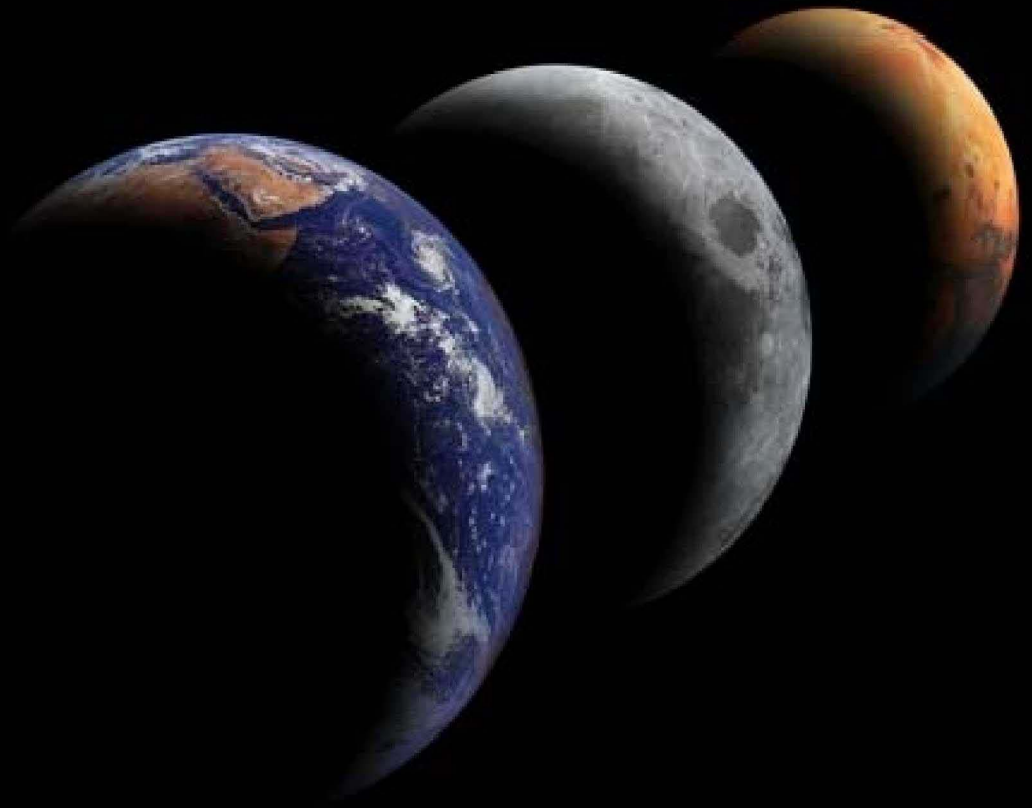
Lunar Commercialization Workshop



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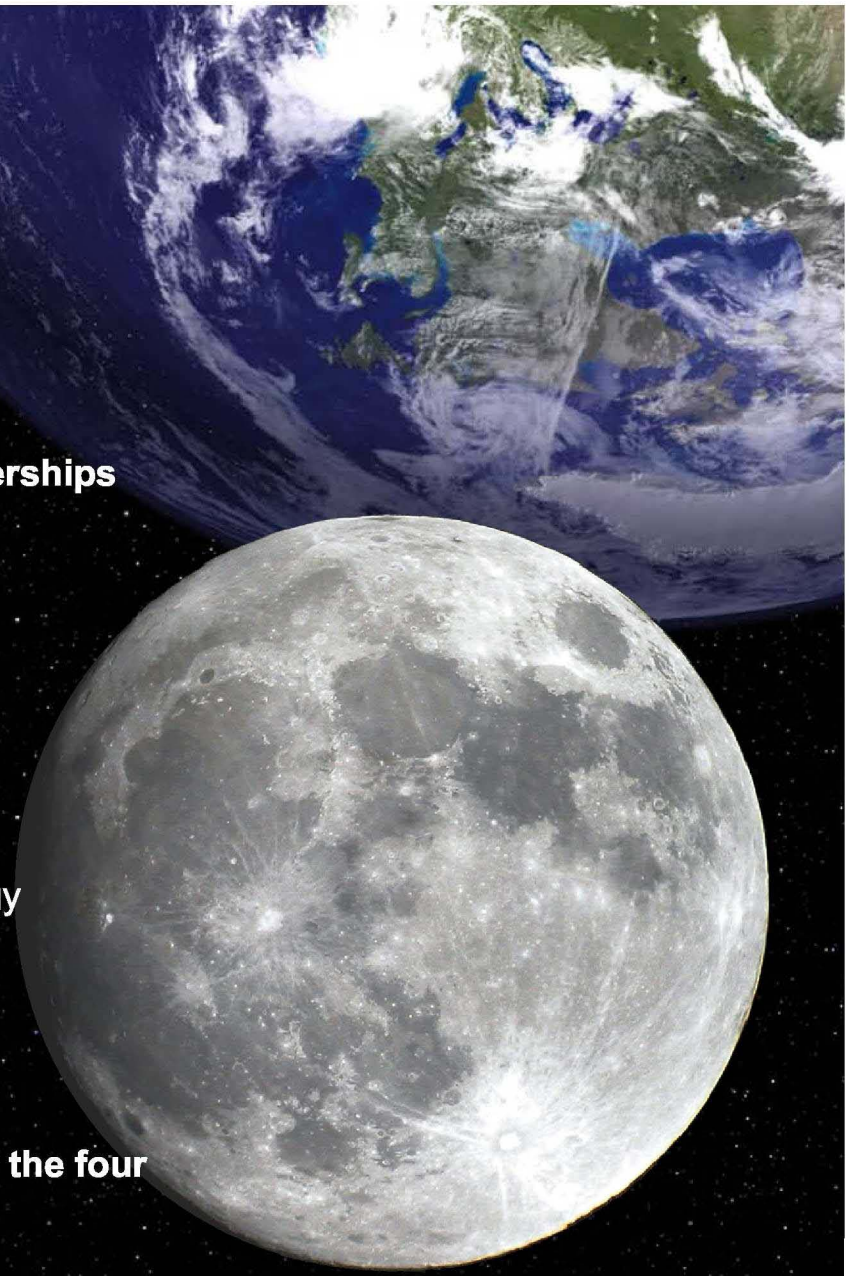
Lunar Commercialization Workshop Agenda

- Overview and workshop description
  - 40 minutes
- Development of Business Plans
  - 120 minutes
- Presentation of business plans to panel
  - 40 minutes - split evenly among the teams
- Wrap-up and discussion
  - 10 minutes

Lunar Commercialization Workshop Description



- **Goals**
  - **Explore viability of using public-private partnerships to open space frontier**
- **Rules**
  - **Form teams - each team represents a space entrepreneurial company**
  - **Create innovative business plans for commercialization of the Moon**
    - Business concept description, market strategy
    - Return on investment, pricing, schedule
    - Competition and other impediments
    - Operations and management plan
  - **Present plan to panel - scored against each of the four elements**
  - **Best plan awarded prize**

Lunar Commercialization Workshop - Scoring

- **Create an innovative business plan**
  - **Business concept description, market strategy**
    - Describe the product/service
    - Describe the customer profile
    - What is your marketing strategy?
    - What is your business model?
  - **Return on investment, pricing, schedule**
    - What services would you provide and what are their cost to you
    - What do you charge for the services?
    - What is your return on investment - over what time period?
  - **Competition and other impediments**
    - Who is your competition?
    - What are your major risk areas?
  - **Operations and management plan**
    - What facilities/infrastructure needs?
    - Who is your management team and what is their experience?

