Google Lunar XPRIZE Market Study 2014

A Report to the XPRIZE Foundation

MEDIA SUMMARY

Prepared by

LE London Economics

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About London Economics

London Economics (LE) is a leading independent economic consultancy, headquartered in London, United Kingdom, with a dedicated team of professional economists specialised in the application of best practice economic and financial analysis to the space sector. As a firm, our reputation for independent analysis and client-driven, world-class and academically robust economic research has been built up over 25 years with more than 400 projects completed in the last 7 years.

We advise clients in both the public and private sectors on economic and financial analysis, policy development and evaluation, business strategy, and regulatory and competition policy. Our consultants are highly-qualified economists with experience in applying a wide variety of analytical techniques to assist our work, including cost-benefit analysis, multi-criteria analysis, policy simulation, scenario building, statistical analysis and mathematical modelling. We are also experienced in using a wide range of data collection techniques including literature reviews, survey questionnaires, interviews and focus groups.

Drawing on our solid understanding of the economics of space, expertise in economic analysis and best practice industry knowledge, our Aerospace team has extensive experience of providing independent analysis and innovative solutions to advise clients (both public and private) on the economic fundamentals, commercial potential of existing, developing and speculative market opportunities to reduce uncertainty and guide decision-makers in this most challenging of operating environments.

All consultants of our Aerospace team are highly-qualified economists with extensive experience in applying a wide variety of analytical techniques to the space sector, including:

- Insightful and accurate market analysis and demand forecasting;
- Analysis of industrial structure, strategy and competitive forces;
- New technology adoption modelling;
- Estimation of public utility benefits;
- Opportunity prioritisation and targeting to maximise exploitation of investment;
- Sophisticated statistical analysis (econometrics, regression);
- Economic and financial modelling, including: Cost-Benefit Analysis (CBA), cost effectiveness analysis, Value for Money (VfM), impact assessment, policy evaluation, business case development, cash flow and sustainability modelling.

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Google Lunar XPRIZE Market Study 2014: Media Summary

This short note summarises the findings of the Google Lunar XPRIZE Market Study 2014, conducted by London Economics' Aerospace team[1] for the XPRIZE Foundation.

Context

Since the inception of the Google Lunar XPRIZE (GLXP)[2] in 2007 the global financial support for lunar exploration has varied, particularly with the cancellation of the Constellation Program and the global economic crisis. Despite these events the GLXP has remained active in its support for lunar exploration.

The global space economy is lucrative and growing ($314 billion in 2013, a 4% increase on 2012), with just under three-quarters of this revenue, and the vast majority of the growth, accounted for by the commercial sector.[3] A 2009 study by Futron[4] established a baseline study for the commercial lunar market.

Objective

This follow-on study builds on the insights developed through the *Google Lunar XPRIZE Market Study 2013*, digging deeper into the consolidated quantitative market demand and opportunity valuations, providing an updated and more in-depth analysis of the market opportunities addressable by teams competing in the GLXP.

Scope

The scope of the study covered established, emergent and future market opportunities available to GLXP teams, with extensions to non-space sector industries. Sponsorship, entertainment and media markets were excluded. The geographic scope of the study was global, focusing on international markets, recent and developing opportunities related to the strategic plans of major established space agencies, emerging space agencies and the growing and increasingly numerous commercial operators. The time horizon for the analysis is the 10 and 25 years following closure of the GLXP in 2015, marked by increasing uncertainty and estimation error out over time.

[1] For further information on London Economics, please see inside front cover.

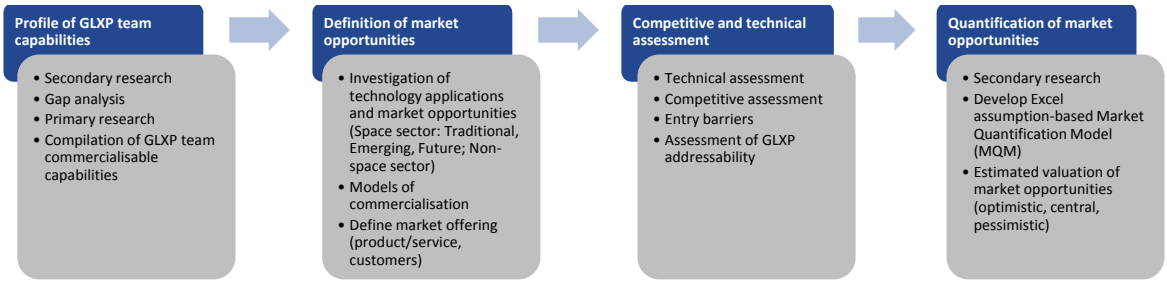
[2] X PRIZE Foundation. 2014. "Google Lunar X PRIZE." Retrieved 8/10/2014 from: http://www.googlelunarxprize.org

[3] Space Foundation. *The Space Report 2014* .

