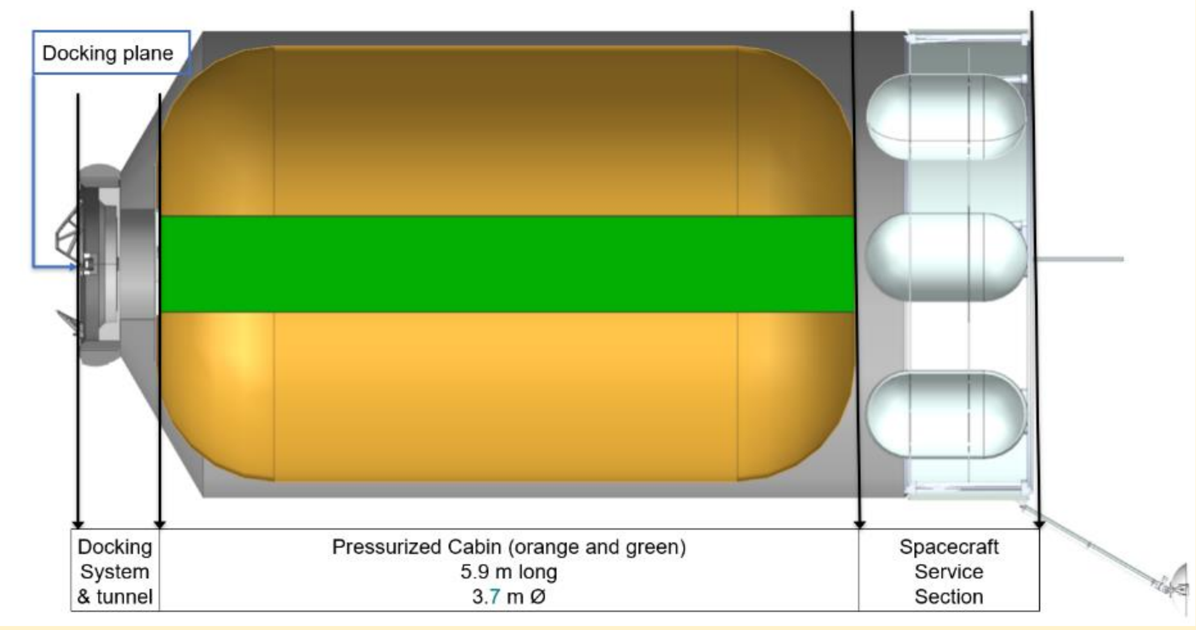
3.3 Provided Data

3.4 Layout Ground Rules

3.5 Required Manifest and Summary of Deliverables

3.3.1 Module dimensions and CAD:

- The Logistics Module for the challenge is 3.7 m diameter by 5.9 m long.
- A translation path with a minimum cross section of 0.8 x 1.1 m is required where crew access is needed (typical layout shown in green).



3.3.2 Cargo Transfer Bags (CTB):

The majority of cargo will be packed in standardized Cargo Transfer Bags (CTBs) that come in several sizes and are made of a woven, flame-resistant Nomex material related to Nylon. The "single CTB" or "1.0 CTB" is roughly the size of a carry-on suitcase. The other bags are sized in increments of the 1.0 CTB (the 2.0 CTB holds two 1.0 CTBs). The sizes go up to 6.0 CTB. Simplified CAD models of the CTBs are provided.

