

National Aeronautics and
Space Administration



EXPLORE SCIENCE

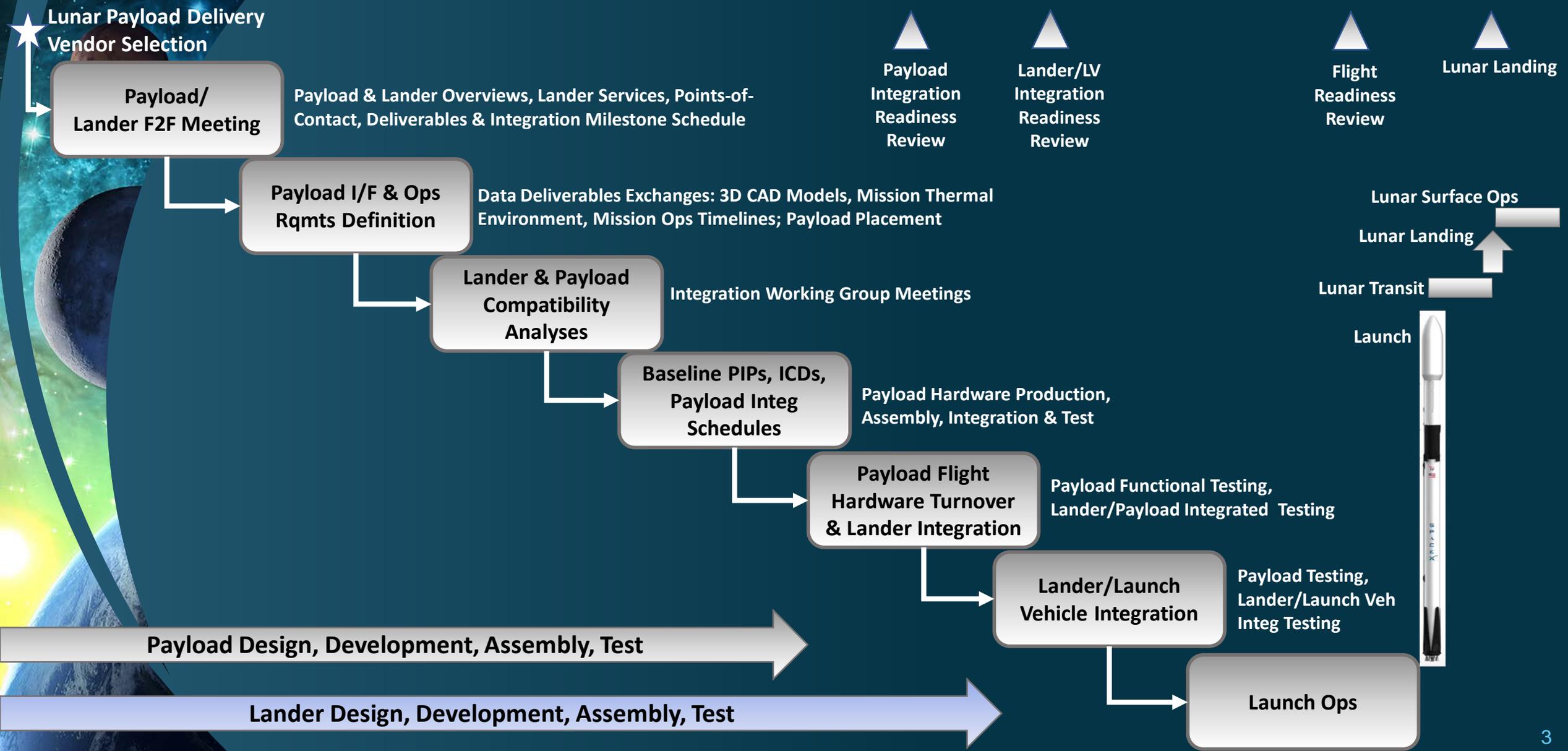
Commercial Lunar Payload Services (CLPS) Technical Integration

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Typical Payload Integration Lifecycle



