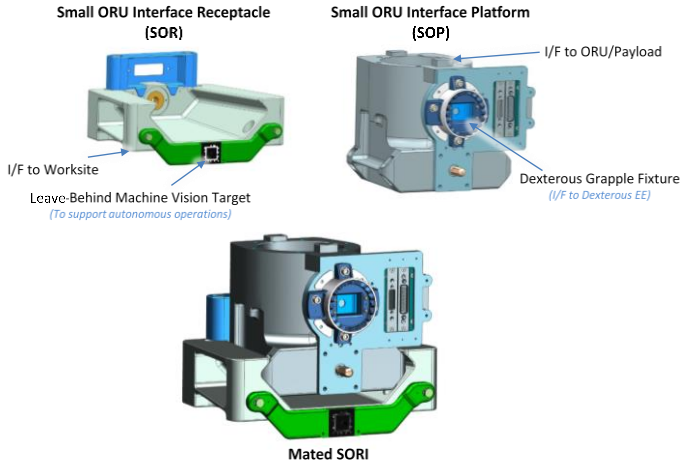
External Payload Interfaces

- **Gateway will adhere to the International Deep Space Interoperability Standards: https://www.internationaldeepspacestandards.com/**
  - Seven standards defined to date: Avionics, Communications, ECLSS, Power, Rendezvous, Robotics, and Thermal
    - Gateway needs to evaluate which will apply to external payloads, to be documented in the Interface Definitions Document (IDD)
  - Robotics Standard defines interfaces for external payloads
    - Specific implementations for each interface is defined

- **For external payloads, Gateway will likely implement:**
  - Small ORU Platform Interfaces
    - Wedge Mating Interface (WMI) / Small ORU Robotic Interface
    - Reduced Loads Wedge Mating Interface (RL-WMI)

- **External robotics will be utilized at the Gateway**
  - Dexterous Fixture Interfaces
    - Standard Dexterous Fixture
    - Dust Tolerant Dexterous Fixture



Natural Space Environments

Environment	LEO	GEO	Cis-Lunar
Solar Irradiance	Same	Same	Same
Neutral Atmosphere	Low Density; Satellite Drag; Removes particulates	None	None, though limited mechanisms for particulate removal
Atomic Oxygen	Material erosion and chemical effects	None	None
Plasma/Spacecraft Charging	Natural dense ionospheric plasma; ISS charging understood	High voltage spacecraft charging; commercial satellite experience	GEO, solar wind, Earth magnetotail, & lunar wake plasmas – controls TBD
Radiation	Trapped radiation (esp. South Atlantic Anomaly); GCRs Earth Shadow; Geomagnetic shield SPEs	High radiation environment; commercial satellite experience	No trapped radiation (outside radiation belts); No geomagnetic shielding of GCRs or SPEs
Orbital Debris	Significant	Bothersome	None (for now)
Meteoroid	Reduced due to Earth shielding	Bothersome	Significant
Thermal	Diurnal cycle insolation; Earth albedo effects	Near continuous insolation	Lunar albedo effects; High insolation
Gravity	Earth-dominated	Earth-dominated	Moon-dominated with Earth effects

Induced Space Environments

Environment	LEO	GEO	Cis-Lunar
Molecular Deposition/ Material Outgassing	Significant ISS contributors/risk factors to sensitive surface performance degradation	Some commercial satellite issues	No significant difference with LEO except the induced thermal environment; Controls TBD
Thruster Plumes Impingement	ISS experience - both visiting vehicle and ISS thruster plume impingement not a significant contributor to sensitive surface performance degradation from contamination and erosion	Very limited commercial satellite issues	No significant difference with LEO; Definition and Controls TBD
Ion Engine Artificial Ionosphere	Plasma Conductor Unit (PCU) on orbit because of spacecraft charging risks presented by natural dense ionospheric region plasma and high speed flight through the geomagnetic field	Very limited commercial satellite issues	Possible operating in an artificial ionosphere-like plasma whenever the Hall thrusters are operating; Extent and Controls TBD

Environments – References

1) Cis-lunar Natural and Induced Space Flight Environments
   Dr. Steve Koontz/JSC/ES411 & Dr. Rob Suggs/MSFC/EV44 DSG&T-DP-59,
   7 March 2018
2) SLS-SPEC-159 Cross-Program Design Specification for Natural Environments (DSNE);
   https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20170008140.pdf
3) Spacecraft charging measurements in geosynchronous orbit and the outer radiation belt: Possible impacts on Orion/Gateway flights: EUS/CPL-Orion first docking maneuver; Dr. Steve Koontz
4) Space Flight Ionizing Radiation Environments; Dr. Steve Koontz; June 29, 2017
5) Spacecraft Charging: Hazard Causes, Hazard Effects, and Hazard Controls; Dr. Steve Koontz

DRAFT Utilization Requirements and Utilization Assumptions for Gateway

- **The Gateway will provide TBD mass allocation (pressurized and unpressurized) for payloads/utilization.**
- **The Gateway shall reserve a minimum of 4 kW power for utilization use.**
- **The Gateway shall provide mechanical, power, and data interfaces to support external equipment and payloads in accordance with the interoperability standards.**
- **The Gateway shall provide external grapple fixture and SORI locations for Utilization, external stowage and Systems use.**
- **The Gateway shall integrate Small ORU Interfaces (SORIs).**
  - The number of SORIs available vary by element.
- **Gateway provides command and control for utilization payloads, including centralized command loads (e.g. instrument timing, cubesat deployment, etc.).**
- **The Gateway will limit quasi-steady acceleration, vibratory acceleration, and transient accelerations. Levels TBD.**
- **TBR: Gateway shall provide TTE network resources in each element (switches, routers, cables etc.) to support Utilization operations with an effective combined minimum rate of 1Gbps.**
- **Wireless C&DH will be available for external payloads.**
- **The Gateway will provide a science airlock to support utilization.**
- **The Gateway shall protect far side of the moon as a unique radio science location.**

Interface-Provided Resources for External Payloads

Resource	WMI / SORI
Mass (on-orbit maximum)	~250 kg (TBC)
Power	Max 500 W (TBC)*
Data	TTE, 1 Gbps effective
Thermal	Payload provided, passively cooled
Communications	Up to 100 Mbps downlink, near continuous communications available
Operational volume	1 m x 1 m x 1 m (TBC)

Other resources to be defined as concept matures

* Power is available to the payload during transfer. However, during mate/demate operations, the payload should nominally be powered off, (no hot mate/demate). Nominally this should take approximately 20 minutes but may take up to 8 hours.

Interface Definition Document (IDD)

- **The Gateway IDD will be developed at a TBD date along with payload-specific Interface Control Documents (ICDs)**

- **Loads – launch and docking loads**
  - Internally launched payloads would be likely launched in a bag in protected “foam”, likely no hard mount during launch in the logistics element
  - Will need to determine design driver for externally launched payloads (additional consideration for payloads with deployable appendages)
  - Specific loads will be defined in the IDD

Integration and Operations

- **Integration – TBD**
- **Operations – TBR**
  - External payloads may be transported externally or transported internally and transferred to an external location
    - For internally transported payloads, see science airlock details on next slide
  - External robotics can relocate payloads, once external robotics have been delivered to Gateway
    - Prior to delivery of external robotics, external payloads would remain in place on logistics module or element
  - No EVA interaction is assumed for payloads
  - Uplink/downlink available for payloads ~24/7
  - Distributed payload monitoring and control for payload operators