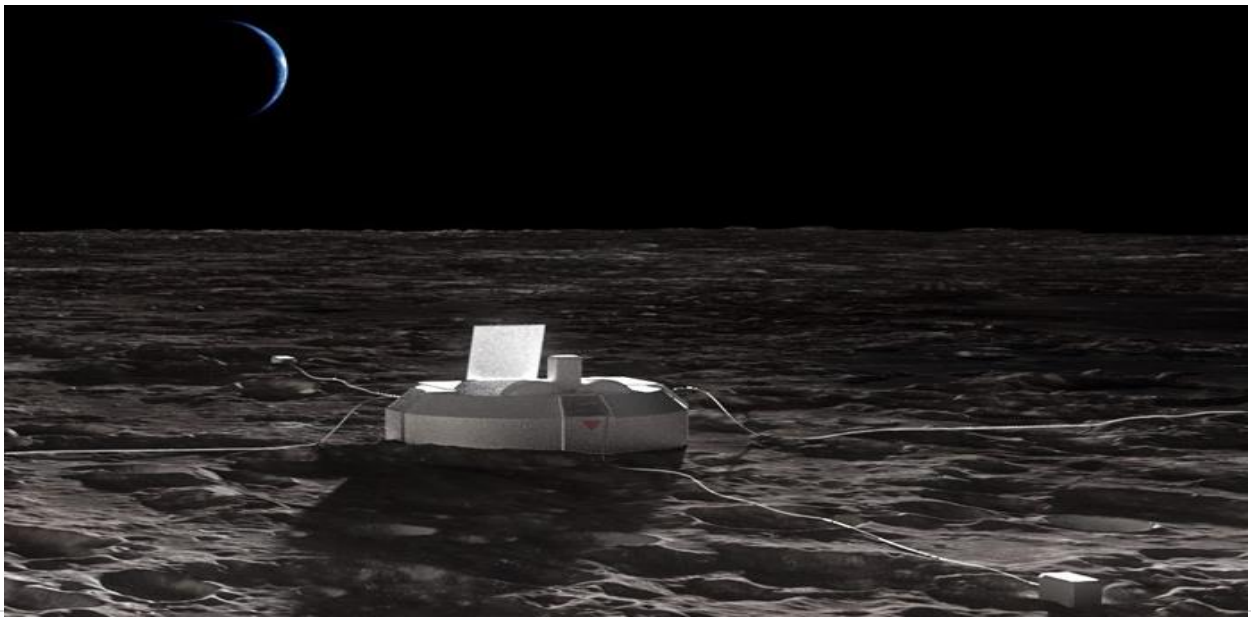
Lunar Geophysical Network for Artemis, Steve Bailey & David Paige

A Lunar Geophysical Network (LGN) is a premier decadal science objective that can be best addressed by a stand-alone science package that can be carried on every CLPS and Artemis Lander. A small, long-lived, self-powered package with independent communication capability that can be placed on to the surface by any lander allows the LGN to be built incrementally within the current Artemis program scope.

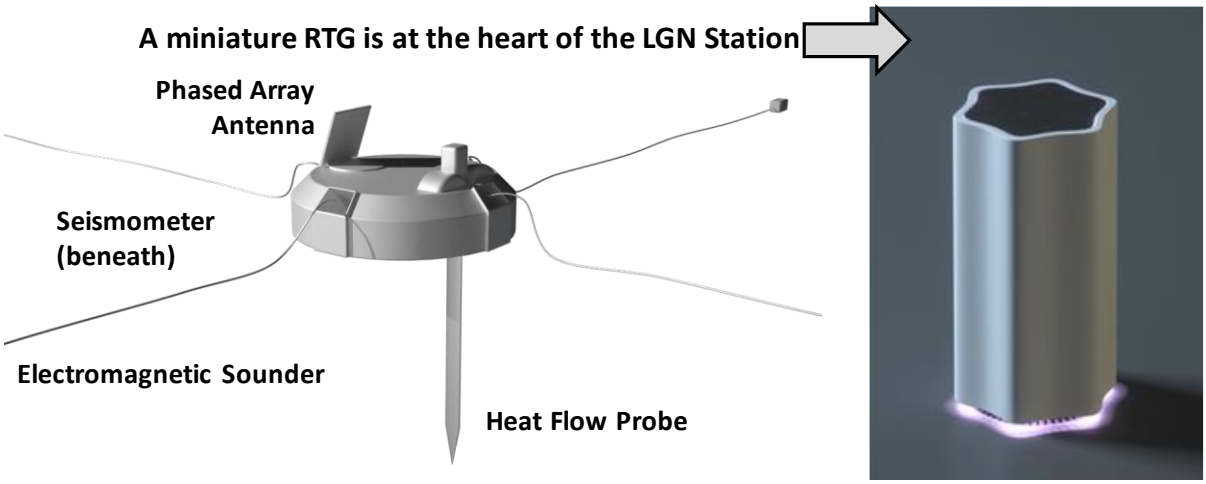
The key elements of an LGN include a seismometer, heat flow probe, electromagnetic sounder, and laser retroreflector. Laser retroflectors are standard equipment for CLPS Landers. They are simple passive systems that require no extended lander services beyond emplacement. But the other LGN equipment is problematic. An effective LGN requires multiple globally distributed surface stations operating simultaneously over many Lunar day/night cycles. Surviving the Lunar night is extremely challenging, but **operating** throughout the Lunar night, processing high rate geoseismic data and relaying that data to Earth, is extremely difficult. A dedicated mission of ruggedized landers landing at a half dozen globally distributed sites with purpose built network science packages would certainly satisfy the need for a LGN, but such a mission would fall outside of a New Frontiers budget and could probably only be addressed as a dedicated Flagship mission. It seems possible, even likely, that with Artemis and CLPS dominating NASA's exploration budget, that an additional LGN Flagship mission would be a long shot. Therefore, it appears that this important objective may be left unfulfilled for a generation or more, unless Artemis and CLPS Landers can somehow be enlisted.