Public-Private Partnerships

- Government procures what it needs from private industry instead of developing and operating the mission on its own
- Benefits to Government
  - Usually cheaper over the life cycle
  - Government does not have to conduct operations and maintain infrastructure
  - Ability to leverage resources with commercial sector
- Benefits to Industry
  - Gain expertise, helps develop new sector
  - Develop infrastructure and retire risk
  - Commercial success is critical to opening the space frontier

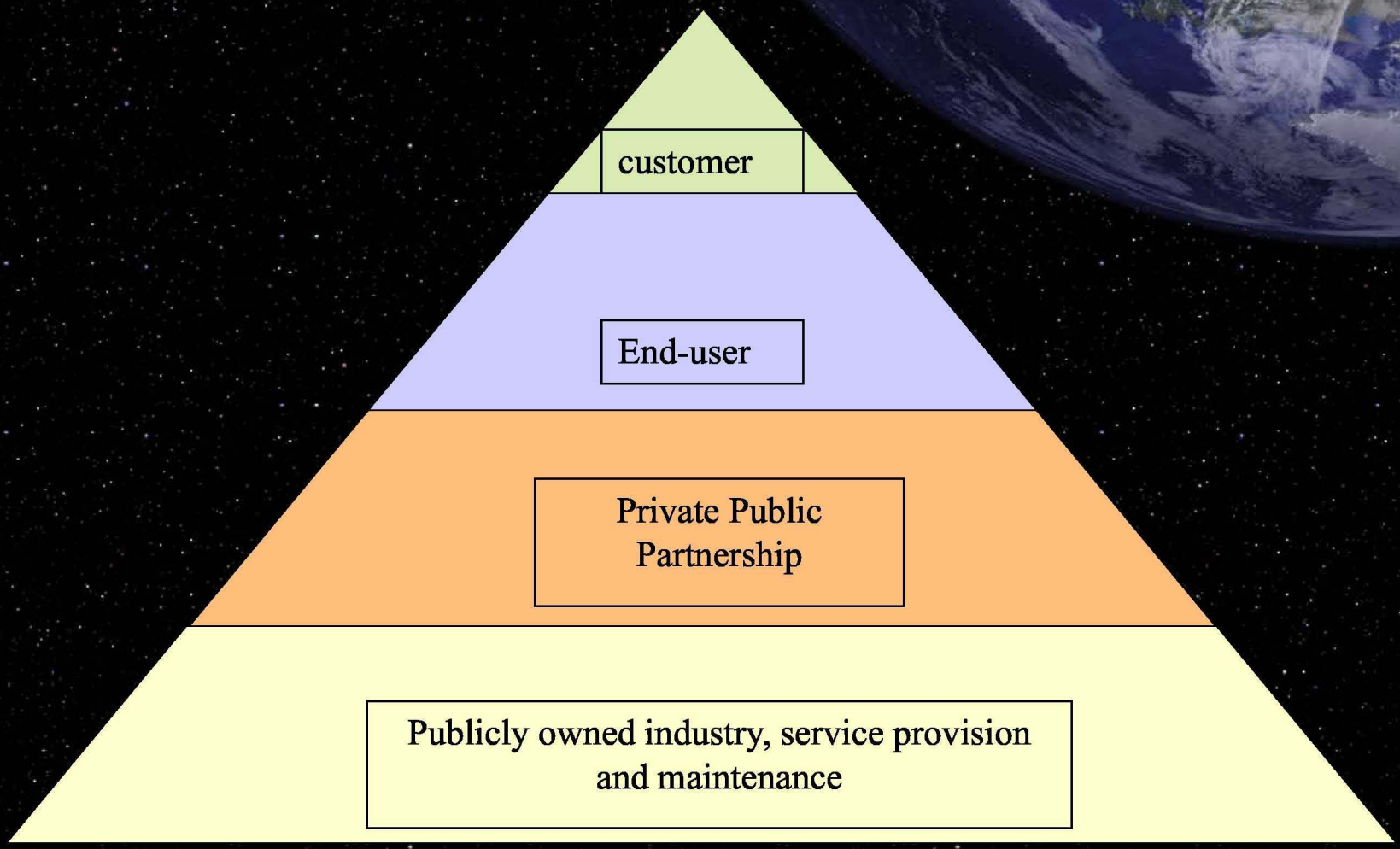
Partnership success…

- Have suitable and well-defined inputs and outputs to the partnership
- Workable agreement on sharing of burden (costs) and benefits
- Keep in mind strategic environment when choosing partners; from the agency perspective a company might simply want to undermine the position of another, rather than care about the success of the partnership
- Have clear organization structures in place that avoid conflict between and within partners
- The requirements of flexibility and safety nets make partnership success much dependent on culture and luck!

