Proposed Europa Lander Descent Stage Overview

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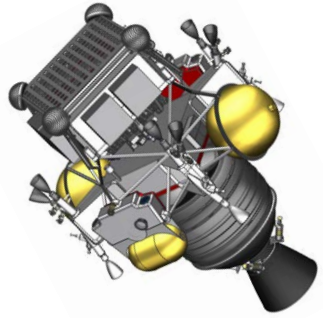
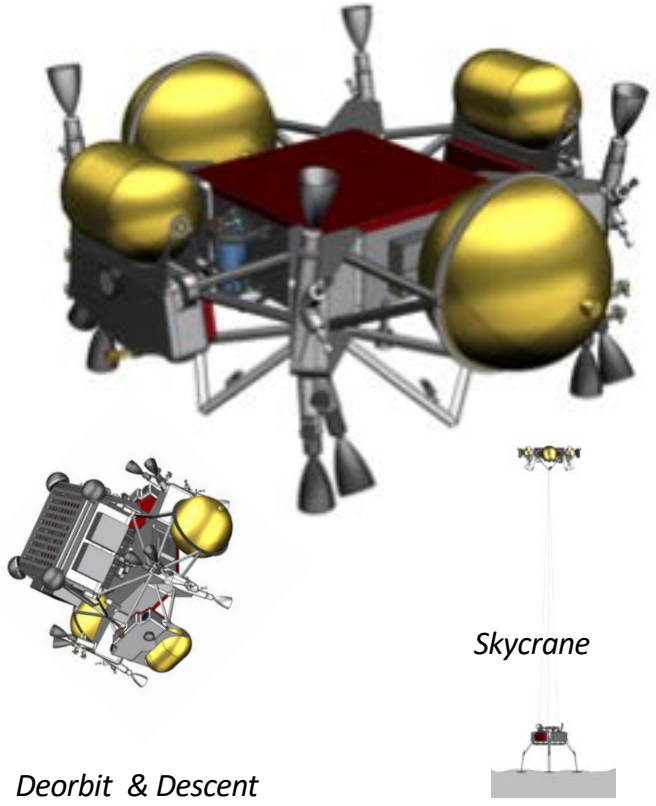
Descent Stage Concept

- The Descent Stage (DS) is conceptually the DDL functional element in the flight system
  - DS would perform all sensing, processing, and commanding from CS separation thru flyaway

- Architectural considerations:
  - 'self-contained' DDL machine
  - no science accommodation
  - tolerant to interruption
  - planetary protection
  - central location in DOV stack
  - operate in multiple configurations:
    - DOV - Coast / DeOrbit
    - PDV - Descent
    - SkyCrane - Landing
    - DS only – Flyaway



