Phased Array Antennas

High performance phased array antennas are needed for high-data rate communication at Ka-Band frequencies and above as well as for remote sensing applications. Communications applications include: planetary exploration, landers, probes, rovers, EVA, suborbital vehicles, sounding rockets, balloons, unmanned aerial vehicles (UAV's), TDRSS communication, and expendable launch vehicles (ELV's). Also of interest are multi-band phased array antennas (e.g., X- and Ka-band) and RF/optical shared aperture dual use antennas, which can dynamically reconfigure active elements in order to operate in either band as required in order to maximize flexibility, efficiency and minimize the mass of hardware delivered to space. Phased array antennas for space-based range applications to accommodate dynamic maneuvers are also of interest. The arrays are required to be aerodynamic or conformal in shape for sounding rockets, UAV's, and expendable platforms and must be able to withstand the launch environment. Potential remote sensing applications include: radiometers, passive radar interferometer platforms, and synthetic aperture radar (SAR) platforms for planetary science.

Ground-based Uplink Antenna Array Designs

NASA is considering arrays of ground-based antennas to increase capacity and system flexibility, to reduce reliance on large antennas and high operating costs, and eliminate single point of failure of large antennas. A large number of smaller antennas arrayed together results in a scalable, evolvable system, which enables a flexible schedule and support for more simultaneous missions. A significant challenge is the implementation of an array for transmitting (uplinking), which may or may not use the same antennas that are used for receiving. Arraying concepts that can enable a single network (i.e., DSN, NEN, and SN) at Ka-band frequencies and above are highly desired.

Large Aperture Deployable Antennas

Large aperture deployable antennas with surface root-mean-square (rms) quality better than $\lambda/40$ at Ka-Band frequencies and above, are desired. In addition, these antennas should significantly reduce stowage volume (packaging efficiencies as high as 50:1), provide high deployment reliability, and significantly reduced mass density (i.e., $\lambda$kg/m$^2$). These large Gossamer-like antennas are required to provide high-capacity communication links with low fabrication costs from deep space (Mars and beyond). Applicability to Ka-Band or higher frequencies is required. Concepts addressing antenna adaptive beam correction with pointing control are also of interest.

Novel Materials for Next Generation Antennas

NASA is interested in exploiting novel materials approaches for next generation antennas. For example, “smart” materials such as shape memory polymers or ionic polymer metal composites to permit active shape control or
beam correction are of interest. Artificial electromagnetic media for phase velocity control and impedance tuning to improve the efficiency and bandwidth of electrically small antennas is of interest. Ferroelectric based technologies as well as multiferroics and spintronics concepts leading to new antenna designs are desirable.

**Smart, Reconfigurable Antennas**

Smart, reconfigurable antennas for applications in planetary operations are of interest. The characteristics to consider include the frequency, polarization, and the radiation pattern. Low-cost approaches are encouraged to reduce the number of antenna apertures needed to meet the requirements associated with rovers, pressurized surface vehicles, habitats, etc. for planetary surface exploration. Desirable features include multi-beam operation to support connectivity to different communication nodes on planetary surfaces, or in support of communication links for satellite relays around planetary orbits. Innovative receiver front-ends or technologies that allow for the DSP to move closer to the antenna terminal furthering the impact of the aforementioned, revolutionary “game-changing” antenna technology concepts are highly desirable.

**Antenna Concepts for Harsh Environments**

Novel, “Game Changing”, robust antenna concepts that can perform optimally and reliably in harsh environments such as those imposed by the Lunar regolith/dust and Martian dust are highly desirable.

For all above technologies, research should be conducted to demonstrate technical feasibility during Phase I and show a path towards Phase II hardware/software demonstration with delivery of a demonstration unit or software package for NASA testing at the completion of the Phase II contract.

Phase I Deliverables: A final report containing optimal design for the technology concept including feasibility of concept, and a detailed path towards Phase II hardware demonstration. The report shall also provide options for commercialization opportunities after Phase II.

Phase II Deliverables: A working proof-of-concept demonstrated and delivered to NASA for testing and verification. Exit TRL 5 is expected at the end of Phase II.