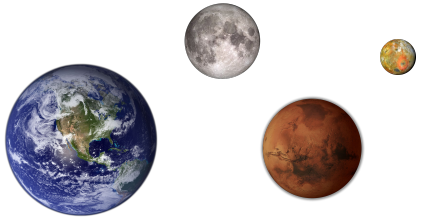
# Critical Requirements to Enable the Strategic Evolution of Space Exploration Through Logistics Development

SICSA Thesis Defense

Leandre Jones



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# Vision

Transition space mission planning from a consumable oriented mindset to independent, sustainable and reusable architecture through an intelligent logistics framework.

# Problem Statement

Successful future space exploration requires a forward thinking process that considers evolving functions and logistics for developing unknown territory.

# Goal

Provide a mission architecture for a station that evolves with the functions of each destination as humans extend their reach throughout space.

*Provide evolutionary adjustments from LEO to Mars & beyond without complete redesigns..*

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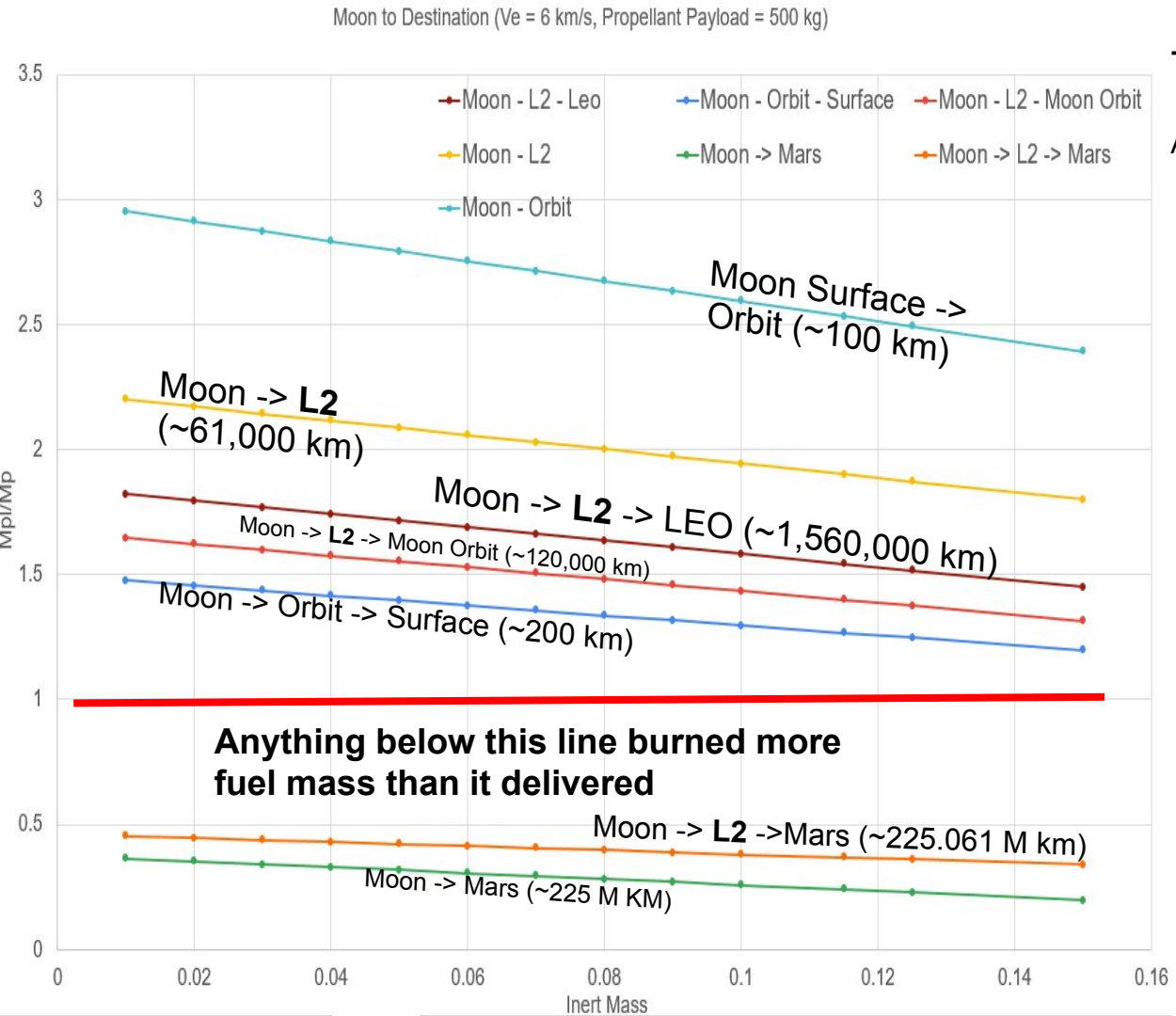


# Trajectory Comparison Criteria

Additional criteria taken into consideration:

- Can move a payload from *L2 to Mars that we can <u>BARELY</u> move from from Earth to GEO*
- L2 is a “stepping stone” location between key destinations
- The fuel cost to leave L2 is orders of magnitude below the cost to leave planets or orbits