Coast



Deorbit & Descent

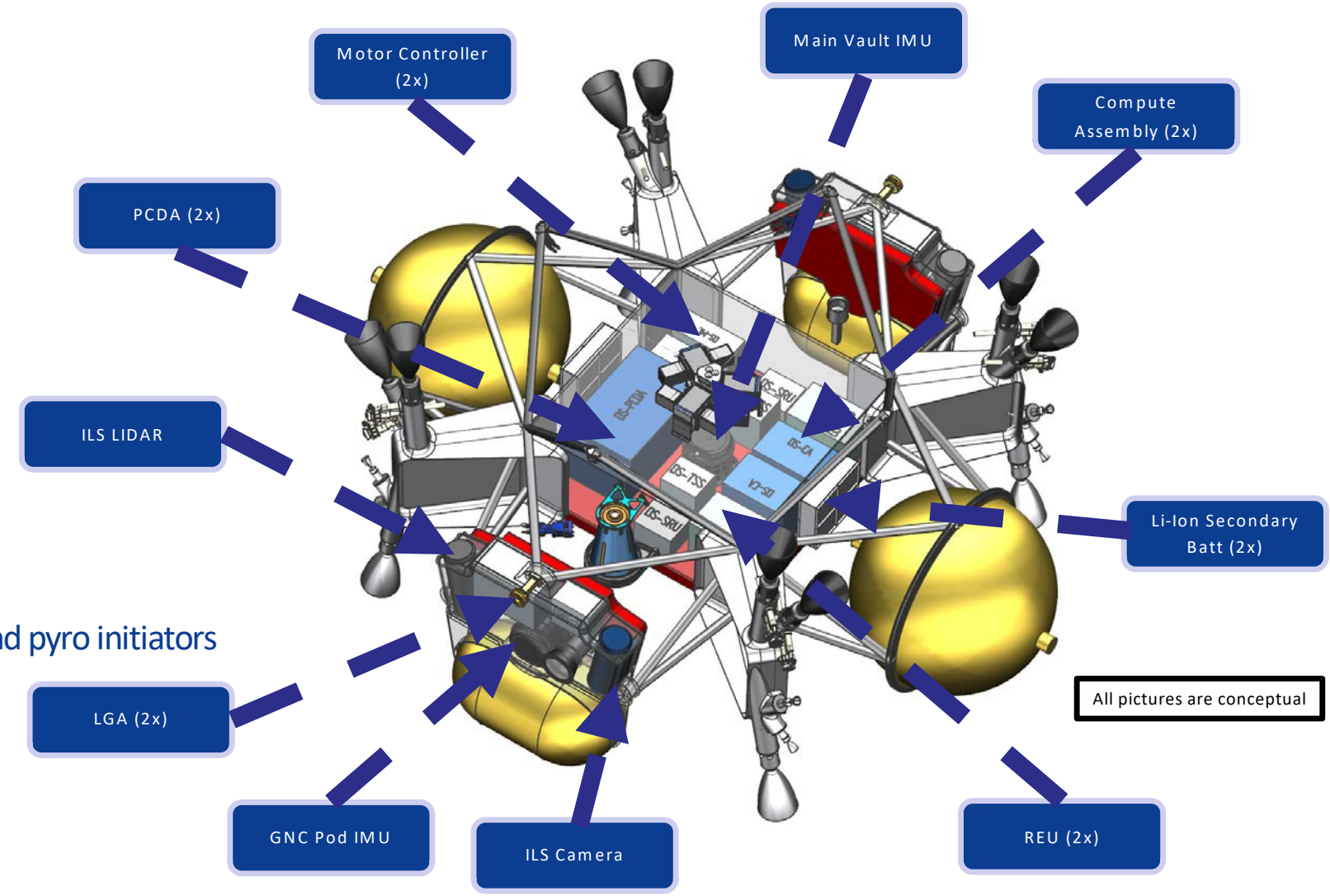
Skycrane

Flyaway

All pictures are conceptual

Proposed Descent Stage : the “Brains”