[4] Futron Corporation. "Lunar Markets Analysis." Bethesda, Maryland. 2009.

Methodology

The follow-on study has revisited the methodology for the 2013 market study summarised in the schematic diagram below.



Once we had established the capabilities being developed by the GLXP teams based on desk-based review of publicly available information and consultation with team leads, we identified market opportunities that could be served by these capabilities (allowing further development over time). Next entry barriers and technical and competitive constraints were considered to assess the addressability of the market by GLXP teams.

The quantification and valuation of market opportunities was achieved by developing an Excel assumption-based Market Quantification Model (MQM). To inform the quantitative modelling, the most important and reputable publicly available sources of market data were reviewed, including purchased industry/market reports and databases, in addition to expert opinion. The study quantified the estimated global market, focusing on international markets, recent and developing opportunities related to the strategic plans of major established space agencies (NASA, ESA, ROSCOMOS, JAXA) in addition to smaller (Canada-CSA) and emerging (India-ISRO, China-CNSA, Brazil-AEB) space agencies. For example, NASA has already signed deals to purchase $30.1 million worth of data over a period of up to five years from six GLXP teams under its Innovative Lunar Demonstrations Data (ILDD) programme.[5]

In order to expand upon the 2013 Market Study, several improvements have been implemented in our methodology, and other assumptions have been refined. These improvements are:

- Probability of mission go-ahead and optimism bias adjustment to launch dates;
- Additional missions identified in an updated scan of planned missions;
- Review of valuations; and
- Real price erosion in valuations over time.

The Market Study was a modest study with ambitious objectives. The estimates of the valued market opportunities are high-level estimates based on research-based assumptions and expert judgement, but remain subject to potentially large estimation bias. Given the degree of uncertainty surrounding many of the estimates a scenario-based sensitivity analysis was used to indicate Optimistic and Pessimistic bounds for our Central estimate. That said, a persistent issue in

[5] NASA Lunar Science Institute.. "NASA Awards Contracts for Innovative Lunar Demonstrations Data." Retrieved from: http://lunarscience.nasa.gov/articles/nasa-awards-contracts-for-innovative-lunar-demonstrations-data/

quantifying future/emergent markets is that quantification is (necessarily) limited to foreseeable future applications; i.e. it may exclude opportunities that have not yet been (at least publicly) acknowledged, imposing a natural conservatism.

Assumptions

Team Capabilities

To ensure coverage of a comprehensive range of the potential commercial opportunities open to GLXP teams, an aggregate profile of GLXP team proprietary capabilities (knowledge, experience, space infrastructure and facilities, innovative technologies, manufactured assets, systems, sub-systems and mission services) was established.

With the competition ongoing, at time of writing, most capabilities considered in the study are still in development. Nonetheless, in forward-looking market forecasting exercises it is necessary to make certain assumptions regarding the future. Accordingly, it was assumed that the expected set of capabilities will be successfully developed, thus opening up access to the identified range of market opportunities. Notably, many of the opportunities could be served without achieving success in the GLXP, or even achieving orbit. This is not an unreasonable assumption. In fact, given that the GLXP teams are, by their very nature, characterised by strong innovation and enterprise, it is possible (if not probable) that additional capabilities will be developed, creating even further market opportunities.

A successful GLXP mission requires a team to develop certain core capabilities[6], but many teams are developing a range of supplementary capabilities to generate additional revenue streams to support the GLXP mission and/or achieve other team objectives. Any further capabilities planned for development after the GLXP (e.g. return module for sample return), were excluded from the scope of the study. The aggregate core and supplementary capabilities are listed below.