Things to Consider

- The Mission *belongs* to the selected CLPS Task Order Vendor
 - They own and execute the mission; any payload requirements (including operational) must be specified up front
 - Each Vendor will have their own unique payload integration process
 - Vendors will specify payload deliverable “Need Dates” which may vary but typical near term deliverables will include 3D CAD, Mass, Thermal, & FEM Models; Power & Data Connector info; Command & Telemetry Definitions
 - The CLPS role is to ensure successful payload integration, lunar delivery, and payload science success
- With the exception of power and comm, provided by the lander, each payload is a self-sufficient unit.
- Shared Accommodations
 - In general, assume there will be multiple payloads or suites of instruments for each CLPS task order

More Things to Consider

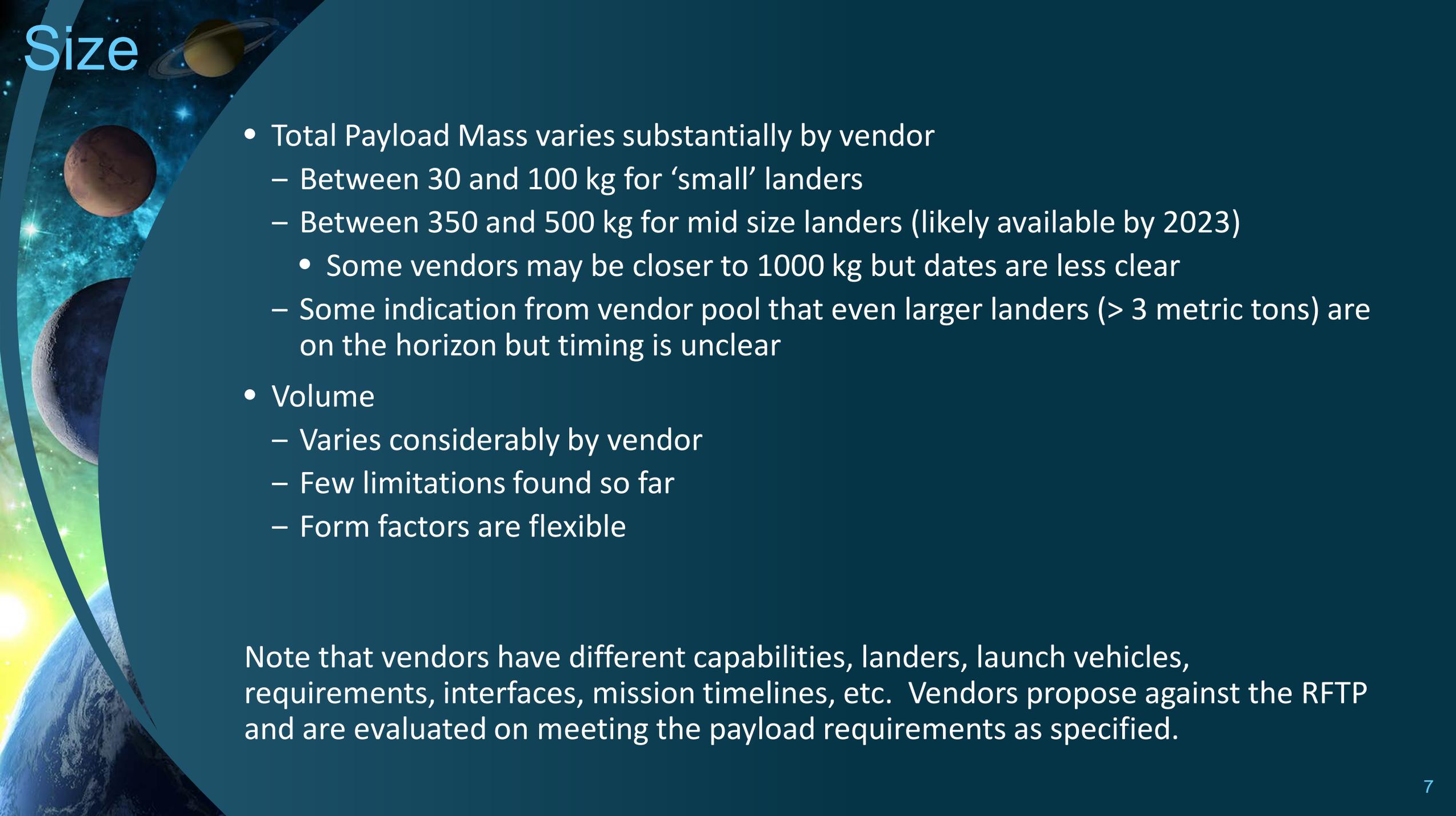
- Currently expecting that CLPS vendors will need 28 – 32 months to get payloads to the Moon once a task order has been awarded
 - Payload requirements have to be fully defined 30 – 34 months prior to landing
 - The maturity of the payload requirements is critical to getting good proposals
 - Hardware needs to be ready for flight integration 8 – 10 months prior to landing
 - Transit time is determined by the vendor (unless specified in RFTP), typically 5-10 days but as long as 3 months depending on the landing site and time of year
- Talking to Vendors
 - The ESSIO office will facilitate discussions between the CLPS providers and NASA mission directorates, other government agencies, and international contributions. Anybody is welcome to talk with the CLPS vendors about their individual lander capabilities.
 - Remember that the vendor for each CLPS task order is competitively selected in response to the RFTP.
 - Payloads that are designed to match a specific vendor's lander design may end up de-manifested if that vendor doesn't win the task order competition.

