

# RETURN TO THE LUNAR SURFACE

## C&N Commercial Opportunities & Strategy

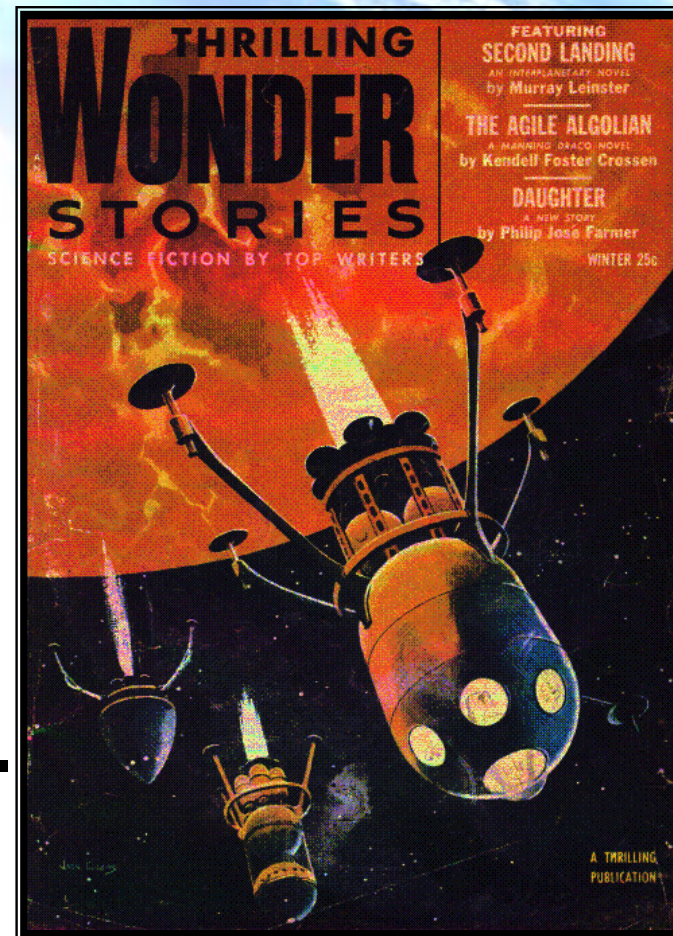
Lun-EX ; LunCommComm

Robert M. Kelso  
Manager, Commercial Space Development  
NASA-JSC, Commercial Crew/Cargo Program  
September 5, 2008

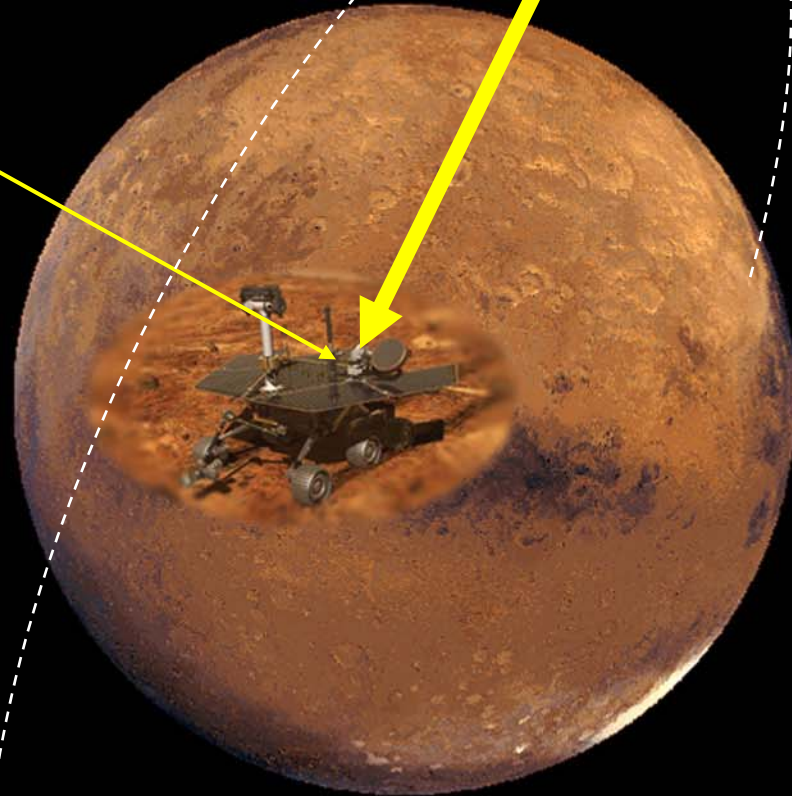
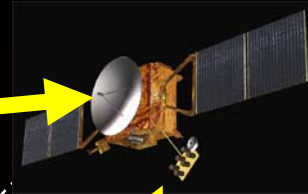
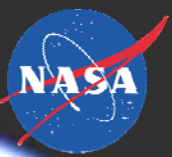