Core	Supplementary

• Spacecraft design and assembly, integration and test (AIT)
• Spacecraft subsystem design and assembly, integration and test (AIT), including:
  • In-space propulsion technology
  • Space power and energy storage
  • Thermal management system
  • Spacecraft navigation subsystem
• Descent and landing system
• Independent surface exploration craft*
• Robotic, tele-robotic & autonomous systems
• Technical/scientific data capture subsystem
• HD imagery capture subsystem
• Communication and data/imagery transmission subsystem
	• Launch propulsion system
	• Auxiliary payload capacity
	• Lunar night operation and survival
	• In-space technology demonstrations
	• Sample extraction system (e.g. scooper)
	• Conduct scientific experiments
	• Permanent lunar installation (e.g. observatory, communications relay)
	• Public/STEM education outreach
	• Patents
	• Other (varies by team)

[6] Note that a small number of teams are developing a lander that is capable of hopping to explore the lunar surface rather than an independent surface exploration craft.

Commercial opportunities

A range of specific commercial market opportunities were identified that could be addressed by the GLXP teams over the next 3, 5, 10, 20 and 25 years, classified according to the delivery timeframe and degree of certainty in the estimates (inversely related): established market opportunities (1+years), emergent market opportunities (5+years) and future market opportunities (10+years). Timeframes quoted are from the completion of the GLXP (year 0: 2015).

Potential customers

The customer types considered were: public sector; commercial sector (companies may play the role of competitor, customer, partner or acquirer); non-space sector; third sector; high net-worth individuals; and the general public. Prominent examples of each type of customer are listed overleaf.

Public sector	Commercial sector	Other
• **Major established space agencies** NASA, ESA, ROSCOMOS, JAXA • **Smaller established space agencies** CSA, European Member States • **Emerging space agencies** ISRO, CNSA, AEB • **Other governmental organisations** US Department of Defence, UK Ministry of Defence, EU Member State Defence Ministries, NOAA (National Oceanic and Atmospheric Administration, National Agricultural Ministries etc.	• **Launcher manufacturers and launch service providers** United Launch Alliance (Lockheed Martin and Boeing), EADS Astrium, Arianespace, Boeing Launch Services, Mitsubishi Heavy Industries, SpaceX, International Launch Services, Sea Launch (Land Launch), SpaceDev (Sierra Nevada Corporation), Orbital Sciences Corporation, Antrix Corporation (India), China Aerospace Science and Technology Corporation, SpaceQuest, ISC Kosmotras, Starsem, Alcantara Cyclone Space, SUPARCO, Yuzhmash, etc. • **Lander, rover and probes** Lavochkin, Teledyne Brown Engineering, China Aerospace Science and Technology Corporation, Deep Space Industries, SpaceX, Planetary Resources, etc. • **Space tourism** Virgin Galactic, EADS Astrium, SpaceX, XCOR Aerospace, Armadillo Aerospace, Bigelow Aerospace, Blue Origin, Golden Spike Company, Masten Space Systems, Mojave Aerospace Ventures, Orbital Sciences Corporation, RocketShip Tours, Scaled Composites, Sierra Nevada Corporation, Space Adventures, MarsOne, etc. • **Satellite communications** SES, Intelsat, Eutelsat, Inmarsat, etc. • **Earth observation/imagery** (e.g. Planet Labs)	• **Third sector** Universities, research institutes (Carnegie Mellon University Robotics Institute etc.), not-for-profit organisations • **Non-space sector companies** • **High net-worth individuals** Lunar burial • **General public** Imagery (e.g. ARKYD telescope)

Roadmap of GLXP opportunity missions

Before quantitatively assessing future market opportunities for GLXP teams, it is informative to set out the projected "state of play" for the industry in which the teams will operate. We achieved this by using London Economics' compiled database of planned missions to create a **Roadmap of GLXP opportunity missions**, starting from the culmination of the GLXP prize in 2015. The result is a total forecasted roadmap which shows the expected demand for landers, rovers and orbiters by year, alongside mission type and public-private split. This Roadmap is a novel element in this 2014 Market Study.