Payload Types

- CLPS can carry a wide variety of payloads
- The metrics we manage are mostly bound by:
 - Mass
 - Volume
 - Power*
 - Bandwidth/Data Volume*
- Other constraints
 - Field of View
 - Interference (of various types)
 - Deployment needs (if any)
 - Mission duration*
 - Payload Ops timeline
 - Payload Delivery (typically L-9 months)*
- All of the above must be defined before a vendor is tasked for the NASA payload lunar delivery

*Has the potential to significantly drive up the cost of the mission

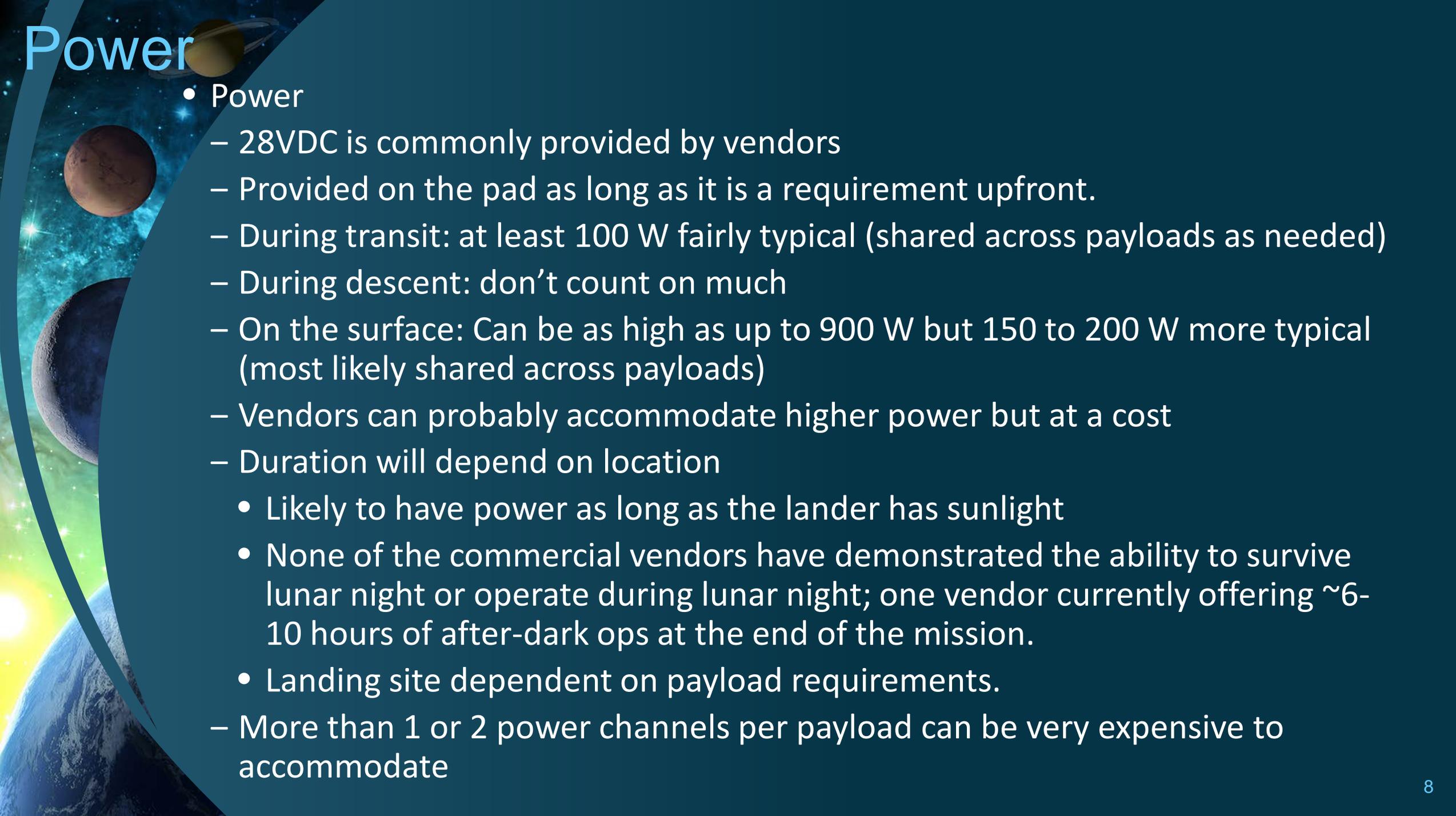
Size

The background of the slide is a dark blue space scene. On the left, a large, curved blue shape frames the text. In the background, there are several celestial bodies: a yellow planet with rings (Saturn) at the top, a reddish planet (Mars) in the middle, and a grey, cratered planet (the Moon) below it. The bottom left corner shows the blue and white horizon of the Earth. The overall aesthetic is futuristic and scientific.

- Total Payload Mass varies substantially by vendor
 - Between 30 and 100 kg for ‘small’ landers
 - Between 350 and 500 kg for mid size landers (likely available by 2023)
 - Some vendors may be closer to 1000 kg but dates are less clear
 - Some indication from vendor pool that even larger landers (> 3 metric tons) are on the horizon but timing is unclear
- Volume
 - Varies considerably by vendor
 - Few limitations found so far
 - Form factors are flexible

Note that vendors have different capabilities, landers, launch vehicles, requirements, interfaces, mission timelines, etc. Vendors propose against the RFTP and are evaluated on meeting the payload requirements as specified.

