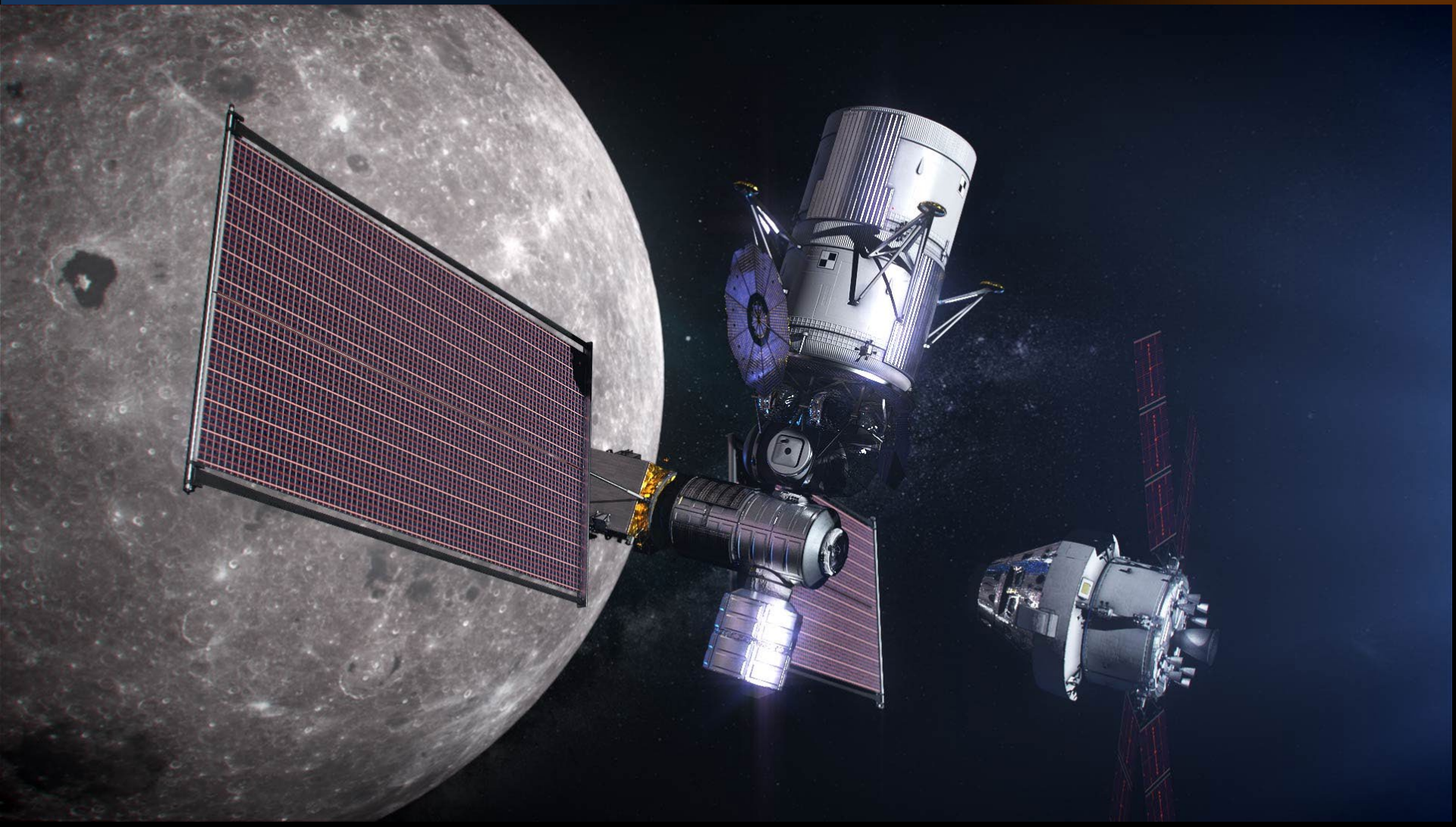
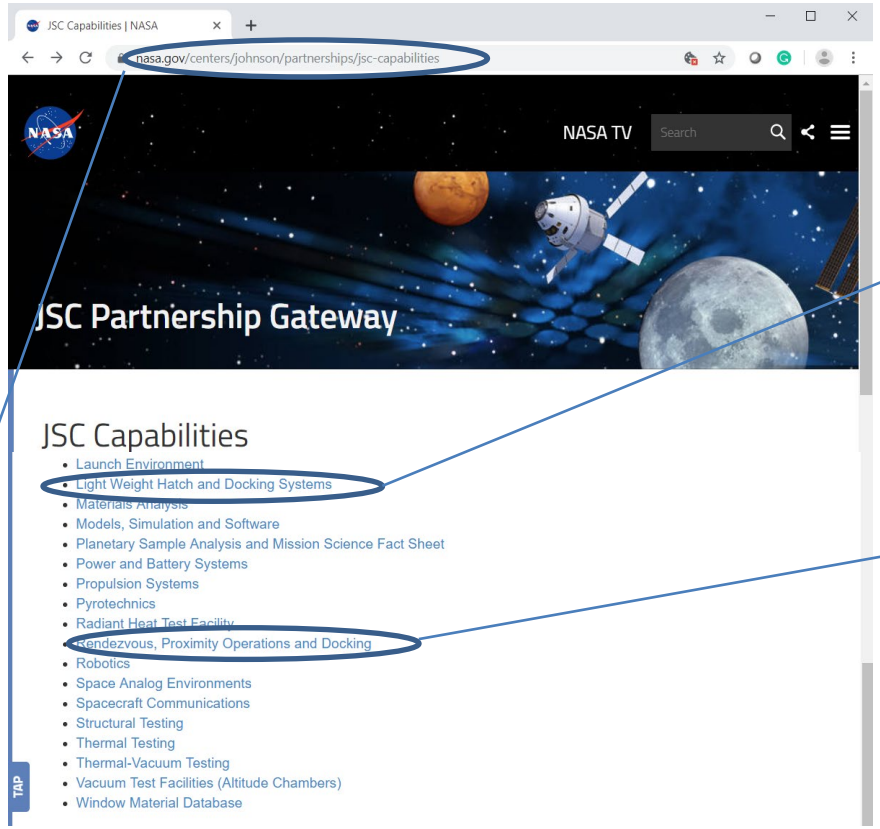
JSC Docking Systems Partnering Opportunities