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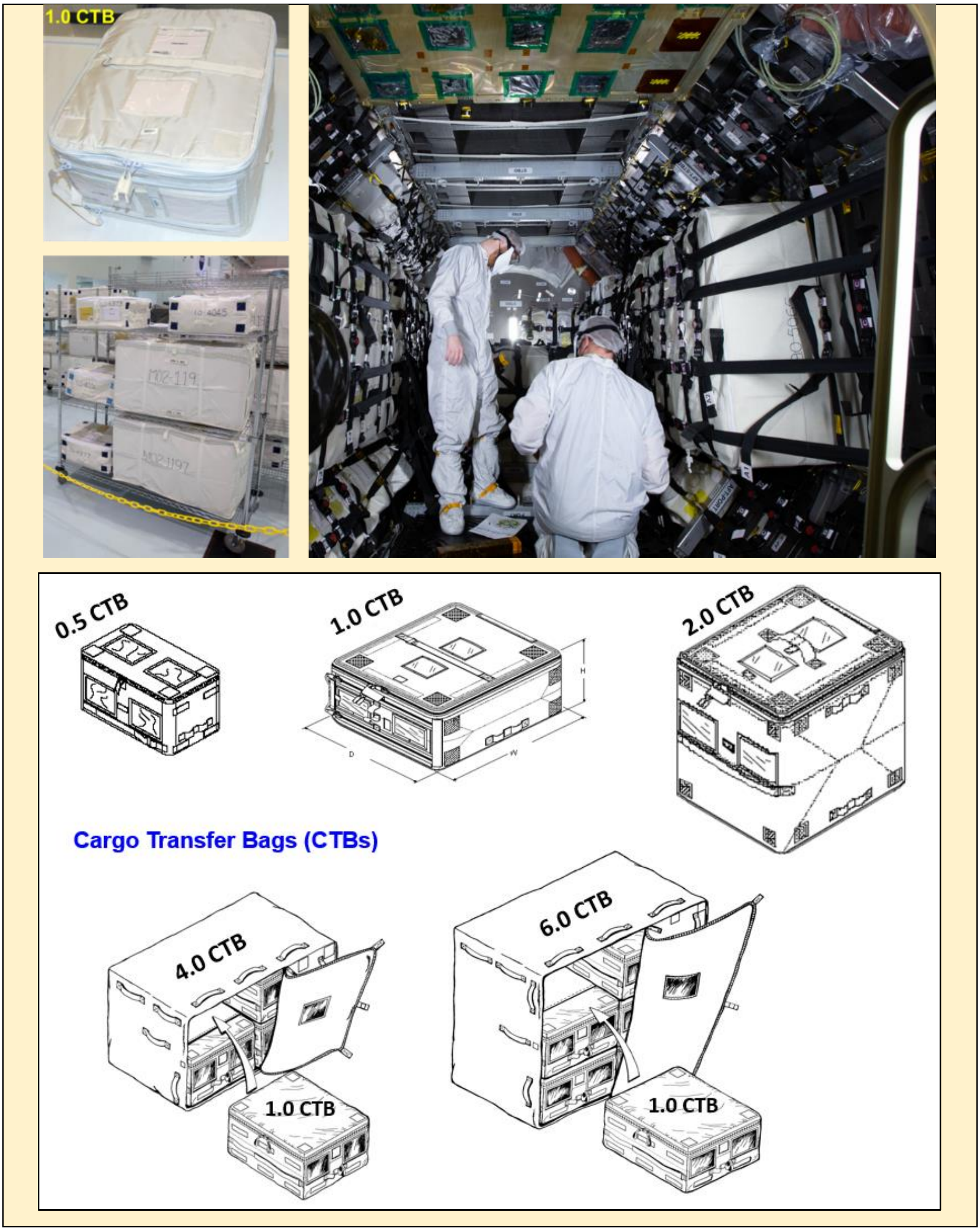

1.0 CTB
0.5 CTB
1.0 CTB
2.0 CTB
Cargo Transfer Bags (CTBs)
4.0 CTB
1.0 CTB
6.0 CTB
1.0 CTB

Typical CTB packing density is 290 kg/m3. For this challenge assume the mass of the loaded CTBs is as provided in the table:

CTB Name	External Dimensions (cm)			Loaded Bag Mass (kg)	External Volume m3
	L	W	H		
0.5 CTB	42.5	24.8	23.5	7.3	0.025
1.0 CTB	50.2	42.5	24.8	15.4	0.053
2.0 CTB	50.2	42.5	50.2	31.0	0.107
3.0 CTB	74.9	42.5	50.2	46.4	0.160
4.0 CTB	89.7	50.8	53.3	70.5	0.243
6.0 CTB	89.7	81.9	53.3	113.7	0.392