# Executive Overview

- **Growing interest in early missions to moon with small landers**
  - Science, technology validation / risk reduction
- **Growing interest in increased commercial/international involvement in NASA Vision.**
  - Commercial lunar payload delivery and data buy
  - Commercial lunar comm



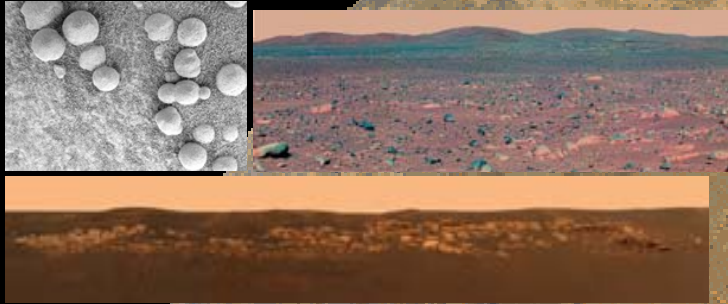
# Motivation for Relay Telecommunications



- **Direct-to-Earth link**
  - Constrained EIRP
  - Large comm path length
  - Low data rates, high energy cost
  - Limited to Earth in view
- **Telecommunications relay**
  - Short comm path length
  - High data rates (even with simple omni links), low energy cost
  - Contact at times when Earth is not in view
  - Connectivity is strong function of orbit



# Mars Exploration: Drivers on Telecommunications



*Increased Science Data Return*



*Energy Efficiency*



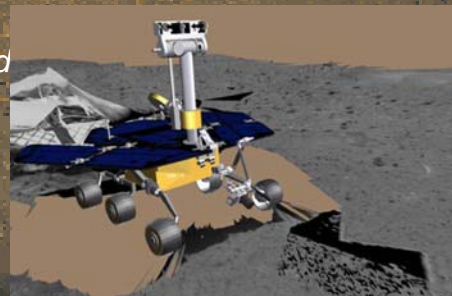
*Robust Capture of Critical Event Tracking and Telemetry*