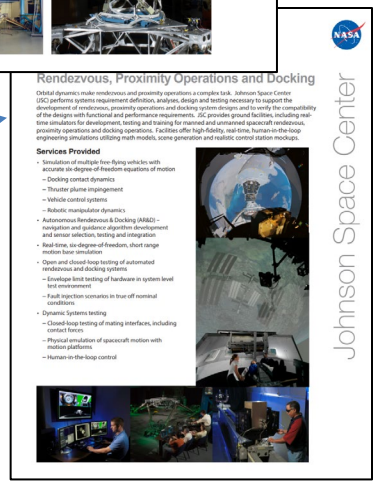


James Lewis 8/21/2019

JSC Engineering Capabilities

- Johnson Space Center is the out-of-this-world leader in ***development and testing of systems for human-rated rendezvous, proximity operations, and docking*** (RPOD) for meeting space functional and performance requirements

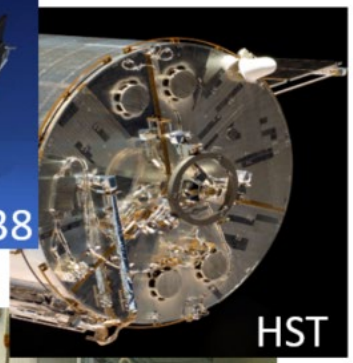


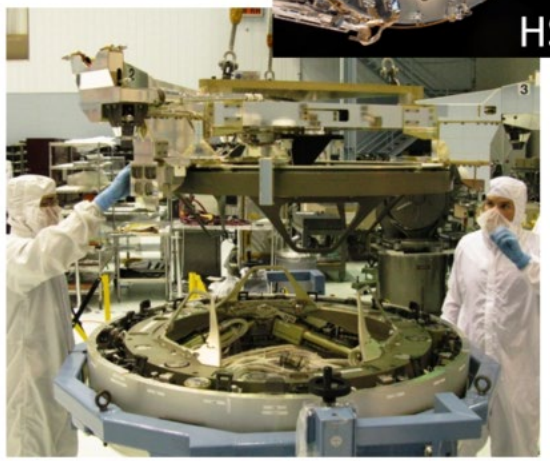


https://www.nasa.gov/centers/johnson/partnerships/jsc-capabilities

JSC Capability

- NASA recognizes that
  - ***RPOD systems and components are very long lead items*** and that limited vendors/sourcing on current pressurized docking system production lines will be a challenge for Vendors competing for contracts in the US efforts to commercialize Lunar orbit and Lunar surface access.
  - Unpressurized mechanism/interfaces required to "integrate" the HLS vehicle accommodating engine bells, abort scenarios, and reusability doesn't exist today.





- JSC Engineering and its Support Contractor Jacobs, have been preparing this year to ***provide extensive access and "reach back"*** to the significant expertise and capabilities resulting from over 60 years* of US space flight in the form of ***in-line partnering, tailored support, and/or turn-key products***.

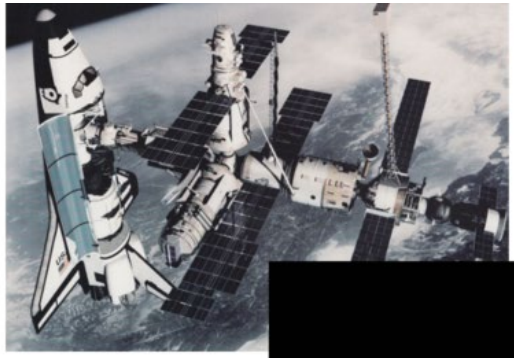
*Agena, Apollo, ASTP, Shuttle-MIR/ISS, X-38, HST, LIDS, Constellation, Orion, ISS

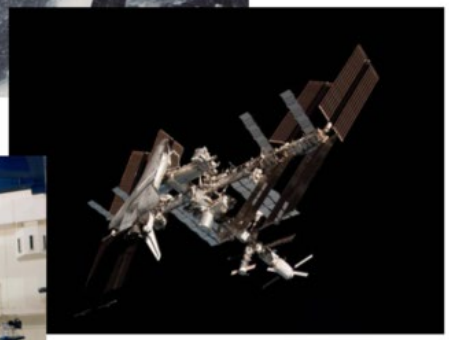
JSC Relevant Experience

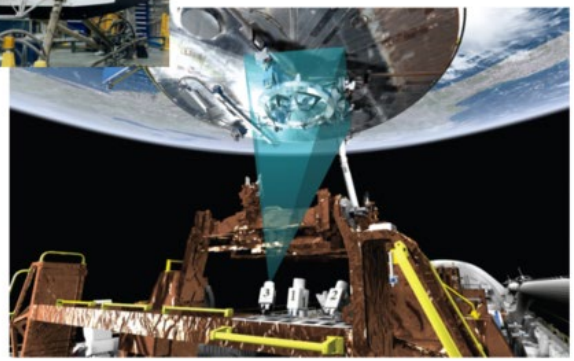
	Engineering Dev/Design	Fabrication and Production	Testing and Verification Including Modeling	Integration into Host Vehicle
Agena/Apollo/ASTP	X	X	X	X
MIR	X		X	
Shuttle	X		X	X
ISS			X	X
LIDS/X-38	X	X	X	X
LIDS/HST	X	X	X	X
NDSB0/Orion-Cx	X	X	X	X
ATLAS (adapter)-Cx	X	X	X	X
Space-X/CCP			X	X
CST-100/CCP			X	X
NDSB1			X	X
NDSB2				X
Orion (incl. hatches)	X	X	X	X
Gateway			X	X
IDSS/GDSS, RPO Stds	X		X	

