The Science Mission Directorate (SMD) needs spacecraft with more demanding propulsive performance and flexibility for more ambitious missions requiring high duty cycles, more challenging environmental conditions, and extended operation. Planetary spacecraft need the ability to rendezvous with, orbit, and conduct in situ exploration of planets, moons, and other small bodies in the solar system. Future spacecraft and constellations of spacecraft will have high-precision propulsion requirements, usually in volume- and power-limited envelopes.

This subtopic seeks innovations to meet SMD propulsion requirements, which are reflected in the goals of NASA's In-Space Propulsion Technology program to reduce the travel time, mass, and cost of SMD spacecraft. Advancements in chemical and electric propulsion systems related to sample return missions to Mars, small bodies (like asteroids, comets, and Near-Earth Objects), outer planet moons, and Venus are desired. Additional electric propulsion technology innovations are also sought to enable low cost systems for Discovery class missions, and eventually to enable radioisotope electric propulsion (REP) type missions.

The focus of this solicitation is for next generation propulsion systems and components, including high-pressure chemical rocket technologies and low cost/low mass electric propulsion technologies. Specific sample return propulsion technologies of interest include higher-pressure chemical propulsion system components, lightweight propulsion components, and Earth-return vehicle propulsion systems. Propulsion technologies related specifically to planetary ascent vehicles will be sought under S3.08 Planetary Ascent Vehicle.

**Chemical Propulsion Systems**

Technology needs include:

- Improved materials and manufacturing processes to produce Iridium/Rhenium apogee class thruster chambers with improved mechanical properties targeting a yield stress of 40ksi and an elongation of 10%;
- Advanced nontoxic mono-propellant rockets for in-space applications.

**Electric Propulsion Systems**

This subtopic also seeks proposals that explore uses of technologies that will provide superior performance in for high specific impulse/low mass electric propulsion systems at low cost. These technologies include:

- Efficient thrusters with up to 1 kW of input power that provide thrust up to 20 mN with a specific impulse between 1600 to 3500 seconds;
- A throttleable dual mode thruster that is capable of operating in both high thrust and high specific impulse
modes for a fixed power;

- High power electric propulsion thrusters (>20 kW) and components including cathodes, ion optics, and low sputtering materials with long life (>1x10^8 N-s).

Proposals should show an understanding of the state of the art, how there technology is superior, and of one or more relevant science needs. The proposals should provide a feasible plan to fully develop a technology and infuse it into a NASA program.

Note to Proposer: Topic X2 under the Exploration Mission Directorate also addresses advanced propulsion. Proposals more aligned with exploration mission requirements should be proposed in X2.