*Public Engagement - Creating a Virtual Presence at Mars*

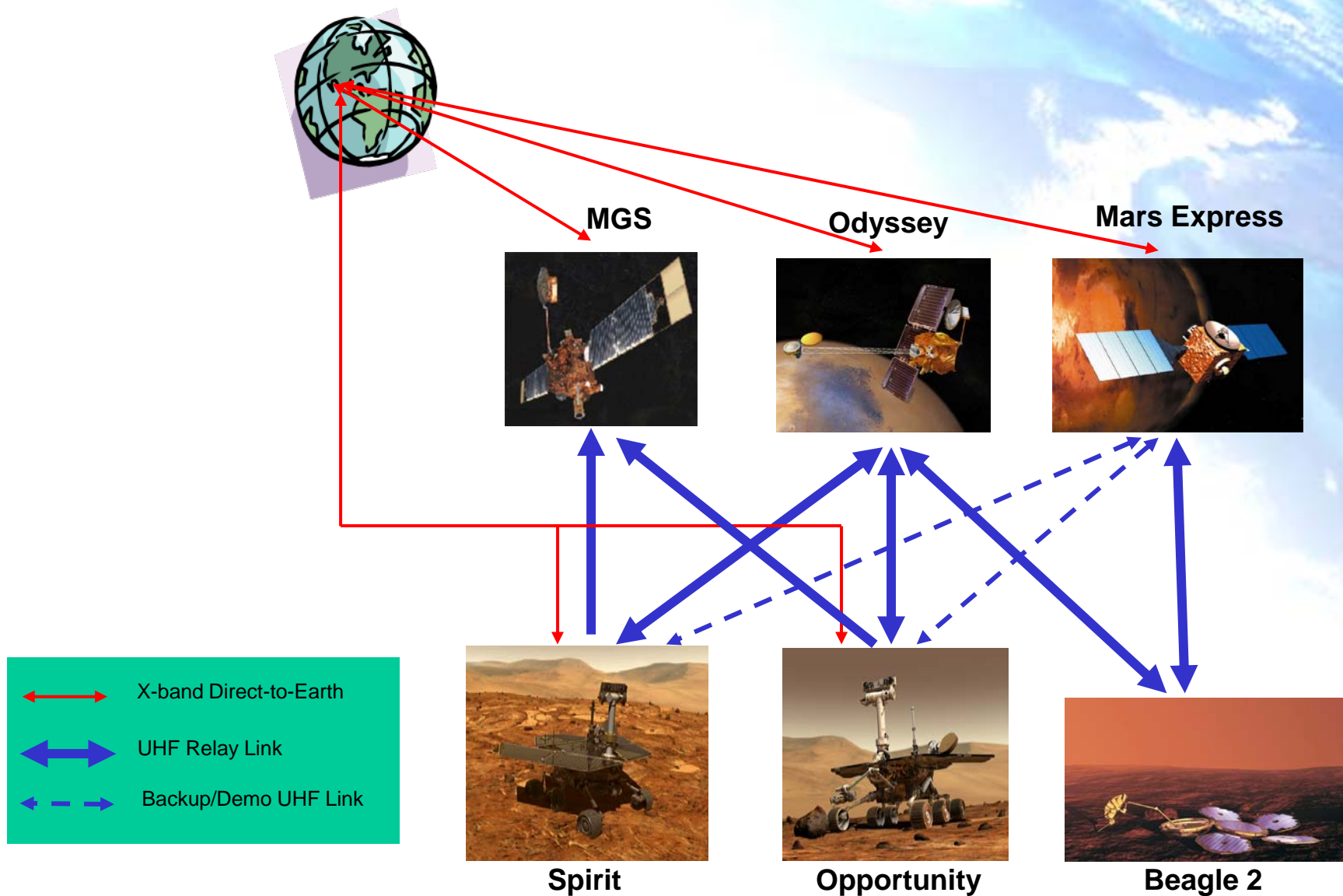


*Precision in situ Navigation and Positioning*



*Increased Comm Contact for Complex Surface Operations*

# 2003/2004 Mars Relay Operations





# Google Lunar X-Prize: Seeding the Market

The Google Lunar X PRIZE is a \$30 million international competition to safely land a robot on the surface of the Moon, travel 500 meters over the lunar surface, and send images and data back to the Earth. Teams must be at least 90% privately funded and must be registered to compete by December 31, 2010. The first team to land on the Moon and complete the mission objectives will be awarded \$20 million; the full first prize is available until December 31, 2012. After that date, the first prize will drop to \$15 million. The final deadline for winning the prize is December 31, 2014.



