This subtopic seeks innovative technologies for both RF and Free-Space Optical Communications supporting missions to Mars, including both planetary and proximity ranges, and for other planetary missions and local planetary networks.

**RF Communications**

- Ultra-small, low-cost, low-power, innovative deep-space transponders and components, incorporating MMICs and Bi-CMOS circuits.
- MMIC modulators with drivers to provide large linear phase modulation (above 2.5 rad), high-data rate BPSK/QPSK modulation at X-band (8.4 GHz) and Ka-band.
- Sub-microradian antenna pointing techniques for Ka-band spacecraft antennas.
- High rate (10–200 Mbps) turbo-encoder and decoder and wavelet compression chips.
- Technologies for surface-to-surface communications in planetary environments.
- Fault-tolerant digital signal processing: Current space qualified DSP elements do not support high bandwidths because of the power consumption associated with radiation hardened manufacturing processes. Reconfigurable signal processing elements are sought that provide autonomous fault detection and correction with a graceful degradation in performance over the service life.
- Antenna systems: Novel materials and approaches are sought to construct large, inflatable reflective and RF focusing surfaces for use as large aperture antennas. Need to provide highly directional surface to orbit antenna patterns to maintain high rate data links.

**Optical Communications**

- Efficient (greater than 20% wall plug), lightweight, flight-qualifiable, variable repetition-rate (1–60 MHz),
pulsed lasers with greater than 1 kW of peak power per pulse (over the entire pulse-repetition rate), and potential for up to 10 W of average power.

- Photon counting 1064 nm and 1550 nm detectors with the gain greater than 1000, detection efficiency greater than 50%, very low additive noise, about 0.5 mm in diameter, bandwidth greater than 500 MHz, saturation levels > 50 Mcounts/s.

- Lightweight, compact, high precision (less than 0.1 micro-radian), high bandwidth (0–2 kHz), inertial reference sensors (angle sensors, gyros) for use onboard spacecraft.

- Novel schemes for stray-light control and sunlight mitigation, especially for large (> 5 m) ground-based optical antennae that must operate when pointed to within a few (about 3) degrees of the Sun.

- Low-cost, lightweight, efficient, compact, high precision (one micro-radian accuracy) star-trackers for spaceflight application.

Research should be conducted to demonstrate technical feasibility during Phase I and show a path toward a Phase II hardware and software demonstration, and that will, when possible, deliver a demonstration unit or software package for JPL testing before completion of the Phase II contract.