CTB equivalent (CTBE) is a convention for measuring cargo volume expressed in units of the 1.0 CTB size. The CTBE is equal to the bag size times the quantity of bags of that size:

$$CTBE = (CTB\ Size) \times (CTB\ Quantity)$$

Examples:

$$(4.0\ CTB) \times (QTY\ 3) = 12\ CTBE$$
$$(0.5\ CTB) \times (QTY\ 4) = 2\ CTBE$$

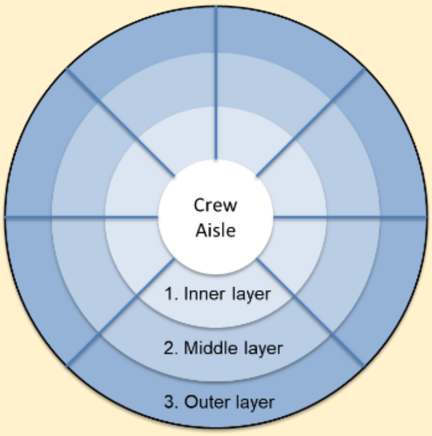
3.3.3 Science Payload Accommodations:

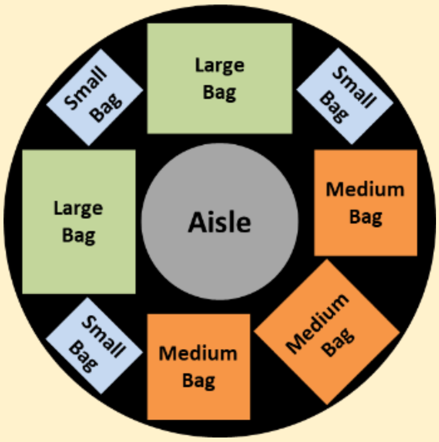
Science payloads are housed within rigid structures, not CTBs, that have a standard size and interfaces (power, data, etc.). This challenge will only address accommodating the size. They are mounted with fasteners at the rear (opposite side of front panel). You can assume the module has attach points at any location. No details or mass need to be provided for attachment to the LM.

- 8 science payloads must be accommodated (CAD model provided).
- Each has dimension of 0.25 x 0.5 x 0.5 m and a mass of 25 kg.
- Allow 1 cm between adjacent powered science payloads.
- The front panel must be easily accessible to crew in space.


3.3.4 Improved access to CTBs:

On the LM, crew will access individual cargo bags, obtain needed items, and return the bag to its stowage location. This can be challenging in zero-gravity because anything not secured in place will move and the crew can get overloaded while attempting to hold several objects at the same time. Zero-gravity also provides opportunities that are not intuitive based on our experience on earth. A critical component of this challenge is to save crew time. An efficient way to access content inside bags and replace the bags is needed. In historical cargo modules, bags on the inner layers near the crew aisle are easy to access, and those in middle and outer layers (near the module shell) may be behind multiple layers of bags and can be harder to access. Bags can also get trapped by corners formed by other bags like the small blue bags in the image below. Translation paths larger than the specified minimum allow easier work and movement but sacrifice cargo space. Your team must balance these needs.





While the crew is accessing deeper bags, if inner bags are detached, moved, and left loose to float and drift in the crew aisle, the bags could interfere with crew activity and be time consuming to regather and restrain. Having a means to restrain, connect, and/or maneuver individual bags or groups of bags, or having bays/compartments that hold bags, could be useful to improve crew access and prevent bags from scattering.

Passive, Mechanized, and Automated approaches:

Passive: uses static structures and relies on crew to retrieve the cargo.

Mechanized**:** could use a rack that moves linearly or radially within the spacecraft to give astronauts access to an entire bay of CTBs, or a closet or pantry style organizer with compartments, doors, or drawers for soft goods or CTBs (see pictures).
Automated: a system that automates cargo bag retrieval for the crew, like a vending machine, can be proposed but must have high reliability, and mass and volume utilization are major factors. This might have a robotic arm, electromechanical components, or another approach to automate cargo retrieval.