Odyssey Moon



Astrobotic



Team Italia



Micro Space



Mystery Team



FredNet



ARCA



LunaTrex



Quantum3



Chandah



Advaeros



STELLAR



JURBAN

## Preferred Partners:



*Moon 2.0: Join the Revolution*

COMMERCIAL CREW & CARGO

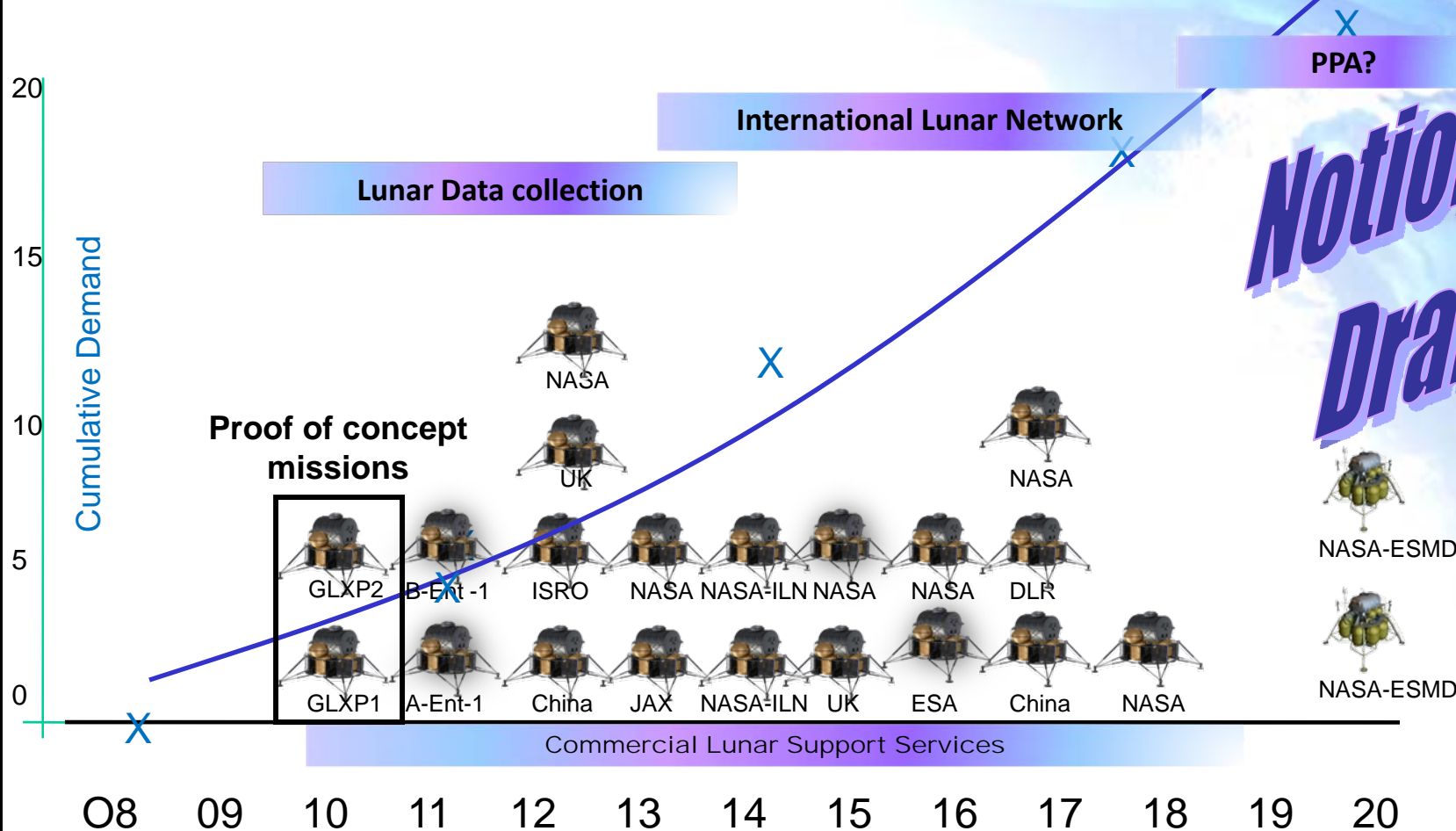




# Lunar Payload Service/Data Demand

Commercial + International + NASA (notional)