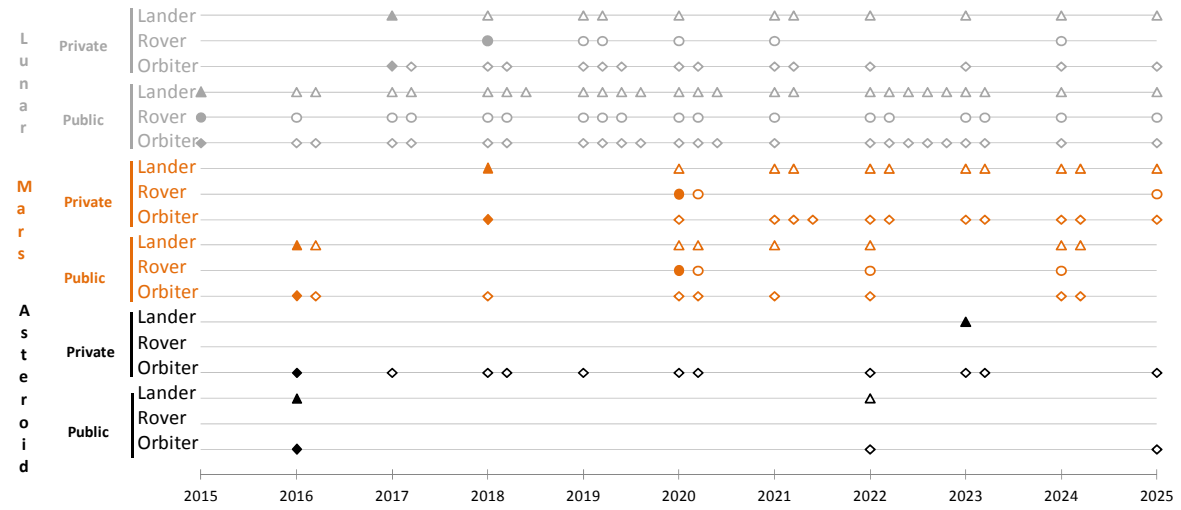
There will be consistently strong demand for landers, rovers and orbiters needed for lunar missions in the 10 years after the completion of the GLXP prize, however most of this demand will

come from the public sector in the form of governmental space agencies. Private lunar missions will not start until 2017 at the earliest and not become frequent until two years later. Further breakthroughs in lunar exploration are expected to arrive in the future, with the Chinese space agency having active plans for a manned lunar mission in the early 2030s, whilst Roscomos, ESA and the Japanese Exploration Agency have hinted at similar missions.

Planetary science missions to Mars have been popular in recent times, yet more missions have been announced in both the public and private sector including the Mars 2020 rover run by NASA and Inspiration Mars who are working towards a manned flyby of Mars in either 2018 or 2021. The colonisation of Mars remains a significant potential breakthrough and future attempts to explore Martian moons are being proposed.

There are the fewest number of missions to asteroids out of the three destination categories that we have considered, with the demand for private orbiters highest of all the six categories. Private missions to asteroids will initially be composed of asteroid mining probes, with claims that if asteroid mining were to take place on a large enough scale it could result in the creation of a trillion dollar industry[7]. On the public side, the Asteroid Redirect Mission scheduled in the late 2020s involves attempting to move an asteroid into a lunar orbit for the first time. If the mission is successful, more missions of a similar nature could take place as well as future endeavours to have the first astronaut walking on asteroids.