JSC Relevant Experience

- Shuttle / MIR
  - Working with RSA/Energia , APAS mechanical and Avionics redesign performed to meet NASA performance requirements
  - APAS integration into Space Shuttle
  - Certification for Shuttle MIR and including in depth capture performance assessments / docking techniques
- Shuttle / ISS
  - Working with RSA/Energia continued evolution of APAS for Shuttle/ISS implementation
  - Integration for APAS systems onto ISS and Space Shuttle
  - Certification for ISS LEO requirements
- Design/Dev of low Impact docking system (LIDS)
  - design started during x38 development effort
  - selected design for Constellation program
  - design transferred to ISS / Boeing, NDSB0
  - hard mate system is NASA design, soft capture replaced by Boeing soft capture system NDSB1
- Hubble space Telescope
  - Passive LIDS docking system built and installed on HST for purpose of deorbit

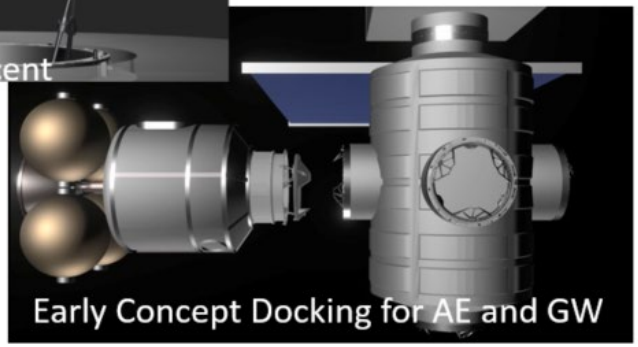






JSC BOM24 Assessment

- NASA design and analysis efforts have validated ***that lightest possible Lunar Ascent vehicle*** is achieved by the incorporation of a ***passive docking interface*** on AE.
  - Gateway AE Docking port is a Passive Docking Interface
  - Active to Active adapter allows Passive on AE
- NASA design and analysis efforts have produced an attachment concept which ***leverages common proven docking components*** to support ***docking of descent element vehicle to the ascent element vehicle to transfer element vehicle.***
- NASA JSC Engineering along with our partner Jacobs Engineering through our HLS DAC2 work and ongoing project planning activities are ***confident these critical BOM24 docking systems and adapter are feasible***.



JSC Engineering has extensive experience and has been preparing for our BOM24 Docking needs

JSC BOM24 Products/Deliverables*

- ✓ DDT&E of a new IDSS/GDSS compatible docking system
  - Based on NDSB1 hard mate system with a new soft capture system, including avionics control system
  - Integrated design support to enable direct integration of a passive docking interface on the Ascent Veh.
  - Integration activities with NG for HALO supporting control & power of active Docking system on the adapter
- ✓ GW-HLS Docking Adapter optimized for volume and mass (including docking aids)
- ✓ Loads analysis and integration
  - Docking dynamics models and simulations for the system correlated to 6 DOF contact testing
- ✓ DDT&E for new docking system supporting AE to DE to TE docking
- ✓ Rendezvous and proximity requirement definition, analyses, simulation, design and testing including
  - Navigation and guidance algorithm development and sensor selection, testing, and integration
  - Open and closed-loop testing of automated rendezvous and docking systems

*Not a comprehensive list of potential products/deliverables; also tailoring is negotiable

JSC Engineering stands ready to partner and/or collaborate with HLS commercial companies for docking development and integration activities.

JSC Docking Systems Partnering Opportunities

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