Entrepreneurial Missions Must Start Early to Capture Demand



Note: ENT missions not counted

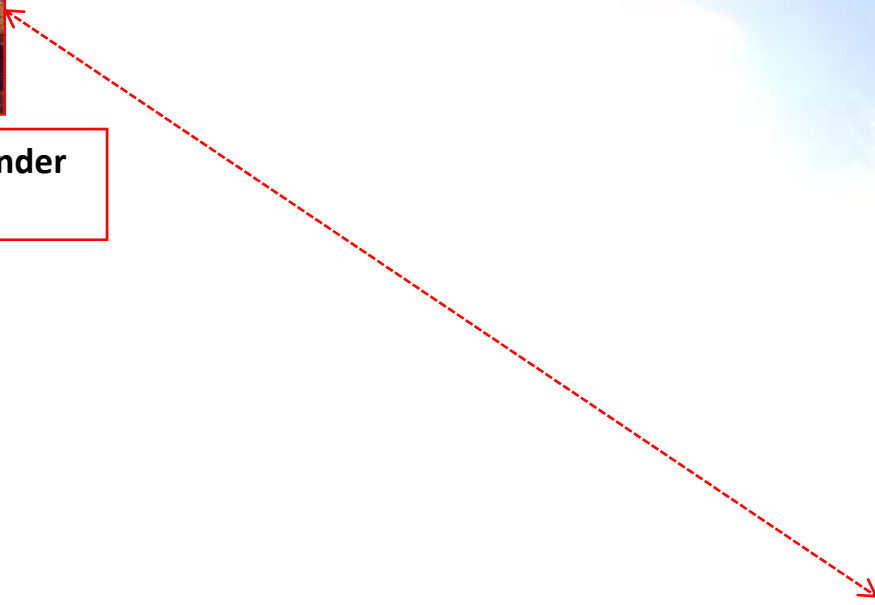
Cumulative Missions	2	4	8	10	12	14	16	19	20	20	22
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# C&N Need Lines Evolution: 2011