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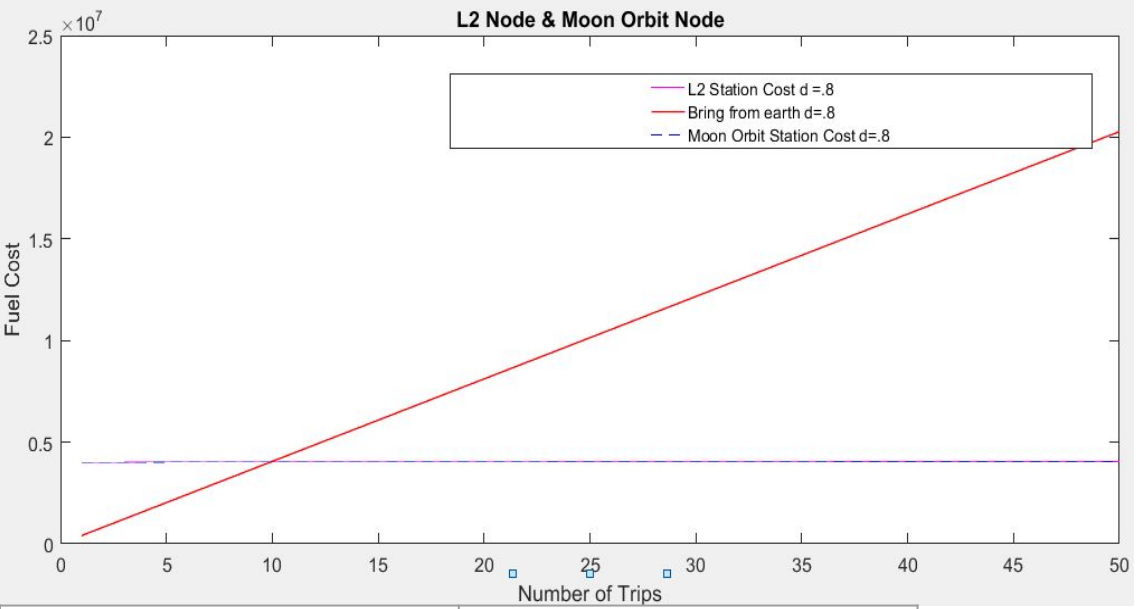
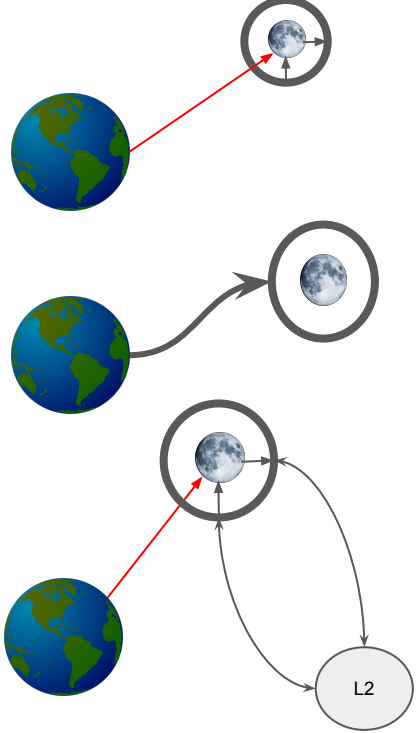



| Equipment Name | Estimated Mass (MT) |
|---|---|
| ISRU Unit | 1.5 |
| Power System | 1.5 |
| Mining Unit | 1.59 |




Investing in a fuel depot on the Moon pays off after **10 trips.**

ISP = 612

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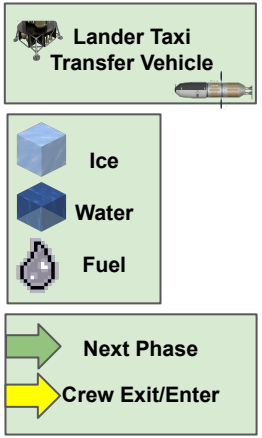
# Timeline/Overall Conops

HF & EXPO Mars Tech Research
(Pressurized Modules on the ISS)

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# Timeline/Overall Conops

Send Habitats, ISRU, Nuclear Power, Lander Taxi and Mining Equipment

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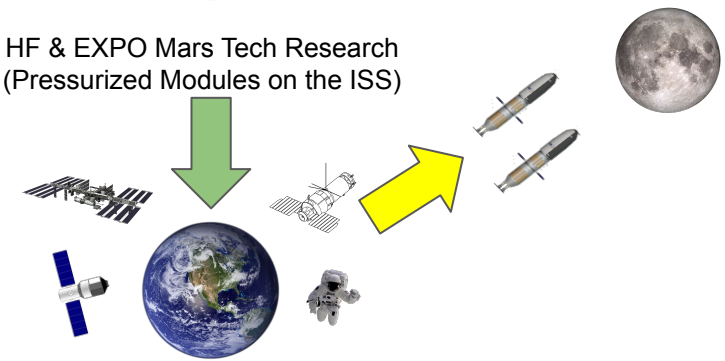
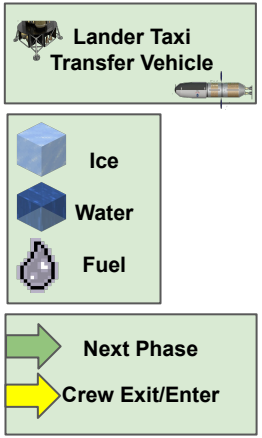


