Cerberus: A Mars Geophysical Network Mission for New Frontiers. W. B. Banerdt[1] and the Cerberus Science Team. [1]Jet Propulsion Laboratory, California Institute of Technology (M.S. 264-420, 4800 Oak Grove Drive, Pasadena, CA 91109, bruce.banerdt@jpl.nasa.gov).

Introduction: For the past 30 years there has been a strong consensus within the international scientific community in favor of sending a network of geophysical landers to Mars to explore the interior structure and composition and to characterize the near-surface weather and climate and determine the large-scale atmospheric dynamics [e.g., 1-18]. Despite this scientific support, there have been a host of proposed missions over the past fifteen years which have failed for programmatic reasons to progress beyond the design stage (Mars Network Mission, MESUR, Marsnet [8], InterMarsnet [9], Mars NetLander [19]).

Recently the NRC NOSSE (New Opportunities for Solar System Exploration) committee recommended inclusion of a geophysical network mission in the mission set to be considered for the third New Frontiers mission [20], and NASA has followed this recommendation and opened the New Frontiers 3 AO to such missions. In response to this opportunity, we are developing a three-lander mission to Mars carrying geophysical instrumentation that fits within the New Frontiers guidelines. This mission concept is named Cerberus, after the mythical three-headed creature that guarded the Greek underworld.

Science Rationale: Although many types of investigations that might benefit from measurements at multiple locations on the surface of Mars, a network mission is essential to enable investigations that require simultaneous, spatially separated measurements. These capabilities are crucial for addressing first-order questions about the origin, evolution and current state of Mars. In addition, there are first-order atmospheric science questions that can be addressed with such a network as well. Cerberus is designed to directly address these questions through delineation of the interior structure and investigation of ongoing tectonic and impact activity, and by monitoring meteorological parameters at multiple locations on the surface. Our scientific objectives, described below, are taken directly from the Decadal Survey and NOSSE reports.

Interior structure objectives

- Determine the internal structure including horizontal and vertical variations in the properties of the crust and mantle, and evaluate implications for how the core, mantle and crust evolved.
- Determine the characteristics of the metallic core (e.g., size, density, and presence and distribution of liquid) and explain the strength or absence of a present day magnetic field.
- Determine interior composition and compositional variations to elucidate differentiation, crust-mantle evolution (plate tectonics, basin formation by impacts, conditions for life), and how the bulk composition relates to that of the Earth and other terrestrial planets and how planetary compositions are related to nebular condensation and accretion processes.

Cerberus will probe the interior of Mars through seismic monitoring, electromagnetic sounding and measurements of its rotational dynamics. This will allow the determination of the overall interior structure, including crust, mantle, and core divisions, and the state of the core (liquid/solid, density). It will also provide information to infer the density and elastic constants of the mantle which in turn lead to strong constraints on its mineralogy, composition and temperature profile. These are key aspects of understanding the formation and evolution of the planet in terms of its accretion, differentiation and subsequent convection history, as well as the planet's internal engine driving volcanism, tectonics and the delivery of endogenic volatiles to the surface.

Atmospheric dynamics objectives.

- Measure the surface winds and their time variability and the near surface global circulation.
- Measure the temperature, pressure, humidity, and radiative flux.
- Understand the relationship between the near-surface general circulation and the physical processes that force it.
- Determine how the near-surface general circulation controls the exchange of dust, water, CO_2 etc., between the atmosphere and surface.
- Begin to establish a weather monitoring infrastructure to support future robotic and manned missions.
- Provide an enhanced assessment of year-to-year atmospheric mass exchange between the atmosphere and polar caps and regolith.

The second primary task of Cerberus is to study the near-surface weather and climate, and the global and regional dynamics of the atmosphere. Simultaneous measurements of pressure, temperature, humidity, opacity and winds across the globe would allow the detailed investigation of the relationship between the circulation and its forcing, and Cerberus will comprise the first three nodes of such a meteorological network. These measurements are essential for characterizing the temporal and spatial structure of the atmospheric general circulation and the present-day climate, as well as the transport and deposition of dust and volatiles. Because the spatial coverage required for accurately characterizing atmospheric circulation will not be possible within the scope of this mission, we will emphasize measurements that bear on the physical processes that govern atmospheric behavior.

Payload: Although the final payload complement is still under study, the core payload will consist of a very-broad-band seismometer [21, 22] and an X-band transponder for precision tracking. In addition, our provision payload includes a low-frequency electromagnetic sounder, a meteorological package including a high-rate boundary layer experiment, and a camera system. The presentation will discuss these instruments and their capabilities in detail.

Mission: Three spacecraft, based on the Phoenix Mars lander system, will be launched on a single EELV in a window extending over approximately three weeks spanning late 2015 to early 2016. The three spacecraft will cruise independently to Mars and descend directly to the surface, separated by a time cushion to prevent overlapping critical events. The three stations will be in the equatorial zone, separated by 3000-4000 km in order to provide the necessary geometry for seismic epicenter location. The mission will last for an entire Mars year and will return continuous data from all three station.

International geophysical network: With a launch opportunity in early 2016, there is an excellent opportunity to extend our network with the Humboldt payload on ExoMars [23], also scheduled for the same opportunity. Humboldt also includes geophysical instrumentation, including a seismometer, precision tracking system, and heat flow probe, along with atmospheric and environmental monitoring instruments.

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