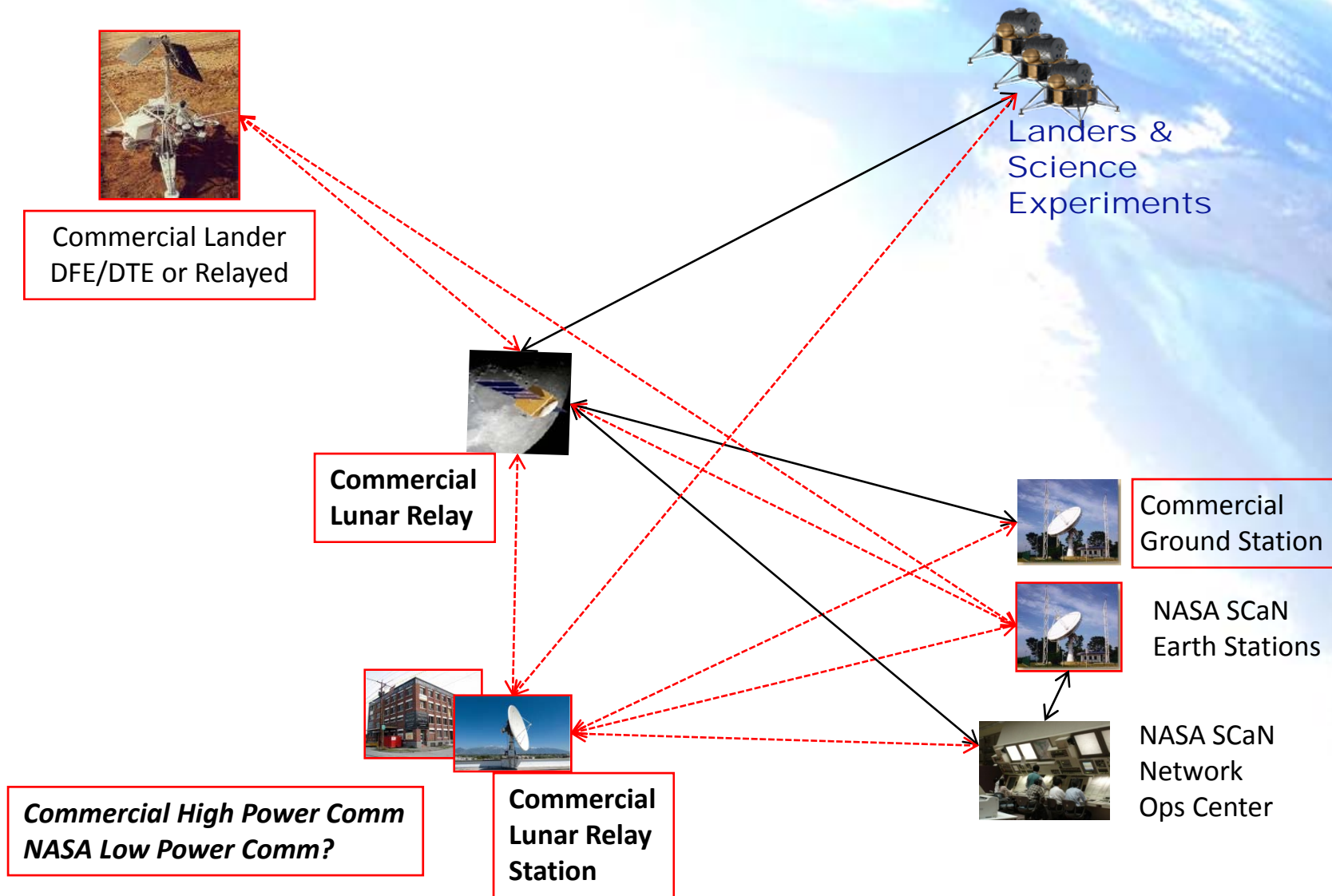
**Commercial Lander  
DFE/DTE**

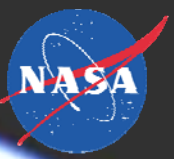


**Commercial Ground Station**



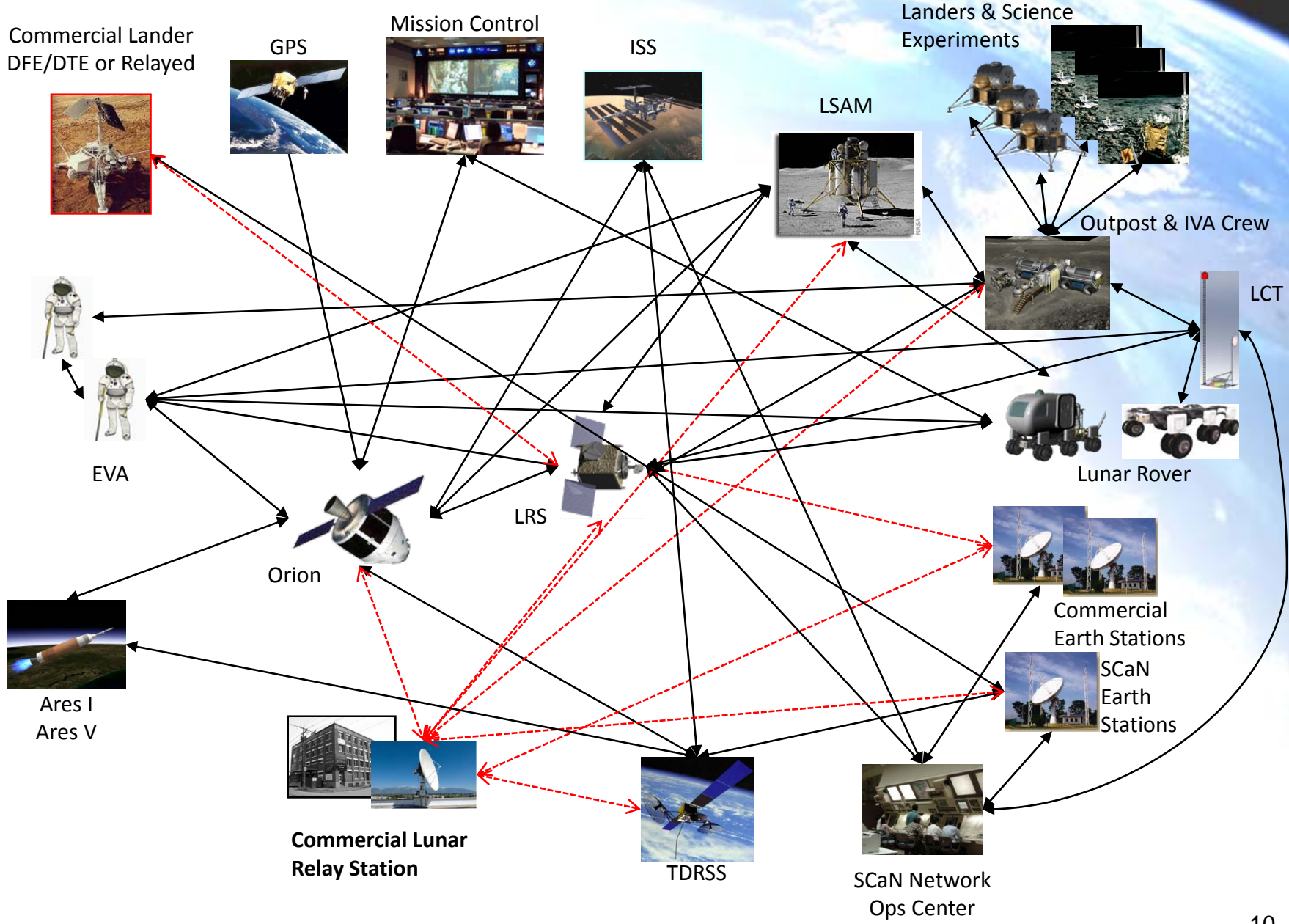
