The goal of this subtopic is to develop innovative chemical propulsion systems and system concepts as well as modeling tools and capabilities that support chemical propulsion system design and analysis. Applications of interest include earth-to-orbit and in-space transportation, with a particular focus on versatile, multi-use in-space cryogenic engines with exceptionally high reliability, space-based reusability (i.e. capability for many restarts with little to no maintenance), and deep-throttling capability. These are needed for all phases of exploration missions, including trans-lunar injection, decent to the lunar surface, ascent to lunar orbit, and return to Earth. Also of interest are safe and affordable earth-to-orbit systems that enable high overall vehicle payload mass-to-liftoff mass ratios, with improvements in thrust-to-engine weight ratio, trajectory-averaged specific impulse, and overall reliability.

Specific areas of interest for technology advancement and innovations include:

- Propulsion system design concepts that address LOX/LH$_2$, as well as LOX/CH$_4$ and other LOX/Hydrocarbon engine and main propulsion systems integration issues;

- Integrated chemical propulsion system concepts that integrate primary propulsion and reaction control system elements;

- Design and analysis tools that significantly enhance the overall systems engineering evaluation of advanced chemical propulsion system concepts. These include tools for sensitivity analysis, quantification of system benefits to changes, propulsion system operability, "bottoms up" weight estimating, cost estimating, and reliability prediction for propulsion systems;

- Manufacturing techniques that allow for significant reduction in the cost and schedule required to fabricate engine and main propulsion system components. These techniques can use current or emerging processes and manufacturing technologies to develop engine and main propulsion system components that will reduce complexity, increase reliability, and that are easier to assemble, install, and test when integrated onto the vehicle;

- Concepts for solid or hybrid rockets that increase mass fraction, decrease the need for thermal insulation, and reduce or eliminate the need for staging; and

- High-performance advanced propellants (as indicated by high specific impulse and high specific impulse density) and non-toxic propellants that can significantly improve safety and cost of propulsion systems operations.
Note: Related technologies of interest but covered under other SBIR subtopics include:

- X7.02 Chemical Propulsion Components
- X8.01 Vehicle Health Management Systems