New Partnerships by default are used to

- Test the water…
- Private sector experience:
  - Equity-based partnerships (joint-ventures)
  - Non-equity partnerships (strategic alliances)
- If partnership succeeds then possible mergers & acquisitions, or spin-off companies follow
- Different model to public-private partnerships, as equity-based partnerships are more difficult to form, 'barter' arrangements are also quite common especially across agency-partnerships
- Usually program-specific partnerships are formed between government agencies and the private sector, which if successful lead to spin-off companies…

Role of Government and Implications for industry structures



Open Architecture: Infrastructure Open for Potential External Cooperation

- **Lander and ascent vehicle**
- **EVA system**
  - CEV and Initial Surface capability
  - Long duration surface suit
- **Power**
  - Basic power
  - Augmented
- **Habitation**
- **Mobility**
  - Basic rover
  - Pressurized rover
  - Other; mules, regolith moving, module unloading
- **Navigation and Communication**
  - Basic mission support
  - Augmented
  - High bandwidth
- **ISRU**
  - Characterization
  - Demos
  - Production

- **Robotic Missions**
  - LRO- Remote sensing and map development
  - Basic environmental data
  - Flight system validation (Descent and landing)
  - Lander
  - Small sats
  - Rovers
  - Instrumentation
  - Materials identification and characterization for ISRU
  - ISRU demonstration
  - ISRU Production
  - Parallel missions
- **Logistics Resupply**
- **Specific Capabilities**
  - Drills, scoops, sample handling, arms
  - Logistics rover
  - Instrumentation
  - Components
  - Sample return

** US/NASA Developed hardware

Lunar Commercialization

- **Lunar Commercialization complements national Lunar objectives**
  - **Early, small scale Lunar transportation enabled by private sector**
    - Commercial delivery system -- "FedEx Lunar"
  - **Near-term technology demonstrations on the Lunar surface**
    - Constellation technology risk reduction
  - **Early start to Lunar science campaign**
  - **Enable more commercial opportunities relative to the moon**
    - Commercial Lunar communications, navigation

Possible Lunar Commercialization Elements

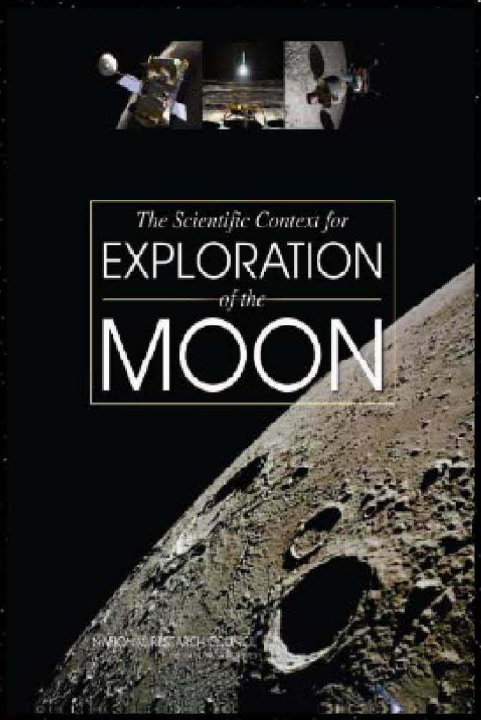
- Utilize emerging commercial capability to land payloads on the Moon
- Includes lunar data purchase and/or agency lunar instrument delivery
- Cost to agency that is less than a dedicated NASA robotic mission ($100M+ if conducted by Agency)
- Operations could begin in 2010 timeframe
- Small payloads ($100M or less)
- Frequent, multiple flights
- Commercially-leveraged: Open Competition for lunar transportation services
- Fixed price service
- Industry provides the “Fed-Ex” to the surface