Consolidated mission and milestone Roadmap

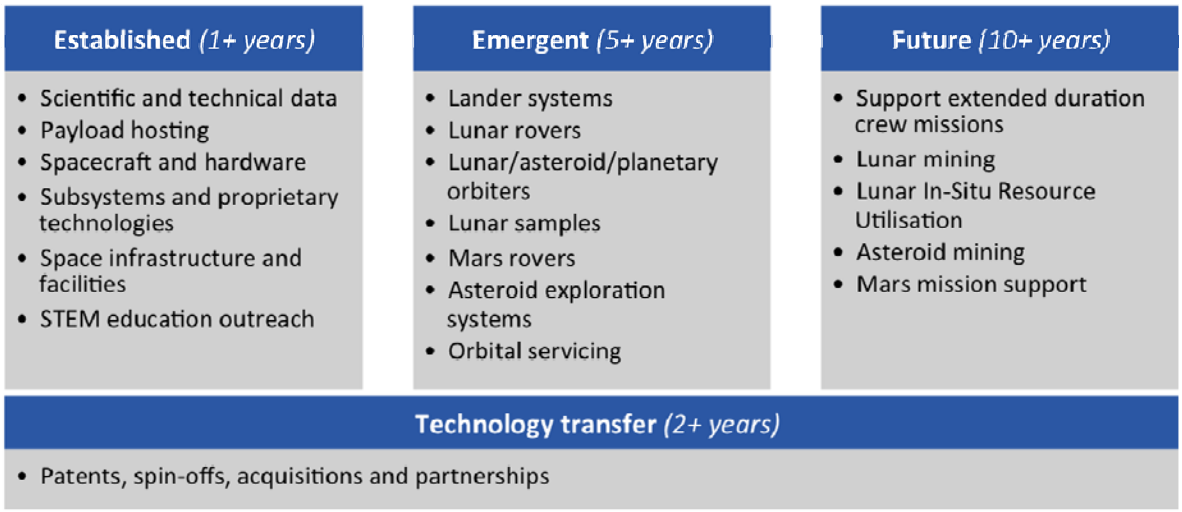


Note: Bolded missions are 'milestone' missions, i.e. the first of their type after the GLXP ends.
Source: London Economics

Market opportunities

The full range of considered commercial market opportunities is listed below, and each classification of opportunities discussed in turn subsequently.

[7] The Trillion Dollar Market: Fuel in Space from Asteroids - http://www.planetaryresources.com/2014/06/fuelspace/ - accessed 29th August 2014.



Established market opportunities

The most readily accessible commercial opportunities for GLXP teams to address with the capabilities developed in a successful GLXP mission are the supply of 'traditional' products and services. Some of these established markets could be addressable immediately (e.g. sales of scientific and technical data) whereas others will entail some lead time (e.g. spacecraft sales).

Emergent market opportunities

Allowing more time for procurement negotiation and technology development, there is a range of markets that are set to develop over the coming years as defined by the medium-term planned missions of the major established and emerging space agencies. To address these commercial opportunities, the GLXP teams will have to adapt their developing technology to become competitive over a timeframe of five to ten years onwards, and are therefore subject to a degree of greater uncertainty.

Future market opportunities

Looking further into the future, the analysis considered markets for products and services that are currently only at the conceptual stage, but that are likely to become very important over the timeframe of 10 to 20 years onwards. GLXP teams are likely to require considerable expansion of their capabilities to compete in these markets, although the technologies they have developed may give them a competitive edge.

Given the long-term nature of these opportunities and the considerable uncertainty involved, the study did not attempt to quantify and value these markets since any such estimates would be highly speculative and lack credibility. Nonetheless, the considerable commercial potential of the future market opportunities is clear.

Technology Transfer

Additional revenue for GLXP teams may result from new, or adapted, products and/or services based on the technology developed for the GLXP mission, sold to enterprises within and outside the space sector.

Examples of non-space applications might include spin-offs to leverage the potential that the already developed technologies (e.g. robotic rover) provide to the open market, especially for sectors which deal with harsh environments, such as fire rescue, deep sea, defence, dangerous production plants (nuclear, chemical, etc.), natural disasters, and tele-operation (e.g. terrestrial mining applications).

London Economics estimated the value of the above technology transfer market opportunities by adopting a 'ripple effect' multiplier. Previous research and analysis by London Economics showed that a factor of 2.0 times the initial technology investments could be used to estimate technology transfer sales to non-space sectors. To quantify the total investment by GLXP teams, a long-tail distribution was assumed for all registered teams with the maximum investment per team set at US$31 million (with launch costs removed). This resulted in a total investment across all teams of $98 million. Applying the estimated ripple effect multiplier to this investment suggests a potential total of technology transfer value of GLXP technology of $197 million, over a period of up to 10 years.

