Optimizing Satellite Operations: Near-Earth to Interplanetary Missions

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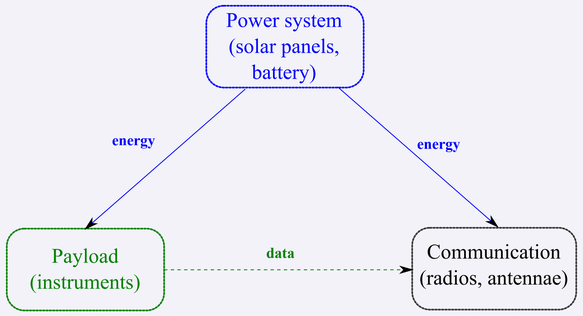
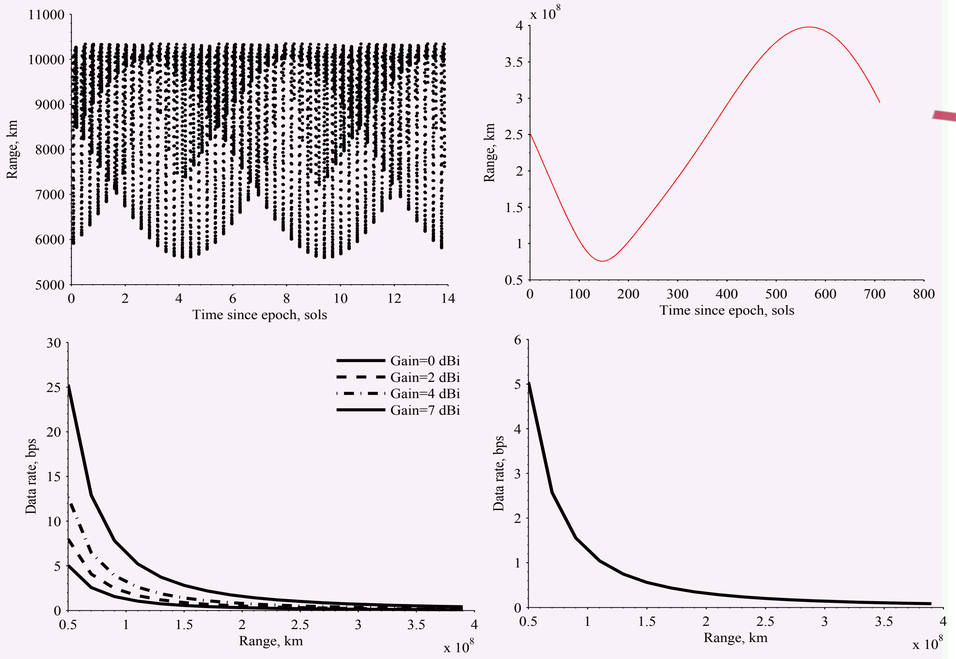
This work focuses on the modeling, analysis, and optimization of near-Earth and interplanetary space networks. The objective is to maximize the data transferred between communication nodes subject to realistic constraints, such as opportunities, subsystem and state interactions, and dyanmic communication links. Ongoing work takes into account the stochasticity of space operations and communication systems.

Modeling



Analytic models capture:
1) orbit, link, and vehicle dynamics
2) payload and download decisions
3) mission constraints and objectives

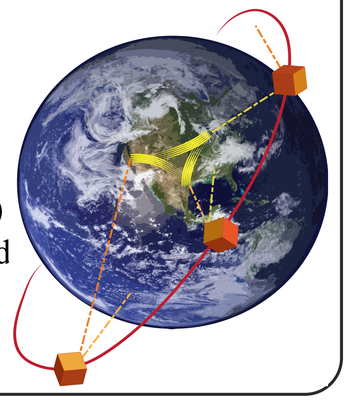
Analysis



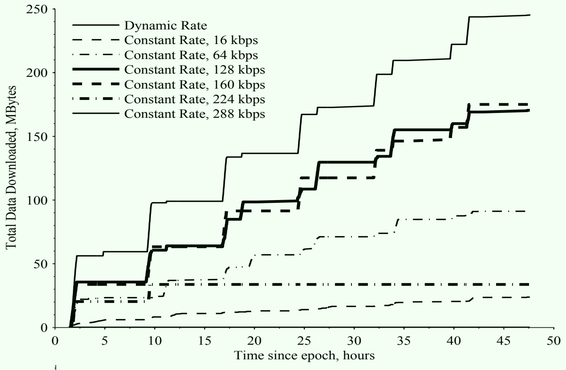
Toolkits enable the analysis of opportunities for energy collection, experiments, and downloads. The plots above show the dynamic distances (top) and data rates (bottom) for the Phobos mission.

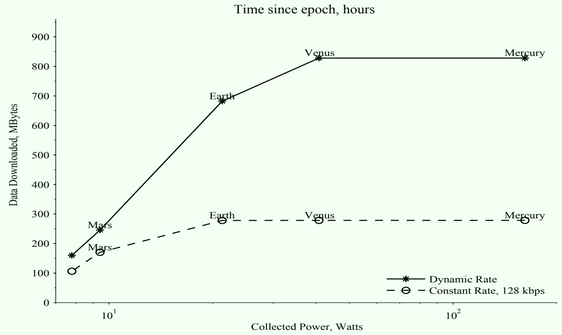
LEO Missions

Past work optimized Low Earth Orbit (LEO) missions and Earth-based networks.



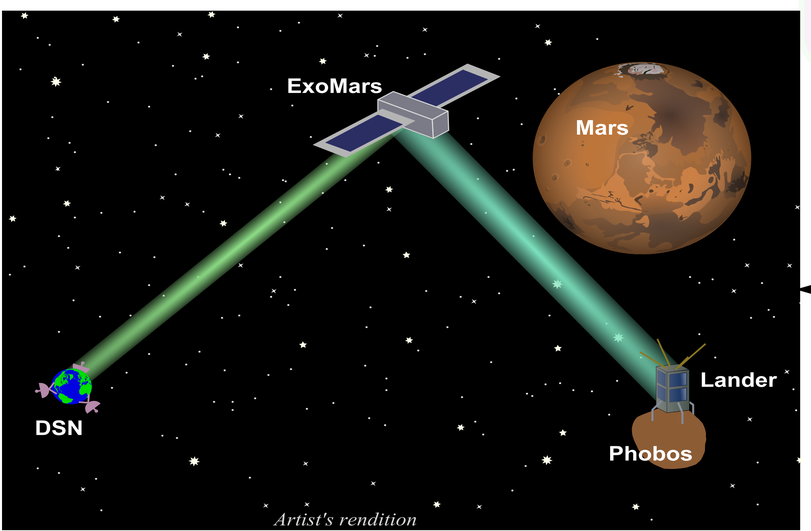
Optimization





Diverse optimization techniques are used to develop schedules, perform sensitivity analysis, and explore the design space. The plots above show optimal solutions (top) and sensitivities (bottom) for the Phobos mission.

Example Interplanetary Application: Phobos Lander Science Mission



We've applied our models, analysis, and optimization work to an example interplanetary mission: a small Phobos lander. The schematic (left) shows the mission architecture. Two diverse communication architectures were compared, see the analysis (above) and optimization results (right).