In any solution, weight must be kept as low as possible while having a robust structure to survive both the launch and repetitive use in a zero-G environment. Thin structures built with lightweight materials, such as aluminum, composites, flame resistant straps, or woven fabrics (CTB materials) could be good options. Structures and mechanisms that will only be used in orbit (zero-G) do not necessarily have to sustain loads at launch. Those could use supplemental launch restraint systems such as ratchet strap hold-downs used for ISS resupply vehicles, that could be released by crew at Gateway.

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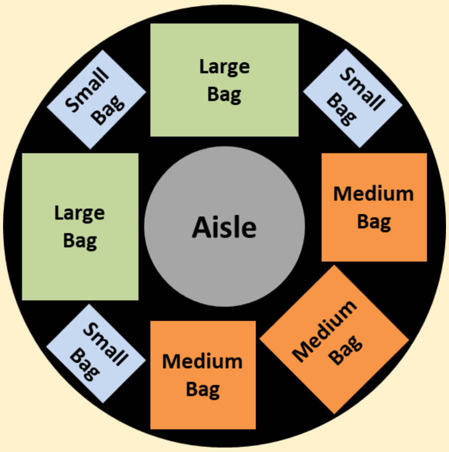
3.3.5 Alternate stowage for soft goods:

As rectangular CTBs are loaded into a cylindrical spacecraft, there will be gaps between bags and near the module shell (below in black). This loading inefficiency can be more than 25% of the module volume when including gaps, crew transfer aisle, and space for structures to restrain cargo.



- Your team can provide unique ways to reduce the gaps and/or provide better access to these spaces that are difficult to use and reach.
- Unique options such as a custom shaped cargo bag/carrier or a structural compartment in the spacecraft may be proposed to make optimal use of this volume.
- Alternate concepts, that do not use CTBs, can be proposed for up to 75 CTBE for bulk cargo items such as towels, clothing, food, and water.
- The usable volume of custom bags or compartments should be calculated and provided in CTBE (1 CTB3 = 0.053 m3). It counts towards your total CTBE. You may reduce an equal volume of CTBs from the required CTB count from any bag size(s) if a custom solution is proposed.

3.4 Layout Ground Rules

1. System must operate in zero G environment.
2. Crew must have access to any critical mechanisms for repair.
3. Crew must be able to access cargo in the event any mechanism fails beyond repair.
4. To secure your proposed storage system to the modules shell, you may assume rigid attach points are available at any location you choose. These are not part of your stowage system mass. No details need to be provided on the module attach points.
5. All cargo shall be placed in the pressurized cabin (orange in image). No cargo shall be placed in the docking system, access tunnel, or service section.
6. A minimum translation path cross section of 0.8 x 1.1 m is required where crew access is necessary.
7. Maintain 4 cm between bays or groupings of cargo bags that are secured independently of each other unless they are separated by a rigid barrier or compartment.
8. Maintain 1 cm between science payloads.

3.5 Required Manifest and Summary of Deliverables

The tables below provide the minimum goal for cargo but exceeding these will improve your score. Include the tables, with the blue sections completed, in your submission.

CTB Deliverables Summary Table:

CTB Size	Target Minimums		Proposed		Notes (optional)
	Qty	CTBE	Qty	CTBE	
0.5	50	25			
1.0	50	50			
2.0	15	30			
3.0	10	30			
4.0	25	100			
6.0	10	60			
Total	**160**	**295**			

Other cargo table:

Custom stowage	Proposed		Notes
	Volume (m3)	CTBE	
Optional			
Science Payloads	**Proposed Qty**		**Notes**
8 required (25 kg each)			

Other required data table:

Data type	Proposed			Notes
Cargo mass (kg):	**CTB**	**Custom**	**Payload**	
Stowage System mass (kg) (optional):				
Crew Translation path dimensions	**Minimum (m)**	**Max (m)**		

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