Market trade restrictions

There are a range of market entry and trade barriers that limit the potential customers and markets that are accessible to specific GLXP teams. Briefly these are summarised as follows:

- **International trade restrictions** - many national governments impose strict restrictions on international trade of aerospace products and technologies to protect national strategic assets. The best-known example of such restrictions is the US' International Traffic in Arms Regulations (ITAR). Depending on whether a license is granted, ITAR can cause either a significant delay, or an absolute barrier to trade in spacecraft technologies.
- **Domestic industrial bias** - for example, NASA predominantly contracts with US-based companies, and Space companies must be located in an ESA-participating member state in order to win ESA contracts. Purchase of established spacecraft may not be an option for emerging space agencies seeking to establish prestige based upon their space-faring capabilities.
- **Legacy systems** - given the long and costly development, testing and technology demonstration cycle for high-reliability space hardware and software, there exists strong inertia towards existing technical standards and legacy technologies and systems. This inertia will be a constraint in the short- and medium-term for GLXP team technologies that are disruptive to the existing standardised frameworks, despite possibly being technologically superior and/or lower cost.

Results and conclusions

Following this study, our updated market value estimates for the commercial opportunities open to Google Lunar XPRIZE teams over 10 years (2016-2025) and 25 years (2016-40) are presented below.

Table 1: Valuation of market opportunities, 0-10 years and 0-25 years (US$m)

Market opportunities	10 years			25 years		
	Pessimistic	Central	Optimistic	Pessimistic	Central	Optimistic
Established market opportunities						
Scientific and technical data	38	53	77	38	53	77
Payload hosting	233	396	504	978	2,592	4,058
Spacecraft and hardware	256	637	1,087	256	637	1,087
Subsystems and proprietary technologies	6	15	23	10	25	38
Sub-total	**533**	**1,101**	**1,690**	**1,281**	**3,306**	**5,259**
Emergent market opportunities						
Lander systems	161	314	627	345	671	1,341
Lunar rovers	56	112	210	254	505	946
Lunar/asteroid/planetary orbiters	127	285	458	278	623	1,002
Lunar samples	43	91	116	204	411	543
Mars rovers	173	347	485	296	592	828
Sub-total	**561**	**1,147**	**1,896**	**1,376**	**2,800**	**4,660**
Future market opportunities						
Support extended duration crew missions	n/q	n/q	n/q	n/q	n/q	n/q
Lunar mining	n/q	n/q	n/q	n/q	n/q	n/q
Lunar In-Situ Resource Utilisation	n/q	n/q	n/q	n/q	n/q	n/q
Asteroid mining	n/q	n/q	n/q	n/q	n/q	n/q
Sub-total	n/q	n/q	n/q	n/q	n/q	n/q
Technology transfer opportunities						
Sub-total	**98**	**197**	**295**	**98**	**197**	**295**
OVERALL ESTIMATE OF MARKET VALUE	**1,213**	**2,445**	**3,881**	**2,756**	**6,303**	**10,214**

Note: Market valuations are nominal (no Present Value adjustment has been applied); n/q: Not quantified.
Source: London Economics analysis

With an overall estimated market value in the 10 years directly following the competition of US$2.4 billion, and $6.3 billion over the 25 year longer term, it is clear that the Google Lunar XPRIZE presents a very significant incentive for teams to organize themselves to pursue and capture the various commercial opportunities that they can access.

Public-Private split

Whilst the market will initially be driven by public sector customers (52% of the US$2.4 billion market at 10 years), the private and third sector will increase in significance (67% of the US$6.3 billion at 25 years) to outstrip public sector demand over the longer time period.

Table 2: Public-Private split				
%	Public		Private	
	10 yrs	25 yrs	10 yrs	25 yrs
Established market opportunities				
Scientific and technical data	63	63	37	37
Payload hosting	25	25	75	75
Spacecraft and hardware	61	61	39	39
Subsystems and proprietary technologies	47	42	53	58
Sub-total	**48**	**32**	**52**	**68**
Emergent market opportunities				
Lander systems	58	36	42	64
Lunar rovers	80	21	20	79
Lunar/asteroid/planetary orbiters	60	37	40	63
Lunar samples	26	7	74	93
Mars rovers	55	54	45	46
Sub-total	**57**	**33**	**43**	**67**
Future market opportunities				
Support extended duration crew missions	n/q	n/q	n/q	n/q
Lunar Mining	n/q	n/q	n/q	n/q
Lunar in-situ resource utilisation	n/q	n/q	n/q	n/q
Asteroid mining	n/q	n/q	n/q	n/q
Sub-total	**n/q**	**n/q**	**n/q**	**n/q**
Technology transfer opportunities				
Sub-total	**50**	**50**	**50**	**50**
OVERALL PUBLIC-PRIVATE SPLIT	**52**	**33**	**48**	**67**

Note: This Public-Private split only takes into account the central forecast scenario; n/q: Not quantified.
Source: London Economics

It is hoped that the study outputs might serve to secure the continued commitment of the 18 registered GLXP teams (correct at the time of writing), financiers, partners, sponsors and anchor customers, as well as assist them in attracting additional funding from angel investors, venture capitalists and other private sources (e.g. advance service deals and orders, sponsors).