Power

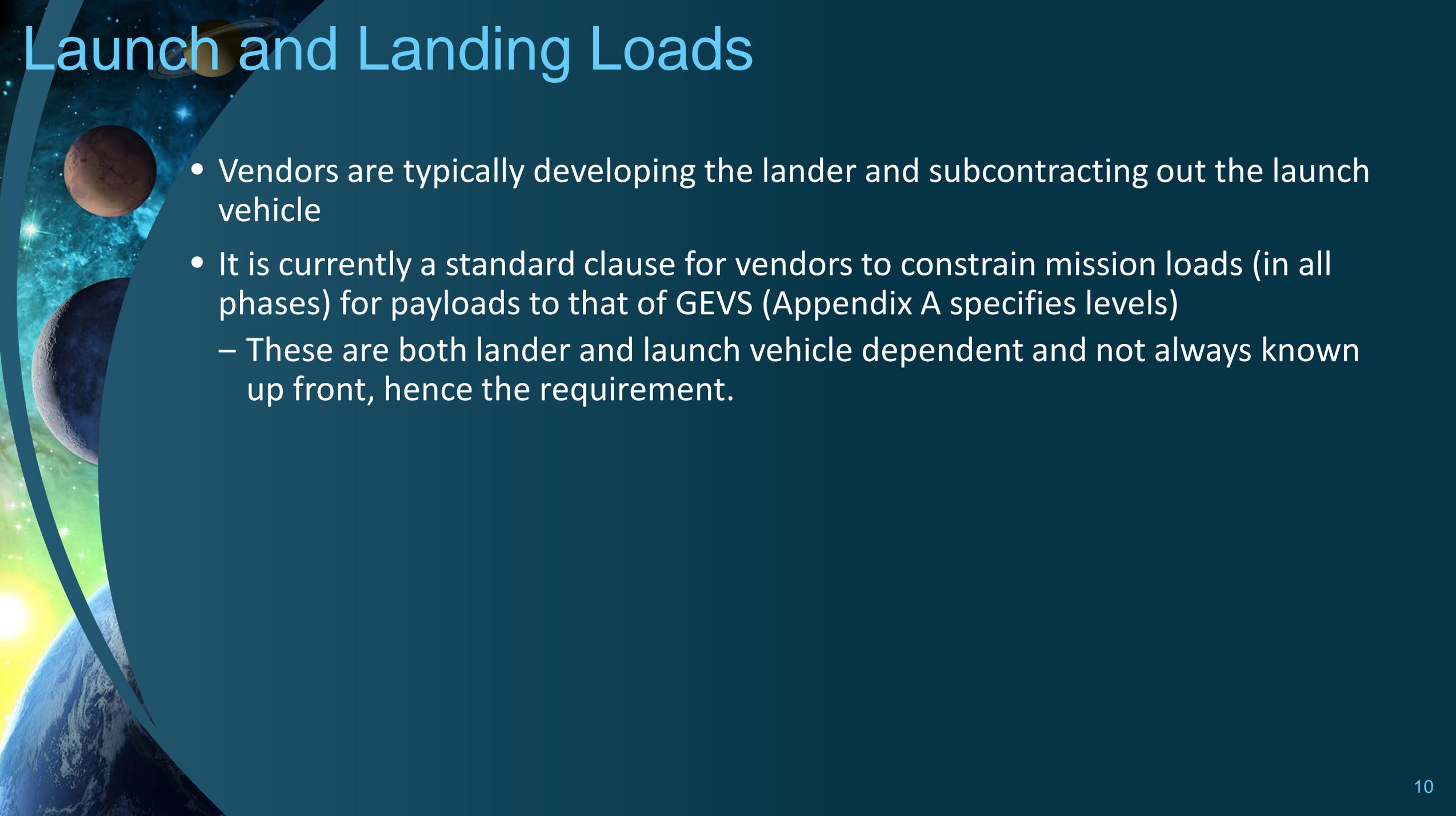


- Power
 - 28VDC is commonly provided by vendors
 - Provided on the pad as long as it is a requirement upfront.
 - During transit: at least 100 W fairly typical (shared across payloads as needed)
 - During descent: don't count on much
 - On the surface: Can be as high as up to 900 W but 150 to 200 W more typical (most likely shared across payloads)
 - Vendors can probably accommodate higher power but at a cost
 - Duration will depend on location
 - Likely to have power as long as the lander has sunlight
 - None of the commercial vendors have demonstrated the ability to survive lunar night or operate during lunar night; one vendor currently offering ~6-10 hours of after-dark ops at the end of the mission.
 - Landing site dependent on payload requirements.
 - More than 1 or 2 power channels per payload can be very expensive to accommodate

Communications

- Type
 - Wired RS-422
 - Wireless: 2.4 GHz IEEE 801.11n
- During transit
 - Expect lower rates; < 10 kilobits per second available for short durations (shared)
 - Unlikely to get extended periods of real time comm; store and dump is the likely model
- During descent
 - Don't count on any data transmission, but collecting and storing data may be possible if power is available
- On the surface
 - Most vendors are offering an average of ~ 250 -300 kilobytes per second shared downlink
 - May be able to get up to a few Megabytes per second of shared bandwidth for finite durations but may result in a higher cost
 - Duration
 - Will depend on landing location and line of sight to Earth
 - DSN access should not be assumed; Commercial ground availability and costs developing
 - Continuous comm is an unrealistic expectation and extended real time comm is likely to be very expensive

