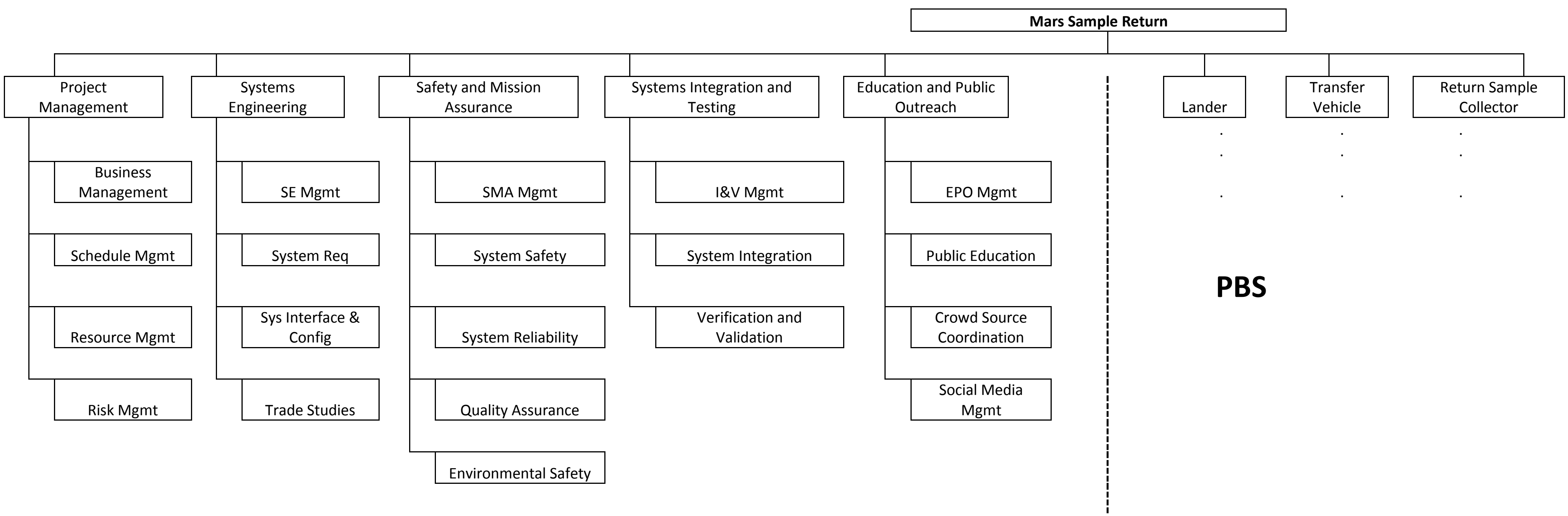
9. Analyze sample in an isolated contained facility



PRODUCT BREAKDOWN STRUCTURE



WORK BREAKDOWN STRUCTURE



LIFECYCLE SCHEDULE

	Start	End
Pre-Phase A - Concept Studies	**4/2014**	**10/2014**
Concept Studies	4/2014	10/2014
Mission Concept Review	10/2014	10/2014
Key Decision Point A	10/2014	10/2014
Phase A - Concept & Technology Development	**10/2014**	**9/2015**
Top Level System requirement Development	10/2014	6/2015
System Requirements Review	6/2015	6/2015
Requirement Flow Down	6/2015	9/2015
Interface definition	6/2015	9/2015
Trade Studies	6/2015	9/2015
Mission Design Review	9/2015	9/2015
Key Decision Point B	9/2015	9/2015
Phase B - Preliminary Design & Technology Completion	**9/2015**	**1/2017**
generate detailed requirements	9/2015	1/2017
Complete plan for component V&V	9/2015	1/2017
Sub System PDRs	11/2016	11/2016
Preliminary Design Review	1/2017	1/2017
Key Decision Point C	1/2017	1/2017
Phase C - Final Design & Fabrication	**1/2017**	**6/2020**
Build / Purchase all components	1/2017	1/2020
Component Test Readiness Review	1/2017	1/2020
V&V Testing on components	1/2017	1/2020
Complete V&V System plans	1/2020	6/2020
Preliminary Launch and Operations Plans	1/2020	6/2020
Critical Design Review /PRR	1/2019	1/2019
System Integration Review	6/2020	6/2020
Key Decision Point D	6/2020	6/2020

	Start	End
Phase D - System Assembly & Test, Launch	**6/2020**	**6/2024**
System Integration	6/2020	6/2023
System Test Readiness Review	6/2020	5/2024
System V&V Testing	6/2020	5/2024
Complete Launch and Operations Plans	5/2024	5/2024
Operational Readiness Review	5/2024	5/2024
Flight Readiness Review	6/2024	6/2024
Key Decision Point E	6/2024	6/2024
Launch	6/2024	6/2024
Phase E - Operations & Sustainment	**6/2024**	**2/2026**
Post Launch Assessment Review	6/2024	6/2024
Flight to Mars	6/2024	3/2025
Mars Landing	3/2025	5/2025
Sample Launch	5/2025	5/2025
Flight to Earth	5/2025	1/2026
Sample Capture	1/2026	1/2026
Sample Analysis	1/2026	*
Key Decision Point F	2/2026	2/2026
Phase F - Closeout (Flight hardware and ground systems)	**2/2026**	**9/2026**
Decommissioning Review	2/2026	2/2026
Archive Data	3/2026	9/2026
Catalog Samples	3/2026	9/2026

***Sample Analysis will continue for decades beyond the end of the mission**

EVALUATION MERIT

The “Sample Collecting Robot” element of the system will be conceptualized and designed by the public through the use of partners like Quirky.com and Localmotors.com. For evaluating the final configuration that will go from concept to design, the top 10 concepts as voted on by participants will be evaluated by NASA using figures of Merit. At least one design will be selected, designed, built and sent to Mars. Multiple designs could be selected if combined cost still fits in the budget. Below is the table that will be used to evaluate the “Sample Collecting Robots”. ***Two “dummy” examples are given to show how merit would apply***:

	2 Mechanical Arms on Static Lander	**Fully Autonomous bi-pedal robot with drills and shovel**
Power Requirements	low	Very High
Total Weight	low	High
Cost	low	High
Robustness of Technology	High	Low
redundancies vs failure points	High	Low
Sample Selection	Limited to within reach	Any
Number of units per launch	high	Low