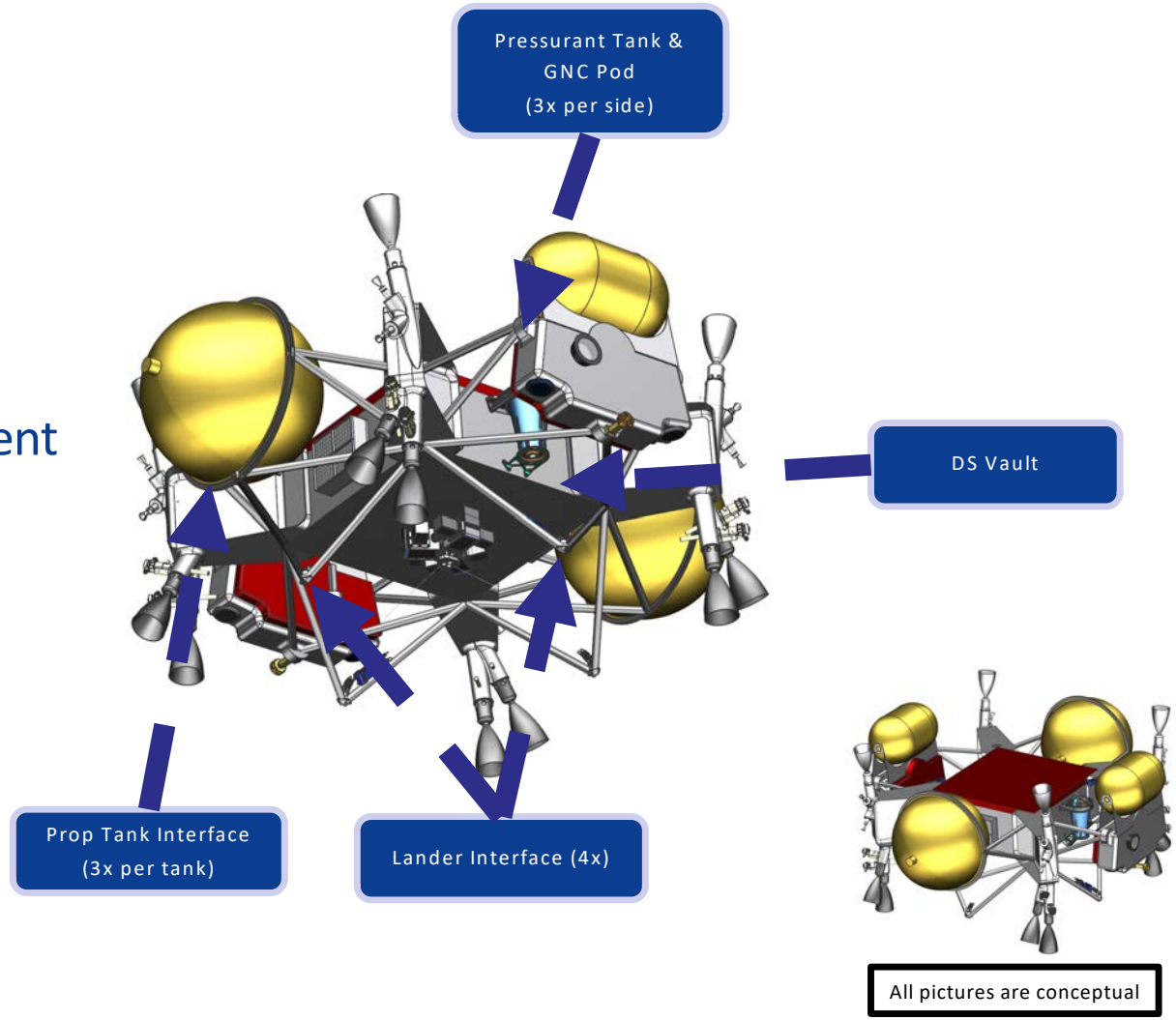
- Dual String Avionics:
  - DS Compute Assembly (2x)
  - DS REU (2x)
  - DS Motor Controller (2x)
  - IMU
- DDL GNC Pods (2x):
  - IMU
  - ILS Cameras
  - LIDAR
  - Star Tracker
- Power:
  - High power secondary Li-ion battery
    - Similar to Mars Helicopter
  - Power drivers are motor controller and pyro initiators
- Telecom:
  - Two LGA’s provide ~omni coverage
  - Tones only DDL Comm
  - Radio/Amp on lander (not shown)



Proposed Descent Stage: the “Bones”