Launch and Landing Loads

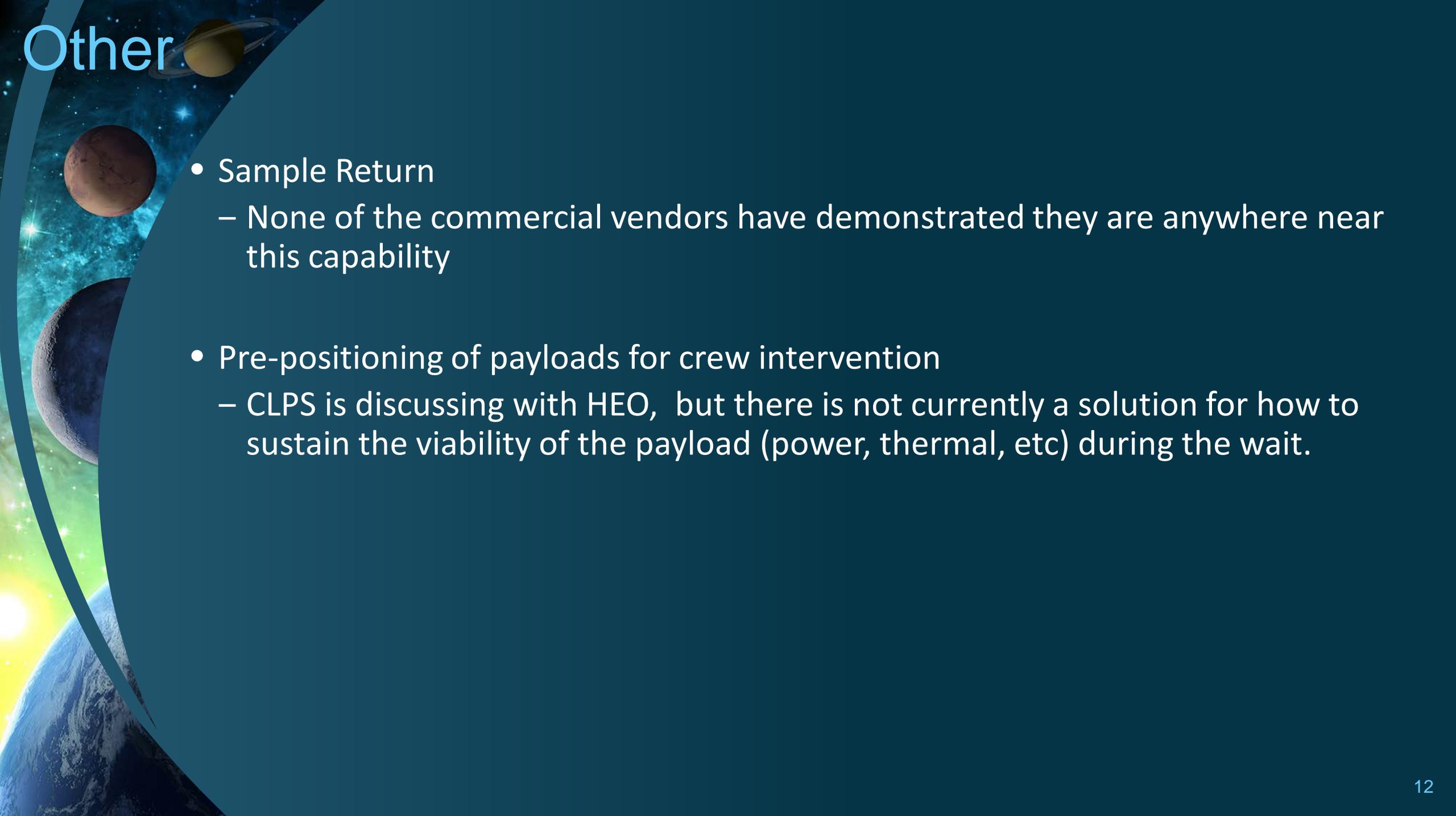
The background of the slide is a dark blue space-themed image. It features a large, bright yellow sun in the bottom left corner, partially obscured by the curved edge of the Earth. Several other celestial bodies are visible: a reddish planet (Mars) in the upper left, a greyish planet (Moon) in the middle left, and a ringed planet (Saturn) at the top. The background is filled with stars and a nebula-like glow.

