



## **NASA STTR 2005 Phase I Solicitation**

### **T3 Glenn Research Center**

The NASA Glenn Research Center at Lewis Field, in partnership with other NASA Centers, U.S. industries, universities, and other Government institutions, develops critical technologies that address national priorities for space and aeronautics applications. NASA Glenn's world-class research and technology development is focused on space power, space flight, electric and nuclear space propulsion, space and aeronautic communications, advanced materials research, biological and physical microgravity science, and aerospace propulsion systems for safe and environmentally friendly skies. One-third of NASA Glenn's program responsibilities are in space and microgravity, one-third in space exploration systems, and one-third in aeronautics. We support NASA's commitment to safely return the shuttle to flight through ballistic impact testing, rudder speed brake actuator analysis, on-orbit repair of the wing, leading edge research, aging analysis, and wind tunnel tests of the external tank. NASA Glenn has two sites in northern Ohio. Situated on 350 acres of land adjacent to the Cleveland Hopkins International Airport, the Cleveland site in northeast Ohio comprises more than 140 buildings including 24 major research facilities and over 500 specialized research and test facilities. Plum Brook Station is 50 miles west of Cleveland and has four major world-class facilities for space research available for Government and industry programs. The staff consists of over 3200 civil service and support service contractor employees. Scientists and engineers comprise more than half of our workforce with technical specialists, skilled workers, and administrative staff supporting them. Over 60 percent of our scientists and engineers have advanced degrees, and 25 percent have earned Ph.D. degrees.

## **Subtopics**

### **T3.01 Aerospace Communications**

**Lead Center:** GRC

The research sought under Aerospace Communications focuses on the development of innovative communications, architectures, networks, and subsystems that significantly increase the capacity and connectivity among satellites, spacecraft, aircraft and ground networks thereby enabling new applications and services. These technologies are aimed at improving the power, bandwidth, and cost efficiency of communications at millimeter-wave frequencies and higher, and the interoperability, reliability, security, and quality of services of aerospace networks. The goal is to address the requirements of: NASA's Vision for Space Exploration, National Airspace System capacity, safety, and transportation initiatives; NASA's mission-unique applications; and NASA's utilization

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of emerging commercial communications services.

Innovations solicited include:

- Development of monolithic microwave integrated circuit (MMIC)-based arrays and array feeds, large-aperture inflatable antennas, miniaturized antennas, and trade-off studies among different antenna technologies for space applications. Potential lower cost, space-fed, active array and reflectarray approaches are also of interest as well as other MMIC and non-MMIC-based approaches (e.g., MEMS-, ferroelectric-, and optical-based approaches);
- Radio Frequency (RF) and optical propagation phenomena through atmosphere and turbulent media, development and validation of communication systems for aviation safety and aviation capacity, and other related electromagnetic phenomena;
- Digital communications, navigation, and surveillance technologies required for aeronautical communications, navigation, and surveillance (CNS) and space communications systems. Specific technologies include: software-defined radios; low-power, reconfigurable transceivers; multi-function, multi-mode digital avionics; network interface controllers, hubs, and routers for space; bandwidth- and power-efficient digital modems; advanced signal processing techniques; and integrated microelectronic or optoelectronic devices;
- Research and development of advanced microwave materials, devices, and circuits as well as the technologies required for integrating individual circuit components into microwave subsystems. Research in high-power transmitters focused on improving efficiency, RF power output, reliability, operating life, and communications qualities (such as linearity of a traveling wave tube amplifier for use in space communications). RF power combining techniques at Ka-Band frequencies are also of interest;
- Research on semiconductor circuits for transmit and receive modules in operational frequency bands designated for NASA's Exploration Systems vision. Specific technologies under development include: wide bandgap semiconductors, such as gallium nitride and silicon carbide; III-V semiconductors; silicon germanium; radio frequency micro-electromechanical systems (RF MEMS) devices/circuits; radio frequency integrated circuits including transmission lines and passive components; and microwave circuit packaging techniques;
- Cryocooled ultra-sensitive receivers for use in terrestrial antenna arrays for reception of signals from deep space and for inter-satellite links;
- Emerging technologies such as, multi-Gb/s photonic and nano-electronics based devices and circuits; and
- Research and development of advanced aerospace communications network architectures, protocols, standards, technologies, and network-based applications. Specific areas of interest include transmission control protocols, modifications, and enhancements to mitigate variable delays and high latency, next generation transport protocols, mobile-Internet protocols/routing, ad-hoc networking, and quality-of-service protocols, design, and implementation of advanced hybrid architectures to support NASA applications.

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## **T3.02 Space Power and Propulsion**

**Lead Center: GRC**

Development of innovative technologies and systems are sought that will result in robust, lightweight, ultra-high efficiency, lower cost, power and in-space propulsion systems that are long-lived in the relevant mission environment and that enable future missions. The technology developments being sought would, through highly-efficient generation and utilization of power and in-space propulsion, significantly increase the system performance, thereby enabling future NASA missions.

Innovations are sought that will significantly improve the efficiency, mass specific power, operating temperature range, radiation hardness, stowed volume, flexibility/reconfigurability, and autonomy of space power systems. In power generation, advances are needed in photovoltaic cell structure including the incorporation of nano-materials; module integration including monolithic interconnections and high-voltage operation; and array technologies including ultra-lightweight deployment techniques for flexible, thin-film modules, and concentrator techniques as well as dynamic power generation systems for nuclear power conversion. In energy storage systems, advances are needed in batteries-primary and rechargeable-regenerative fuel cells, and flywheels. Advances are also needed in power management and distribution systems, power system control, and integrated health management.

Innovations are sought that will improve the capability of spacecraft propulsion systems. In solar electric propulsion technology, advances are needed for ion, Hall, and advanced plasma thrusters including cathodes, neutralizers, electrode-less plasma production, low-erosion materials, high-temperature permanent magnets, and power processing. Innovations are needed for xenon, krypton, and metal propellant storage and distribution systems. In small chemical propulsion technology, advances are sought for non-catalytic ignition methods for advanced monopropellants and high-temperature, reactive combustion chamber materials. Also, advances are sought for chemical, electrostatic, or electromagnetic miniature and precision propulsion systems and nano- and autonomous systems that include nano-materials, high temperature shape memory alloys, and piezoelectric materials as well as control systems for autonomous, adaptive engine control and sealing.