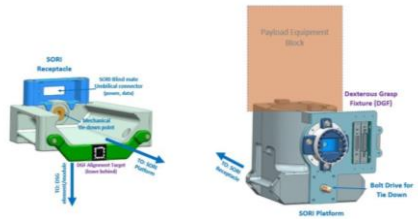
External Payload Interfaces

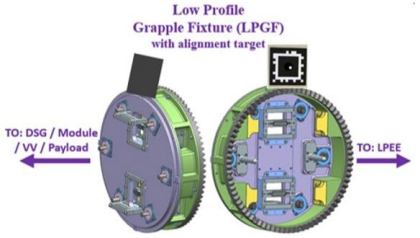
- **Gateway will adhere to the International Deep Space Interoperability Standards: https://www.internationaldeepspacestandards.com/**
  - Seven standards defined to date: Avionics, Communications, ECLSS, Power, Rendezvous, Robotics, and Thermal
    - Gateway needs to evaluate which will apply to external 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 utilize external robotics**
  - Provided by the Canadian Space Agency
  - Low Profile Grapple Fixtures, and Dextrous Grapple Fixtures
  - Small ORU Robotics Interfaces
    - Launch Variant, and Reduced Loads Orbital Variant
  - CSA has published a related Request for Proposal (RFP) with details:

    https://buyandsell.gc.ca/procurement-data/tender-notice/PW-19-00871935
  - Below is a requirement document published as part of this RFP:

    ftp://ftp.asc-csa.gc.ca/users/geri/pub/CSA-GERI-RD-0001%20Rev%20B%20-%20GERI%20Mission%20Requirements%20Document.pdf



Small ORU Robotics Interface (SORI)



Low Profile Grapple Fixture (LPGF)

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

Select Utilization Requirements/Assumptions for Gateway

- The Gateway shall have a minimum of 1,000 kg on-orbit mass allocated for utilization, for each crewed Gateway mission
- The Gateway shall reserve a minimum of 4 kW power for utilization use
- The Gateway shall provide power, data, video, structural support and thermal services, as applicable, to external robotically compatible equipment, during all phases of operation
- The Gateway shall provide external robotically compatible attachment locations that provide services for ORUs, systems, and payloads during all ORU/payload life-cycle phases
- The Gateway shall transfer samples and external hardware from free-flying vehicles and payloads to the Gateway interior for return to Earth
- The Gateway shall allocate a minimum of 5.15 Tbits/day (644 GB/day) for utilization use
- The Gateway shall provide internal and external wireless communications
- The Gateway shall protect far side of the moon as a unique radio science location

Interface-Provided Resources for External Payloads

Resource	SORI
Mass (on-orbit maximum)	~250 kg (TBC)
Power	Max 500 W*
Data	TTE
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 Gateway Utilization Interface Requirements Document (IRD)

Integration and Operations

- **Integration**
  - Gateway phase 1 is not budgeted to ‘put science in a box’ – payloads must come plug-in ready
  - Goal for early utilization is to keep the process and documentation simple, with a small utilization team assigned to work with other Program Office expertise
  - Goal is to capture a significant portion of payload data and requirements into a single document, authored and book-managed by the utilization team with PD support
  - Plan to utilize common training, mission planning and execution tools for systems and payload operations

- **Operations**
  - Distributed payload monitoring and control for payload operators
  - Uplink/downlink could theoretically be available for payloads ~24/7, but agreements for providing comm are still in work
  - External robotics can relocate payloads, once external robotics have been delivered to Gateway in Phase 2
    - Prior to delivery of external robotics, external payloads would remain in place on logistics module or element
    - External payload transfer to/from inside Gateway may be provided later via a science airlock – incorporation of such an airlock is under consideration
  - No EVA interaction is assumed for payloads