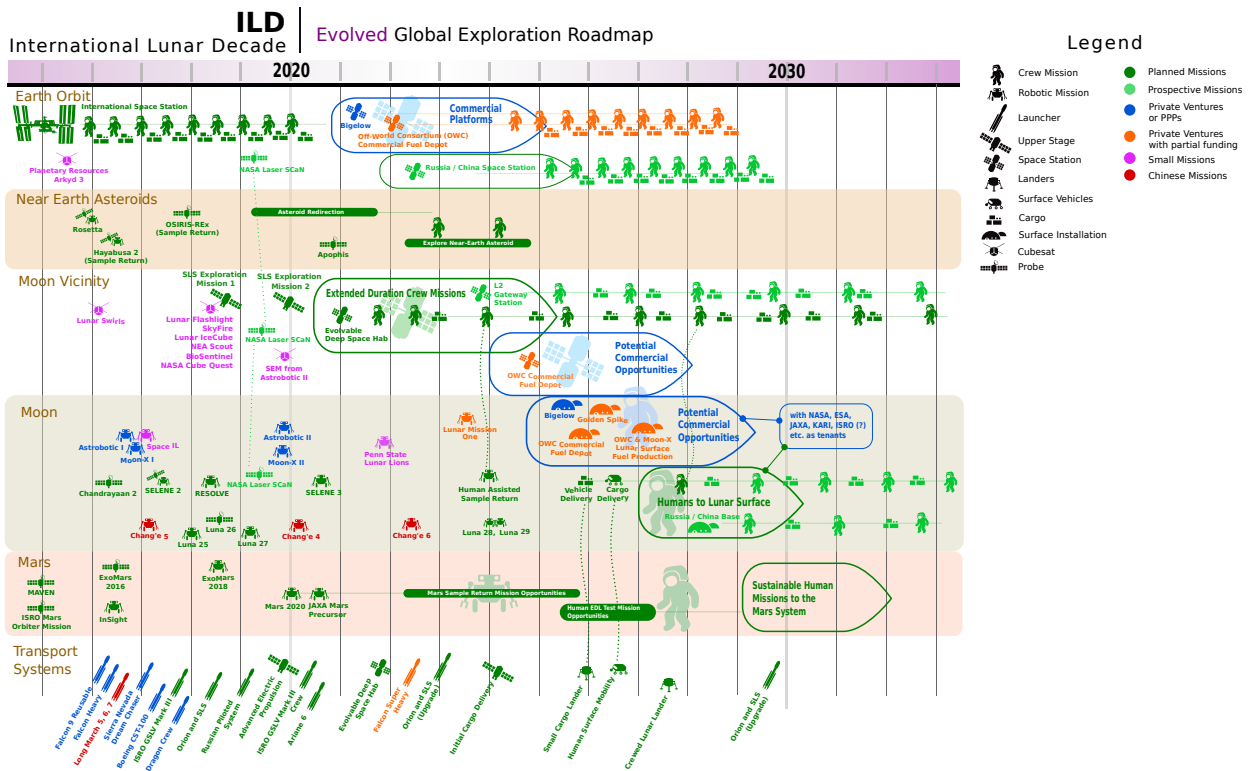


**An Evolved International Lunar Decade Global Exploration Roadmap.** David Dunlop. Author<sup>1</sup> and Kim Holder. Author<sup>2</sup>, <sup>1</sup> National Space Society, 410 Ashland Ave, Green Bay Wisconsin, dunlop.david@gamil.com, <sup>2</sup> National Space Society (Patzcuaro, Michoacan, Mexico, Kim Holder@gmail.com).

**Introduction:** Since 2007 an International Space Exploration Coordination Group (ISECG) of 14 of the largest national space agencies has met to look at the potential of collaborative planning and coordination of their national space exploration activities. While these meetings have generally been closed door events a 2013 edition Global Exploration Roadmap (GER) was produced (signed off) by 12 of the 14 countries reflecting their projected space program activities in the categories: Low Earth Orbit, Lunar Vicinity, Moon, Mars, Asteroids, and Transportation.(1) This GER is a formidable measure of collaborative efforts and spirits and a reflection of significant global cooperation. Yet just two years later it does not present the picture of where we stand today and what we are likely to see develop. An Evolved International Lunar Decade Global Exploration Roadmap has been produced to address some of many omissions(2):

