Small Mars Missions based on Common Spacecraft Systems: 2. Mars Weather/Comm Infrastructure. M. Malin[1], T. Yee[1] and the Malin Space Science Systems Mars Stationary Orbiter Science and Engineering, and T. Svitek[2] [1]Malin Space Science Systems, P.O. Box 91048, San Diego, CA 92191-0148, malin@mssss.com
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Introduction: Using the technologies we described in our MSO abstract #1, we would propose a combined meteorological and telecommunications relay satellite constellation of generally similar S/C design, but capable of addressing broader science objectives with both global coverage from areostationary platforms and global coverage from low altitude, circular, sun-synchronous orbit, and depending on the requirements, a larger and more diverse science payload. The intent would be to deploy systems similar to the terrestrial GOES and NOAA systems.

The GOES equivalent system (Aerostationary Environmental and Relay Orbiter System. AEROS) would consist of at least 4 S/C, separated by a minimum of 90° of longitude. Using the initial pathfinding MSO as an extra system, and establishing the longitudes based on either the most active weather or the need for telecom support for landers, or a combination of both, these satellites would provide about 100 observations during a martian day of their visible hemispheres at scales commensurate with numerical models of the martian atmosphere.

The NOAA equivalent system (Mars Meteorological Satellite System, MMSS) would consist of no fewer than 3 polar orbiting, sun synchronous S/C with daytime equatorial nodes of 09:30 LTST, 12:30 LTST, and 15:30 LTST, or other times based on the science and programmatic requirements.

Important Trades:

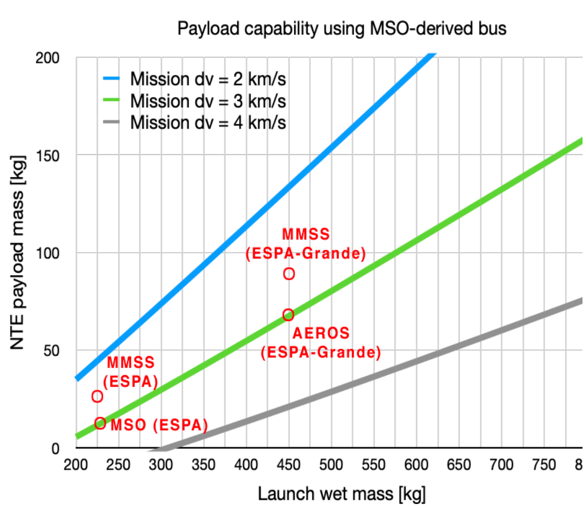

Figure 1 illustrates major trade space for rideshare spacecraft missions to Mars. The trades are payload mass, launch wet mass and the delta velocity required to get to Mars and into the required orbit from Geosynchronous Transfer Orbit as a rideshare.

An areostationary orbit requires the most ΔV (~|3 km/s). A 400 km circular polar synsynchronous orbit requires about 2.5 km/s. MSO has a limited payload (10 kg) for 6 IR cameras and 1 visible camera at low resolutions, so we would propose scaling the operational AEROS and MMSS spacecraft to mid-range ESPA=Grande launch mass, with six-fold increases in payload capacity. In particular, the MMSS is likely to require substantially higher spatial sampling, and for the IR, that will require more cameras owing to the small scale and large pixels of microbolometer detectors. Additional payload might include a wind measurement instrument, although those used for Earth are still too large.

Mission Objectives*:* The primary objective is to establish a weather and communications satellite network at Mars, at the lowest unit cost. The network could be established relatively quickly on a dedicated launch of no less than 7 spacecraft, or over time using rideshare opportunities.

The primary science objective is to transition knowledge of the martian atmosphere to a level comparable to our satellite view of the Earth's atmosphere. The primary programmatic objective is to provide surface assets communication, positioning, navigation, and timing support.

Costs: MSO development costs are $18M, this includes about $6M of NRE. Assuming that both the AEROS and MMSS spacecraft are ESPA-Grande scale and will require additional NRE and potentially additional redundant S/C systems, S/C hardware costs for sub-systems and labor, and inflation, the cost per S/C is likely to be about $20M. Thus the minimum global network would cost about $140M. Operations of this network would require substantially more personnel than will be used on MSO. DSN costs for tracking and data delivery will be comparable to the other operations costs. Each S/C is likely to require around $1M/yr to operate, so annual costs of the full network operations would be ~$15M. Assuming a 5 Mars Year operational life, operations would be about $140M over 9.5 Earth years. Thus the total mission cost would be about $280M, on the order of a small Discovery mission.