Future Spacecraft and instruments for NASA’s Science Mission Directorate will require increasingly sophisticated thermal control technology. Innovative proposals for thermal control technologies are sought in the following areas:

1. Optical systems, lasers, and detectors require tight temperature control, often to better than +/- 1°C. Some new missions require thermal gradients held to micro-degree levels. Methods of precise temperature measurement and control to this level are needed.

2. Heat flux levels from lasers and other high power devices are increasing, with some projected to go as high as 100 W/cm². They will require thermal technologies such as spray and jet impingement cooling. Also, high conductivity, vacuum-compatible interface materials will be needed to minimize losses across make/break interfaces.

3. Future missions will use large structures, like mirrors and detector arrays, at both ambient and cryogenic temperatures. Some anticipated technology needs include: advanced thermoelectric coolers capable of providing cooling at ambient and cryogenic temperatures, high conductivity materials to minimize temperature gradients and provide high efficiency light-weight radiators, and advanced thermal control coatings such as variable emittance surfaces and coatings with a high emissivity at ambient and cryogenic temperatures.

4. The push for miniaturization also drives the need for new thermal technologies approaching the MEMS level. Miniaturized heat transport devices, especially those suitable for cooling small sensors, devices and electronics are of interest.

5. Future robotic missions and reconfigurable spacecraft present engineering challenges requiring systems which are more self-sufficient.

Some of the technology needs are:

- Single and two-phase mechanically pumped fluid loop systems which accommodate multiple heat sources and sinks, and long life, lightweight pumps for these systems;
• Efficient, lightweight vapor compression systems for cooling up to 2 KW;

• Advanced thermal modeling techniques that can be easily integrated into existing codes, emphasizing inclusion of two-phase system and mechanically pumped system models;

• Integration of standardized formats into existing codes for the representation and exchange of Thermal Network Models and Thermal Geometric Models and results.