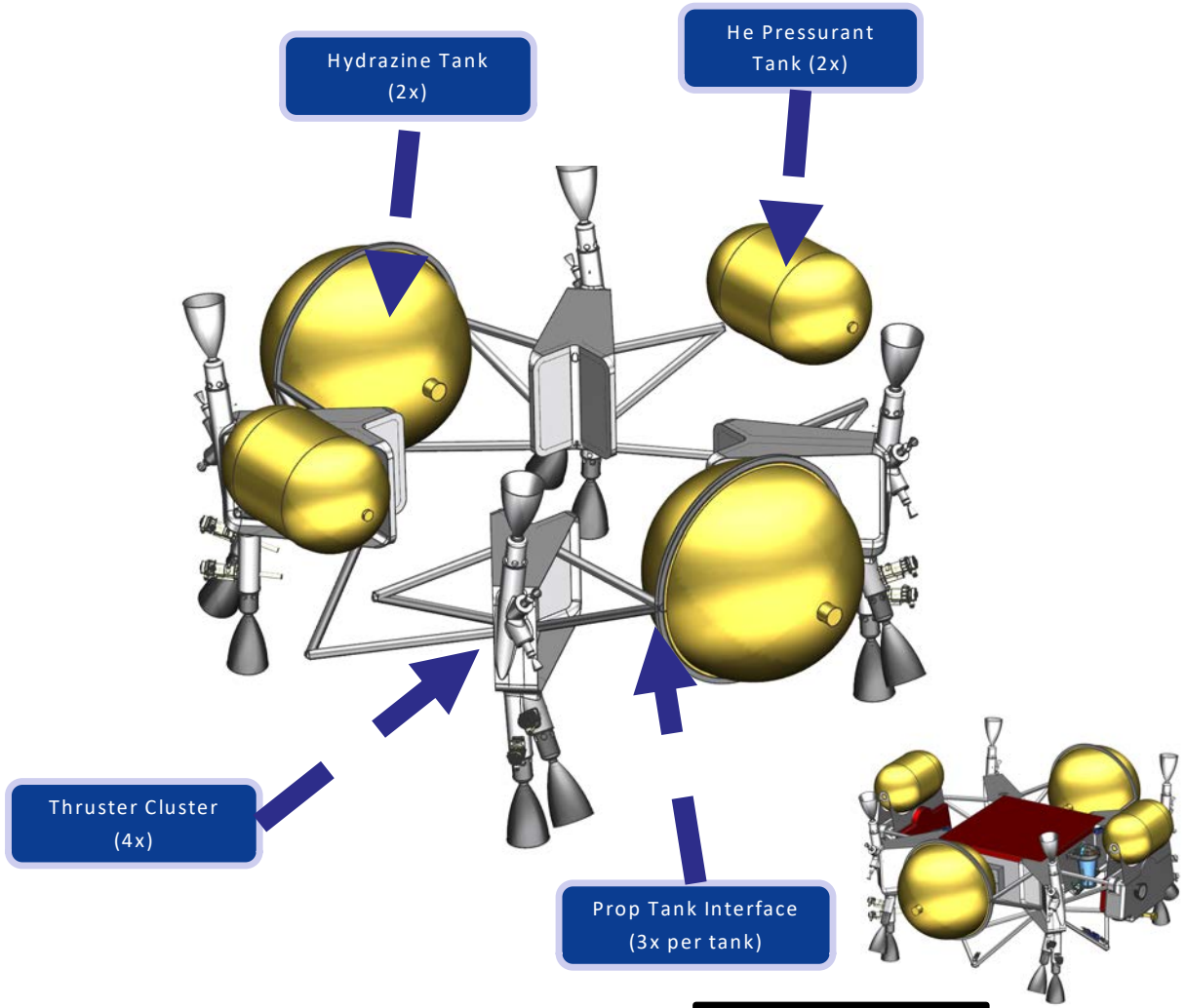
- Core structure would take advantage of thick vault walls (8.5 mm) driven by radiation environment
  - >20 hz primary structure
  - Primary load path thru DS

- Secondary structure would interface to adjacent FS assemblies and DS hardware
  - 4 point interfaces to DOS / Lander
  - Interfaces to sensors and tanks
  - >20 hz mounting stiffness



Proposed Descent Stage : the “Muscle”

- Propulsion sized to accommodate required T/W during DDL
- Multiple engine sets divided by function:
  - Thrust Vector Control (TVC) – 4x MR-104G (800N)
    - Used for ”periapsis drop maneuver” after separation and to manipulate SRM thrust vector
  - Descent Engines (DE) – 8x MR-104G (800N)
    - Primary engines for Powered Approach and Landing
    - MSL style throttle valves for descent engines
  - Attitude Control Thrusters (ACS) – 4x MR-106 (22N)
    - Used for attitude control primarily during Coast
- Custom propellant and helium tanks to accommodate fuel requirements