# C&N Need Lines Evolution: 2015

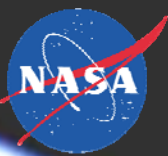




# C&N Need Lines Evolution: 2024

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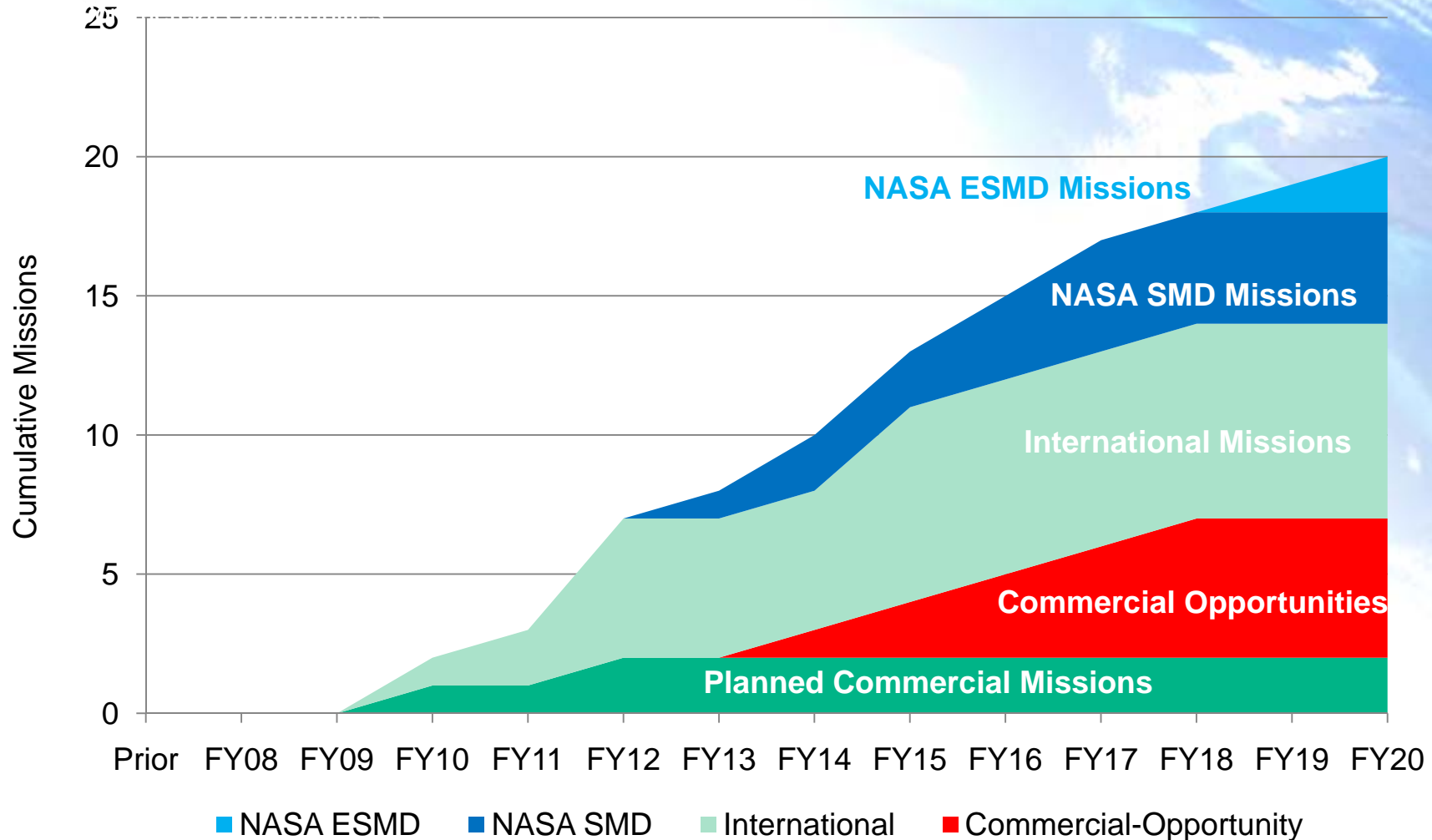