- Vendors are typically developing the lander and subcontracting out the launch vehicle
- It is currently a standard clause for vendors to constrain mission loads (in all phases) for payloads to that of GEVS (Appendix A specifies levels)
 - These are both lander and launch vehicle dependent and not always known up front, hence the requirement.

Environmental Constraints

- Standard aerospace practices with particular specifications from the vendors will apply in the following areas:
 - EMI/EMC
 - Off-gassing
 - Safety/hazards
 - Cleanliness (vendors and payloads may have requirements)
 - Thermal Vac testing
 - Vibration testing (no fundamental frequency below 100 Hz)
- NASA payloads must meet NASA internal standards for planetary protection.
- Susceptibility to plume exposure must be evaluated by payloads and requirements established up front on any accommodations
- Payload developers are responsible for all engineering aspects of a self-sufficient payload ready to operate in the lunar environment (temperature, radiation etc.)

Other

The background of the slide is a dark blue space-themed image. It features a curved, semi-transparent blue shape on the left side. Within this shape, there are several celestial bodies: a yellow planet with rings (resembling Saturn) at the top, a reddish planet (resembling Mars) in the middle, and a grey, cratered planet (resembling the Moon) below it. The background also shows a bright yellow sun or star in the bottom left corner and a blue and green nebula or galaxy in the middle. The overall aesthetic is futuristic and space-oriented.

- Sample Return
 - None of the commercial vendors have demonstrated they are anywhere near this capability
- Pre-positioning of payloads for crew intervention
 - CLPS is discussing with HEO, but there is not currently a solution for how to sustain the viability of the payload (power, thermal, etc) during the wait.

Typical RFTP Payload Requirements

- Mass
- Dimensions
- Mechanical mounting/Orientation
 - Brackets/bolt hole pattern
 - Position relative to horizon
 - Height above surface
 - Obstruction free area for movement/other
- Field of View
 - Keep out zone
 - Sun exposure
- Thermal interface conductance
- Payload temperature range
- Operations
 - Description of function(s)/objectives
 - Phases/rough timeline of operation
 - Coordination/cooperation with other payloads
- Functional checkout requirements/phase
- Electrical
 - # Power channels, Watts/channel/phase/DC voltage supply
 - Data Channels
- Data
 - Number of channels
 - Connection (wired/wireless)
 - Connector pinouts for existing hardware
 - Type of wire communication (RS-422 standard)
 - Communication protocol/data format
 - Rates and timeline for commanding & downlink
 - Data volume for downlink
 - Phases and purpose of communication
 - Synchronization needs
 - Timestamp needs

A vibrant space-themed background featuring a large blue and yellow arc on the left side. The background is filled with various celestial bodies: a bright yellow sun in the lower left, a large blue and white Earth in the lower right, a dark blue Moon in the center, a ringed planet (Saturn) in the upper left, and a reddish planet (Mars) in the upper left. The sky is a mix of blue, green, and yellow, with numerous white stars and a blue nebula in the upper right.

Lessons Learned

- NASA is a critical player in establishing early commercial capability
- The vendor pool is both capable and robust but future market projections are very incomplete
- To create the right partnership between NASA and commercial entities requires both sides to adapt and make adjustments
 - NASA has a very hard time sticking to a set of requirements
 - NASA has to approach mission concepts in a different way when using commercial services
- Areas such as Mission Assurance and cross payload responsibilities need a lot more discussion
- The opportunity to fly to the Moon multiple times per year will have a significant impact on both Lunar science and human exploration



EXPLORE MOON_{to}MARS

MOON LIGHTS THE WAY

<https://www.nasa.gov/clps>

