Enabling Lunar Surface Payloads via an evolving Science/Engineering Partnership P.E. Clark[1], D.C. Bugby[1], and D. C. Hofmann[1], [1]Jet Propulsion Laboratory/California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, pamela.e.clark@jpl.nasa.gov

Purpose: Credible opportunities for delivery of small payloads to the lunar surface via commercial landers are emerging. Characterization of the highly interactive lunar environment requires continuous operation. Due to the extreme lunar surface conditions (high radiation, two-week <100 K night, two-week up to 400 K day), radioisotope power systems (RPS) have been required for either full day and night operation (Apollo Lunar Surface Experiment Packages using RTGs) or day operation and night survival only (all others including Lunakhod and Yutu, and several proposed commercial designs that would use RHUs).

Background: The most challenging problem is creating low-cost, thermally isolating, generic, reconfigurable, and easy to integrate packaging for compact (CubeSat-scale) packages without relatively costly RPS to, at minimum, survive, and preferably operate on limited duty cycle, during lunar night. A Lunar Geophysical Network (LGN) study indicated a 400:1 thermal switching ratio would be required for battery mass viability. Preliminary environmental modeling indicated that the availability of a reverse thermal switch (to maintain a thermal control box) with 1000:1 switching ratio, 10 times better than state of the art MER ratio of 100:1, would be required to allow a CubeSat-scale package (<20 kg, <2W during lunar night) to survive lunar night. Recently, Bugby and coworkers [1] have demonstrated the capability of a reverse thermal switch with a 2500:1 switching ratio.

Thermal Concept: Two prototypes of the crucial thermal switch components were designed, built, and tested. Their basis of operation is the mating/de-mating of parallel (near mirror finish) flat metal surfaces. The physical mechanism causing the motion is the DTE of mid-CTE, high thermal conductivity (k) metallic end-pieces compared to a low-CTE, low k two-piece metal/polymer support beam. The requirements of operation were to be fully ON above 300 K with 1335 N force and fully OFF below 260 K. Testing to raise the TRL of the switches to 6 has been completed. In addition to the thermal switches, Ball high performance MLI [2] and kevlar pulley packaging system, both of which have successfully flown in space, would provide even greater performance enhancement in thermal packaging.

Applications: Two instruments with very different requirements, including SILVIR, an imaging camera requiring a cryocooler and window, and a dual magnetometer (VHM and FGM) with external sensors on booms, provided the basis for requirements and thermal modeling of the generic package concept to confirm that all instrument components would remain within acceptable temperature limits. In principle, compact instruments ranging from spectrometers to field/particle instruments could be accommodated.