THE LUNAR GEOPHYSICAL NETWORK MISSION. C. Neal[1], R. C. Weber[2], B. Banerdt[3], C. Beghein[4], P. Chi[4], D. Currie[5], S. Dell'Agnello[6], R. Garcia[7], I. Garrick-Bethell[8], R. Grimm[9], M. Grott[10], H. Haviland[2], T. Kawamura[11], C. Johnson[12,13], S. Kedar[3], P. Lognonné[11], S. Nagihara[14], Y. Nakamura[15], C. Nunn[3], L. Ostrach[16], M. Panning[3], N. Petro[17], N. Schmerr[5], M. Siegler[13], T. Watters[17], M. Wieczorek[18], and K. Zacny[19]. [1]Univ. of Notre Dame; [2]NASA MSFC; [3]NASA JPL; [4]UCLA; [5]Univ. of Maryland; [6]INFN-LNF; [7]ISAE-SUPAERO; [8]UC Santa Cruz; [9]SwRI; [10]DLR; [11]IPGP; [12]U. British Columbia, [13]Planetary Science Institute; [14]Texas Tech Univ.; [15]UT Austin; [16]USGS; [17]NASA GSFC; [17]Smithsonian Institution; [18]Observatoire de la Côte d'Azur; [19]Honeybee Robotics.

Introduction: The Lunar Geophysical Network (LGN) mission will be part of NASA's New Frontiers 5 call [1]. Work conducted as part of NASA's Planetary Mission Concept Study initiative has further developed this mission [2]. The primary LGN goal is to understand the initial stages of terrestrial planet evolution, which is preserved in the Moon as seen from understanding the source region compositions of mare basalts.

Baseline Mission: Four identical landers will be put into lunar orbit together and deployed sequentially around the Moon. A dedicated relay satellite will communicate with a farside station. Nearside stations will use direct-to-Earth communication but can use the relay satellite if needed, for redundancy. The mission duration is 6 years (1 lunar tidal cycle) with a goal of 10 years. Each lander will carry identical instrumentation: both short period and very broad band seismometers, a lunar magnetotelluric sounding suite, heat flow probes, and laser retroreflectors. This allows landers to be re-directed in case of non-optimal deployment.

Objectives and Investigations: LGN has four science objectives that will be achieved through five investigations:

Objectives:

1. Evaluate the interior structure & dynamics of the Moon
2. Constrain the interior and bulk composition of the Moon
3. Delineate the vertical/lateral heterogeneities within the interior of the Moon as they relate to surface features and terranes
4. Evaluate current lunar seismo-tectonic activity.

Investigations:

1. Determine the size, state, and composition of the lunar core
2. Determine the state and chemical/physical stratification of the lunar mantle
3. Determine the thickness of the lunar crust and characterize its vertical and lateral variability
4. Determine the thermal state of the lunar interior and elucidate the workings of the planetary heat engine
5. Monitor impact events on the lunar surface.

Landing Sites: Three nearside sites (PKT; Schickard Basin – SB; Mare Crisium – MC) and one farside site (Korolev Basin – KB) have been identified as candidates that best meet LGN science objectives [3]. These sites best enable definition of the structure of the lunar interior (SB & KB are favorably located for core phase observations from known deep moonquake nests) and span crustal thicknesses. The SB and KB sites are close to lobate scarps and could investigate shallow moonquake seismicity. Heat flow and magnetotelluric sounding will be determined from distinct terranes, both heat-producing (PKT) and without the crustal layer (MC). The deployed laser retroreflectors will significantly expand the current network (Apollo and Lunokhod sites) allowing much needed increased fidelity on ranging measurements to place better constraints on the Moon's geodetic parameters.

CLPS and LGN: NASA has now selected multiple Commercial Lunar Payload Services (CLPS) landers to deliver science instruments to the Moon beginning in 2021, and continues to solicit new instruments annually. CLPS landers can currently carry ~35kg of total payload (LGN nominal payload mass is ~76kg) and survive for one lunar day (LGN requires a minimum of 6 years which is equivalent to ~76 full lunations); NASA is the marginal customer, meaning that CLPS landers primarily serve as delivery platforms rather than integrated science missions. While CLPS is an exciting model for lunar surface access, it is not yet proven, and the scope is very different – these missions do not replace the function of Discovery and New Frontiers to enable Decadal-level science investigations. Rather, CLPS missions can enable LGN by retiring key risks such as deployment strategies, lander noise characterization, and thermal and power performance. In the next few years, the repeated success of multiple new lander providers may eventually enable a mission like LGN to shop around and save on mission bus costs.

References: [1] Letter from the Planetary Decadal Committee Chairs (2021). [2] Neal, C. R. et al. (2020) The Lunar Geophysical Network Planetary Mission Concept Study Final Report, NASA. [3] Haviland, H. F. et al. (2021) Planetary Science Journal special issue on Planetary Decadal Mission Concept Studies, in press.