It is clear that the GLXP awards serve as significant monetary incentives to attract teams of individuals and companies from around the world to embark on the challenge of achieving a commercial lunar mission, but the real payoff will come from the commercial opportunities that follow in the short, medium and long-term after the GLXP mission has been completed, in a newly created commercial cislunar/lunar mission market.

Alternative market demand scenarios

In this follow-on market study we also considered and modelled three additional market scenarios reflecting alternative paths that the commercial (cis)lunar market might evolve along: a moon-heavy scenario, a Mars-heavy scenario, and an asteroid-heavy scenario. Analysis of the mission database and London Economics' industry expertise determined the assumptions associated with the different '-heavy' scenarios and give the results shown in the table below. The Moon-heavy

scenario provides the largest overall market value for GLXP teams in both the 10 and 25 year forecast, primarily due to the relatively high level of addressability of lunar missions for the GLXP teams.

Table 3: Moon, Mars and asteroid heavy scenarios (US$m)

Market opportunities	Moon heavy scenario		Mars heavy scenario		Asteroid heavy scenario	
	10 yrs	25 yrs	10 yrs	25 yrs	10 yrs	25 yrs
Established market opportunities						
Scientific and technical data	53	53	53	53	53	53
Payload hosting	396	2,592	396	2,592	396	2,592
Spacecraft and hardware	927	927	717	717	717	717
Subsystems and proprietary technologies	15	25	15	25	15	25
Sub-total	**1,391**	**3,596**	**1,181**	**3,386**	**1,181**	**3,386**
Emergent market opportunities						
Lander systems	549	1,612	417	1,356	324	715
Lunar rovers	247	1,042	112	505	112	505
Lunar/asteroid/planetary orbiters	435	1,225	351	1,061	351	908
Lunar samples	125	556	91	411	91	411
Mars rovers	347	592	442	950	347	592
Sub-total	**1,704**	**5,026**	**1,411**	**4,282**	**1,224**	**3,131**
Future market opportunities						
Support extended duration crew missions	n/q	n/q	n/q	n/q	n/q	n/q
Lunar Mining	n/q	n/q	n/q	n/q	n/q	n/q
Lunar in-situ resource utilisation	n/q	n/q	n/q	n/q	n/q	n/q
Asteroid mining	n/q	n/q	n/q	n/q	n/q	n/q
Sub-total	**n/q**	**n/q**	**n/q**	**n/q**	**n/q**	**n/q**
Technology transfer opportunities						
Sub-total	**295**	**295**	**246**	**246**	**216**	**216**
OVERALL ESTIMATE	**3,390**	**8,918**	**2,838**	**7,914**	**2,621**	**6,733**

Note: Market valuations are nominal (no Present Value adjustment has been applied); n/q: Not quantified.
Source: London Economics

Notes for editors

About XPRIZE Foundation

XPRIZE is the leading organization solving the world's Grand Challenges by creating and managing large-scale, high-profile, incentivized prize competitions in five Prize Groups: Learning; Exploration; Energy & Environment; Global Development; and Life Sciences. Active prizes include the $40 million Google Lunar XPRIZE, the $10 million Qualcomm Tricorder XPRIZE, the $2.25 million Nokia Sensing XCHALLENGE and the $2 million Wendy Schmidt Ocean Health XPRIZE. For more information, go to www.xprize.org.

About the Google Lunar XPRIZE

The Google Lunar XPRIZE is the largest international incentive based prize of all time with $40 Million in incentive based prizes sponsored by Google and operated by the XPRIZE Foundation. It aims to do something that humanity hasn't done since 1972: to safely land on the surface of the Moon. More than half of the world's population has never had the opportunity to view a live transmission from the lunar surface. The Google Lunar XPRIZE aims to create a new 'Apollo moment' for this generation and to spur continuous lunar exploration by challenging and inspiring engineers and entrepreneurs from around the world to develop low-cost methods of robotic space exploration.