Rather than attempting to ruggedize and equip all future CLPS Landers with Lunar night survivability and operability, we believe the most effective way to achieve an LGN is with a self-powered instrument package that can be carried on any Lunar Lander, foreign or domestic. Recently, the US Government has invested in the development of small-scale RTGs using alternative isotopes. There are compelling reasons to consider using these RTGs that are cost-effective, lightweight, and can be easily sized to support a lower power LGN system. Additionally, these RTG designs incorporate many of the "lessons learned" from heritage space nuclear power systems designs and materials, as well as safety analyses and environmental assessments conducted to support previous U.S. deployment of RTGs in space.



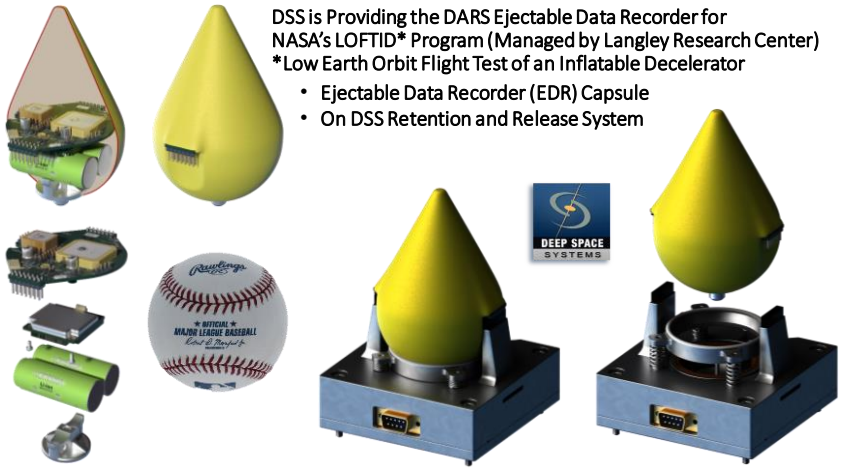
Lunar Geophysical Network for Artemis, Steve Bailey & David Paige

Breakthroughs in modern low power electronics, pioneered by cell phone, tablet and Internet of Things (IOT) developers have created the opportunity to satisfy LGN objectives with as little as 3W average power. This includes substantial on-board data processing and compression balanced by optimized burst data transmission. We envision a ~10kg LGN Station that, once placed on the Lunar surface, is completely independent of the Landing system. This package includes a highly sensitive seismometer, a heat flow instrument with a self-setting probe, and electromagnetic subsurface sounder and field measurement system that accomplishes its own deployments. Waste heat from the RTG is rejected during daytime operations and used at night instead of electrical power to keep system components within their operational temperature ranges.



Similar miniature, low-power, rugged, releasable systems are in active production for NASA flight programs such as LOFTID and are proposed in various NASA technology development programs such as Lunar Surface Technology Research (LuSTR).

As an incremental first step, a demonstration system can be fielded in the very near future based on work that is currently funded by NASA. A 0.3W RTG can be integrated into a ~1kg package that includes a LoRa telecommunications system that has been developed and demonstrated by the NASA LOFTID program for their Ejectable Data Recorder (EDR). This kind of demonstration can be completed in about a year, paving the way for actual LGN stations.



Artemis-3 can and should be an essential part of the emplacement of a long lived Lunar Geophysical Network. By undertaking some modest near-term development, we can make the Artemis program immensely more effective in achieving this fundamental decadal survey objective.