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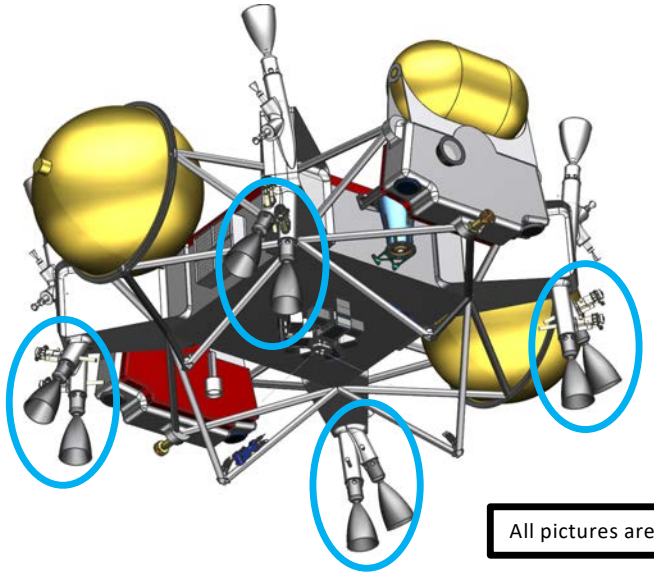
Proposed Descent Stage : the "Muscle"

Proposed Descent Engine (DE) configuration similar to MSL:

- 4x MR-104 engines – canted 5° (not used after lander sep)
  - Maintain High Thrust to weight through powered approach
- 4x MR-104 engines – canted 30°
  - Preserves plume-free zone along y-axis
- 800N max thrust per engine
- MSL style throttle valve adapted for MR-104s

DE Performance Drivers	Notional Requirement
T/W_{max} @ PA_{start}	>2.5
T/W_{max} @ TD_{minus}*	>1.2
T/W_{min} @ TD_{plus}*	<0.8
Att. Control @ PA_{start}	>50 °/s^2
Att. Control @ SC_{start}*	>50 °/s^2



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MR-104

http://www.rocket.com/propulsion-systems/monopropellant-rockets

Proposed Descent Stage : the “Muscle”

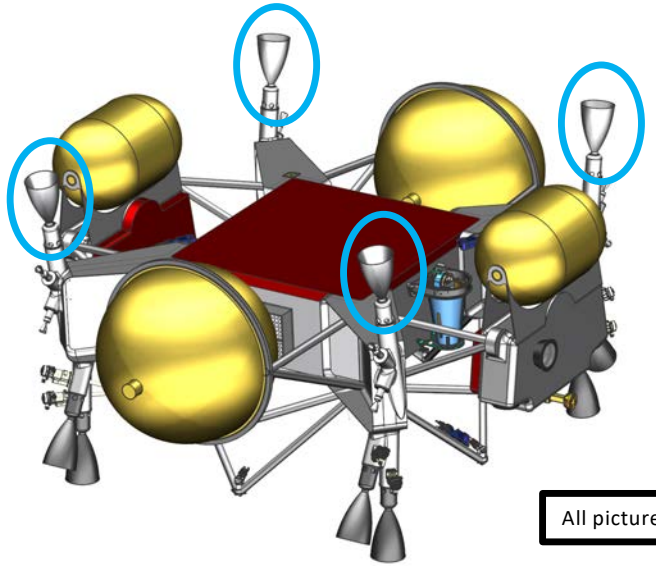
Proposed TVC Engine Configuration:

- 4x MR-104 engines
- 800N max thrust per engine
- Pulsed valve

Proposed ACS Engine Configuration

- 8x MR-106 engines
- 22N max thrust per engine
- Pulsed Valve

ACS Performance Drivers	Notional Requirement
Deadbanding Fuel Consumption in Coast	< 1 kg
DOV Max Slew Duration	< 120 sec
PDV Slew Rate from Min Torque Bit^ (for imaging)	> [1] °/s



