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Author: Mr. Julian Wahlmueller
Team Tumbleweed, Austria

Mr. Julian Rothenbuchner
Team Tumbleweed, The Netherlands

BEYOND TRADITIONAL ROVERS: A SWARM DEPLOYMENT MODEL FOR ENHANCED MARS EXPLORATION AND DATA COLLECTION

Abstract

Traditional Mars rovers (and satellites) collect data from wherever they roam, for as long as they have power. They rarely visit the same place twice. As a result, there are no Martian geospatial stationary, time-series data of physical quantities at scale available. It is essential for scientists to have both historical time series of one or more physical quantities from many geospatial locations, and a reliable flow of near real-time data.

R-selected wind-driven rover swarms have the capability to deploy a constellation of measurement stations at a sufficient scale and at orders of magnitude lower cost per data point (i.e. cost/kbyte) and higher mission success rate (i.e. lower risk of mission failure) than previous or planned Mars data acquisition missions.

We show, that the resulting architecture consists of a spherical (i.e., tumbleweed) rover swarm deploying a network of gram-scale measurement stations on Mars that simultaneously collect multiple physical observables with sufficient coverage. Based on a computational graph, we identify the key drivers to derive the objective functions for the multi-objective optimisation model. The simulation is performed using the Mars Climate Database data. We calculate the optimal range of number of rovers and stations that provide sufficient product utility in direct relation to potential revenue, capital expenditure and operational costs. We benchmark these with traditional rover designs and missions.

The research shows that the selected rovers and their deployed measurement network follow Wright's law, providing a low-risk, very low-cost approach to collecting data at scale from remote locations.