# Aggregate Lunar C&N Demand

**DRAFT**

**Entrepreneurial Missions Must Start Early to Capture Demand**







## “Food for thought....”

- What is government minimal essential comm if we assume a commercial lunar comm services?
  - 1. Trade study between lunar base, earth base, onboard, and crew.
  - 2. minimum capability to “remain” there vs min capability to “operate” there
    - STS-83 fuel cell loss resulting in early mission return
- Think “Right-to-Left” that includes a broad portfolio of lunar missions and comm services
  - MARS architecture → 2020 architecture → 2010
- Think “evolv-ability”
- Strategy for testing/demonstrations/risk-mitigation for NASA/commercial comm between 2010-2013.
- Where commercial-leveraging might apply (NASA seed funding for demonstrated capability leading to service)
- Relative to the commercial “lunar network”, think endpoint capability for services vs detailed system-level requirements
  - Define “what”..... not “how”

- **Lunar orbit**
  - **Conventional relay services, i.e., similar to Earth-orbiting**
  - **Extensions to NASA-provided “essential C&N”**
    - **More satellites – capacity, location**
    - **High rate services – especially HDTV**
    - **Secondary payloads**
    - **IP-routed services & network applications**
- **Lunar surface**
  - **WLAN & high rate services**
  - **Ties into services that ride on communications – entertainment, news, scientific support, historical recording**
- **Earth-based**
  - **Ground stations – augment / replace portions of DSN**
  - **Value-added services**
- **International collaboration – aiming for open, standards-based, commercially & internationally interoperable architecture**



# Next Steps

- **Complete integration of NASA's lunar "needs" :**
  - 2010-2013 flight testing/demo
  - Develop the time-phased, integrated "need-lines" list for 2010-2020
- **Assessment of industry interest (RFI) and market assessment**
- **Define "enabling strategy" - trade tree of options including pure government, pure commercial, pure international, & hybrids**
  - Characterize benefits, relative costs, & risks of each option
  - Consider "soft" factors: external politics, internal ability to manage, social factors



# Backup

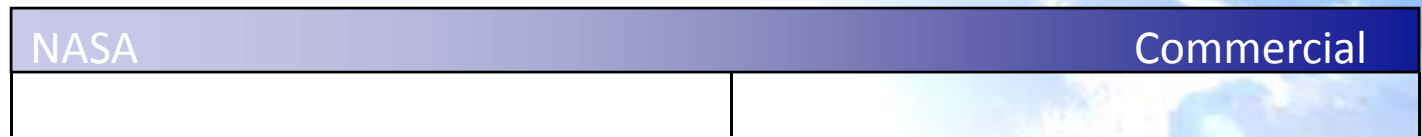


# Options for Commercial Participation in NASA Lunar Exploration Missions



COMMERCIAL CREW & CARGO

## Spectrum of Options for Commercial Participation



	NASA			Commercial
Programs	Apollo & ISS	Shuttle	ISS Cmrc'l Rsply Srvc	COTS
Communications	TDRSS	Polar Communications Network		NISN
Navigation	GPS	TD Navigation	Beacons	
Data	Command & Control		DTE	RELAY
MISSIONS	Surveyor & LRO <i>(NASA funded and managed)</i> ISS National Lab Science Earth Observations Sub-Orbital Observations Free Flyers	Lunar Exploration Science Campaign - Regular Small Missions to the Moon <i>(Hybrid model - NASA and commercial funding and management)</i>	Lunar C&N Lunar Micro-Landers Lunar Observatories • Lunar Sample Return (e.g. dust)	Lunar X-Prize <i>(Commercial funded and managed)</i> COTS: Space-X Odyssey MoonATK