In order to win this money, a private company must land safely on the surface of the Moon, travel 500 metres above, below, or on the lunar surface, and send back two 'Mooncasts' to Earth.

Fig. 1 LAUNCH

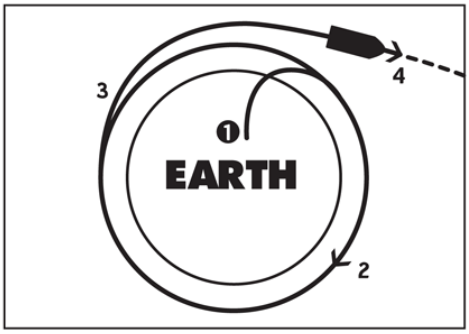


Fig. 2 LUNAR LANDING

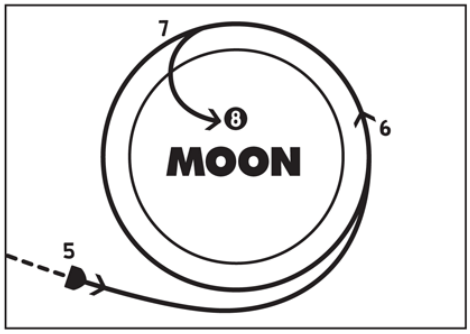


Fig. 3 LOCOMOTION

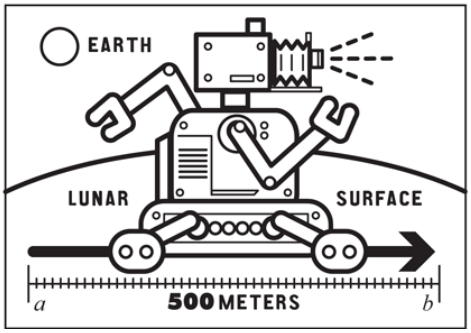
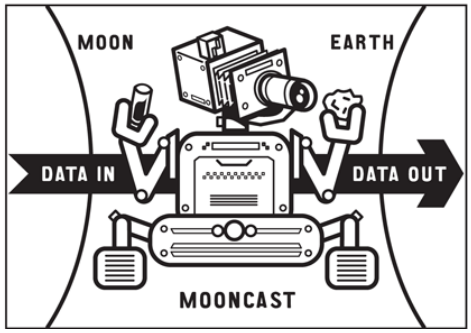


Fig. 4 DATA COLLECTION AND TRANSMISSION



The first team to do so will claim a $20 million Grand Prize, while the second team will earn a $5 million Second Prize. Teams may also compete for $5 million in Bonus Prizes (image Apollo site/artefact; image heritage site/artefact; find water; survive the lunar night; travel the furthest distance; promote diversity in education and outreach), $6 million in 'Terrestrial' Milestone Prizes (imaging; mobility; landing), and $4 million in 'In-Space' Milestone Prizes. All of this must be completed by December 31, 2015. At time of writing, 18 teams active in more than a dozen countries are participating in the Google Lunar XPRIZE.

For more information, go to www.googlelunarxprize.org.

About London Economics

See inside front cover.

Glossary

AEB	Agência Espacial Brasileira
CNSA	China National Space Administration
CSA	Canadian Space Agency
EAR	Export Administration Regulations
EREP	European Robotic Exploration Programme
ESA	European Space Agency
GEO	Geostationary Earth Orbit
GER	Global Exploration Roadmap
GES	Global Exploration Strategy
GLXP	Google Lunar XPRIZE
ILDD	Innovation Lunar Demonstrations Data
IP	Intellectual Property
ISRO	Indian Space Research Organization
ISRU	In-situ Resource Utilization
ITAR	International Traffic in Arms Regulations
JAXA	Japanese Aerospace Exploration Agency
LEO	Low Earth Orbit
LLO	Low Lunar Orbit
MQM	Market Quantification Model
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
REE	Rare Earth Elements
ROSCOSMOS	Russian Federal Space Agency
SELENA	Sustainable Experiment on Lunar Exploitation
STEM	Science, Technology, Engineering and Mathematics

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