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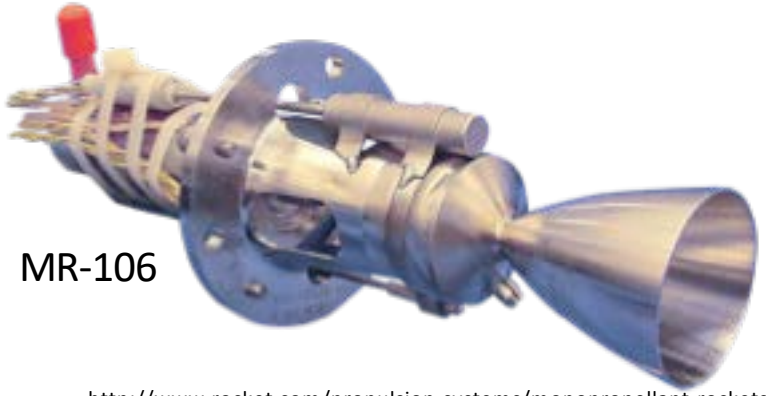

MR-106

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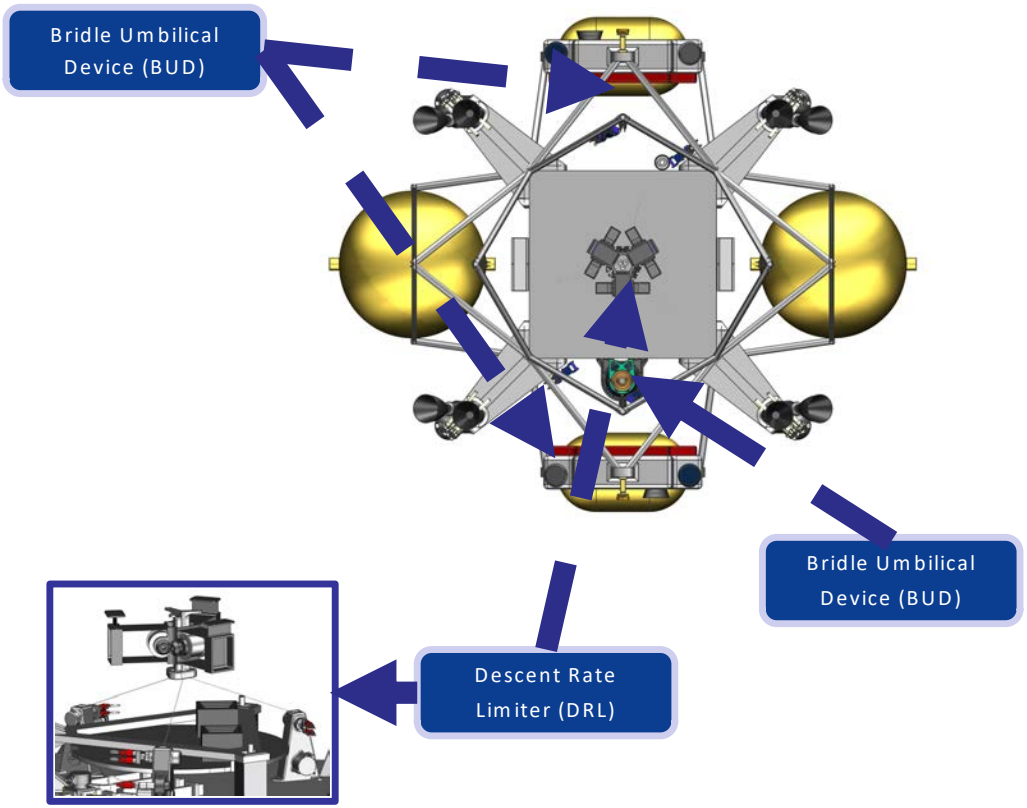
Proposed Descent Stage: mechanisms

- Separation hardware would have significant flight heritage

- DRL and BUD hardware design concepts:
  - DRL and BUD must be at least 10m long to accommodate skycrane
  - DRL concept incorporates lessons learned from MSL development
  - BUD concept is copy of MSL
    - Other options are being investigated

- TSS hardware – several concepts under study:
  - Mass/volume reserved as shown
  - Maintaining flexibility to accommodate baseline once established



Backup