Lunar Commercialization

- **Exploration Demand**
  - The Constellation Program Office has identified lunar data needs, of which a subset would require in-situ measurement
    - Dust characterization & mitigation
    - Landing site reconnaissance
    - Lunar model validation (tie to ground truth)
    - Local radiation measurement
    - Spacecraft charging evaluation
    - Regolith handling/site preparation
    - ISRU characterization and demonstration
    - Hydrogen form and location characterization
    - Lighting perspective (permanent low incidence at poles)
  - Technology demonstration
    - Communications (surface mobile comm)
    - Mechanisms (1/6G performance, dust impact on lifetime)
    - Materials (dust compatibility)
    - Thermal (surface influence, radiator dust exposure)
    - Navigation and guidance (Precision Landing)
    - Propulsion (system performance, plume interaction)
    - Mobility (traction, dust impact)
    - Power (Re-charging mobile robotic assets, fuel cell tech)
    - Avionics (Open architecture, Rad hard)
    - Cryo handling & storage (test demo)
    - ECLSS (water loop performance in 1/6g, dust filters)

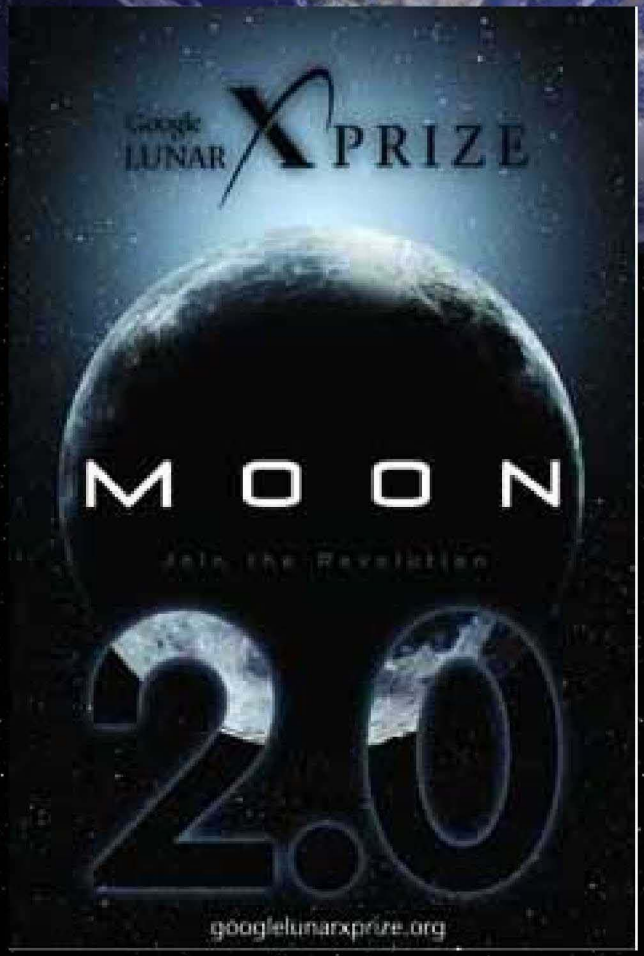
Lunar Commercialization

- Science Demand
  - Exploration of the South Pole-Aitken Basin remains a priority
  - Diversity of lunar samples is required for major advances
  - The Moon may provide a unique location for observation and study of Earth, near-Earth space, and the universe



Commercial Capability

- Market *Supply* side - transportation
  - Google Lunar X-Prize (GLXP): Astrobotic Tech, Odyssey Moon, others
- Individual instruments delivered near term at an estimated cost on order of $1M to $3M dollars per kilogram
- Launch is clearly a large expense, and a significant portion of the total mission costs
  - Falcon 9 / Minotaur V class
    - $25M - $35M
    - TLI: 465 kg (1025 lbm)
  - Possible to fly as secondaries
    - Secondary payload adapter (ESPA)
    - 180kg
    - ~$2M



Good Luck