- 1 The 2013 GER edition did not reflect the Chinese government lunar mission series beginning with the 2013 Chang'e III successful landing, and reflecting Chang'e IV (now scheduled for 2020 targeting the lunar farside, Change'e V (sample return now scheduled for 2017) with a Change'6 Mission indicated as a back-up to the sample return mission. (3)
- 2 The GER did not reflect any of the Google Lunar X-Prize Missions. Several teams such as Astrobotic and Moon-X and Team Space IL have received significant financial support, have developed flight hardware, and while slipping behind the earlier 2015 deadline are planning missions to the Moon perhaps succeeding in 2016 or when more affordable reusable launchers become commercially operational. (This does not preclude other GLXP teams from consideration in the future if they gather additional support even after the GLXP competition conclude)
- 3 The GER also does not reflect the exploration objectives of the LEAG Roadmap in a coherent fashion on the Moon Section. A The establishment of an International Lunar network of 8 to 10 surface station has been an objective unrealized since the financial col-

**GER 2013 Omissions:**



lapse of 2008. B The GER does not reflect the establishment of a lunar farside radio telescope initiative. C The GER does not reflect the development of a series of sortie missions which would cover exploration and assay of frozen volatiles deposits identified by remote sensing instruments on LRO, LCROSS, and Chandrayaan I in both the Northern and Southern polar regions. D The GER does not reflect the development of a series of sortie missions which could provide a global range lunar samples. An absolute lunar and solar solar system chronology, is a major Science Theme goals for such sampling sorties. (4) (This argues for a planning commitment for a series of such sortie missions tied to LEAG roadmaps objectives and reflected in an evolved GER) 4 The GER roadmap does not reflect commercial lunar activities which are planned for post GLXP mission by Astrobotic, Moon-X, other participants in the NASA Lunar catalyst program. Other Companies such as Bigelow, and Shackleton Energy have also indicated planning for lunar surface missions. These missions overlap the scientific interest in frozen volatiles by determining whether “operationally useful” deposits of ice exist and can be commercially mined for rocket propellant at a price point below that provided by an Earth sourced supply chain. These would reflect the Feed Forward and Sustainability Themes of the LEAG roadmap. The potential for funding synergies between public science and commercial missions (which represents opportunities to further drive down publicly funded science costs via the commercial on ramp mentioned in the LEAG roadmap) has not been captured by the GER. These opportunities have been pointed out in the Evolvable Lunar Architecture Report by NexGen LLC CEO Charles Miller (5) 5 Another omission in the GER is that there is no indication of the Lunar CubeSat revolution taking place. At the time of the release of that document Lunar Cube satellites were considered by some fringe possibilities with marginal potential for the conduct of science. In a remarkably short time they have become a mainstream with NASA supporting a variety of lunar missions with its ALANA and Cube Quest programs. Several will fly on the SLS-Orion unmanned test Mission One. 6 There is no mention of An International Lunar Survey Working Group mechanism for providing cartographic planning and a common geodetic registration system requirements for lunar data sets that could will enhance both scientific and commercial objectives. ) These system support requirements are needed for an effective ILD campaign which begins at the Moon. (6)

7 An additional omission is for supporting infrastructure requirements for communications navigation, and refueling. **Emerging Trends and An Evolving Process in an Evolved Global Exploration Roadmap:** The Evolved ILD Global Exploration Roadmap attempts to address some of these omissions above and a variety of commercial proposals. No

doubt new proposals will emerge and omissions in this new version will create a requirement for an Evolving Global Exploration Roadmap update at least annually.

An International Lunar Decade campaign reflects a convergence of efforts in both the entrepreneurial communities and national space agencies. An integrated approach to lunar scientific exploration and development must also reflects the vigor and acceleration in prospective activities and planning. The Evolved ILD GER produced by the NSS Moonwards Chapter attempts a broader scope than the earlier official ISECG 2013 GER. The dual commitments to an EM-L2 Gateway station and a lunar base(s) will require a robust and redundant supply chains. It also presents a new technology infrastructure and prospective commercial developments leading to the economic settlement and development of the Moon which are expressed in the chapter Logo imagining a developed Moon whose settlements shine at night like the Earth’s.



Like the campaign to further explore and development the Moon this Evolved ILD GER is a work in progress that over time will increase its fidelity and hopefully a growing range of international participation. **References:** (1) [www.nasa.gov/exploration/about/isecg](http://www.nasa.gov/exploration/about/isecg), GER pdf, chart page 50, ISECG. (2) Dave Dunlop and Kim Holder, 2015, NSS Moonwards chapter Evolved ILD GER graphic. (3) Li Ping, CAST, May, 23, 2015, ISDC, Toronto Canada, slides presented by Dr. Feng Hsu. (4) [www.lpi.usra.edu/leag/roadmap/](http://www.lpi.usra.edu/leag/roadmap/) (5) Charles Miller, NexGen LLC, July, 13, 2015, [www.nss.org/docs/EvolvableLunarArchitecture.pdf](http://www.nss.org/docs/EvolvableLunarArchitecture.pdf), p. 90. (6) B. A. Archinal, Need for Lunar and Planetary Cartography Planning, Annual Meeting of the Lunar Exploration Analysis Group (2014).