Free Flying Modules for Commercial Industry Support (Pressurized & Unpressurized Modules)

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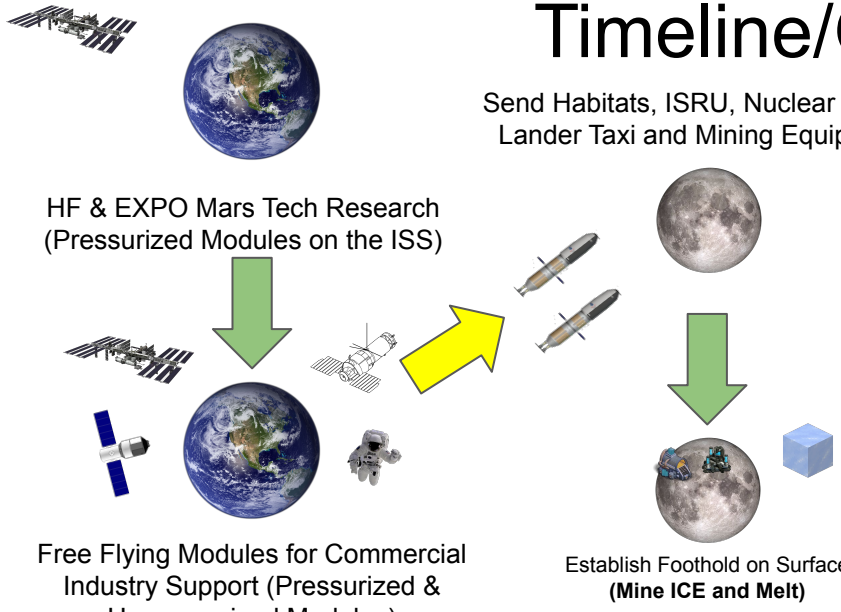


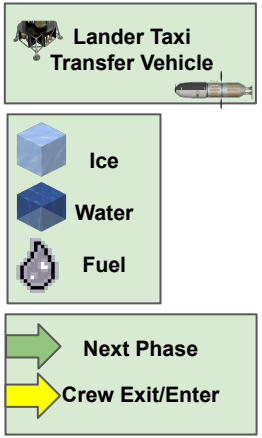


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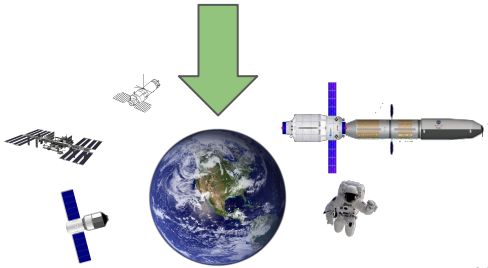
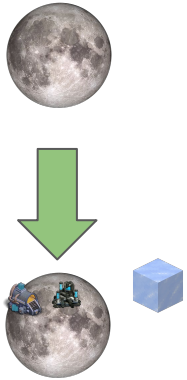
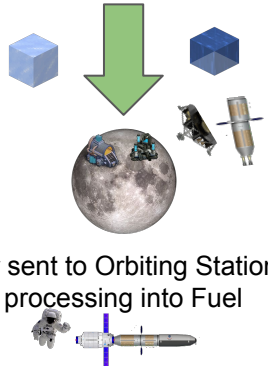


Unpressurized Modules Prepare Shipyard Functions

Send Habitats, ISRU, Nuclear Power, Lander Taxi and Mining Equipment

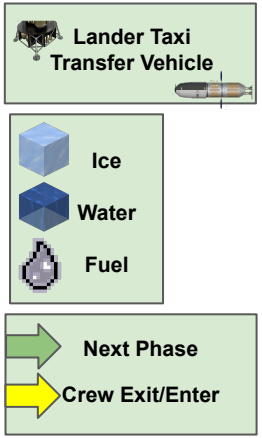


Establish Foothold on Surface
**(Mine ICE and Melt)**



Water sent to Orbiting Station for processing into Fuel



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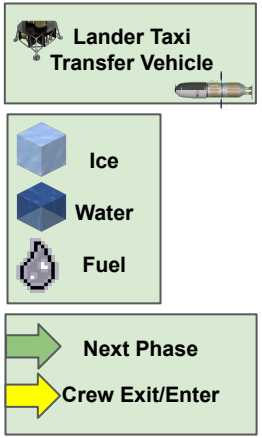
Water processed into fuel in Orbit and transfer vehicle with crew is refueled while the crew is on the surface

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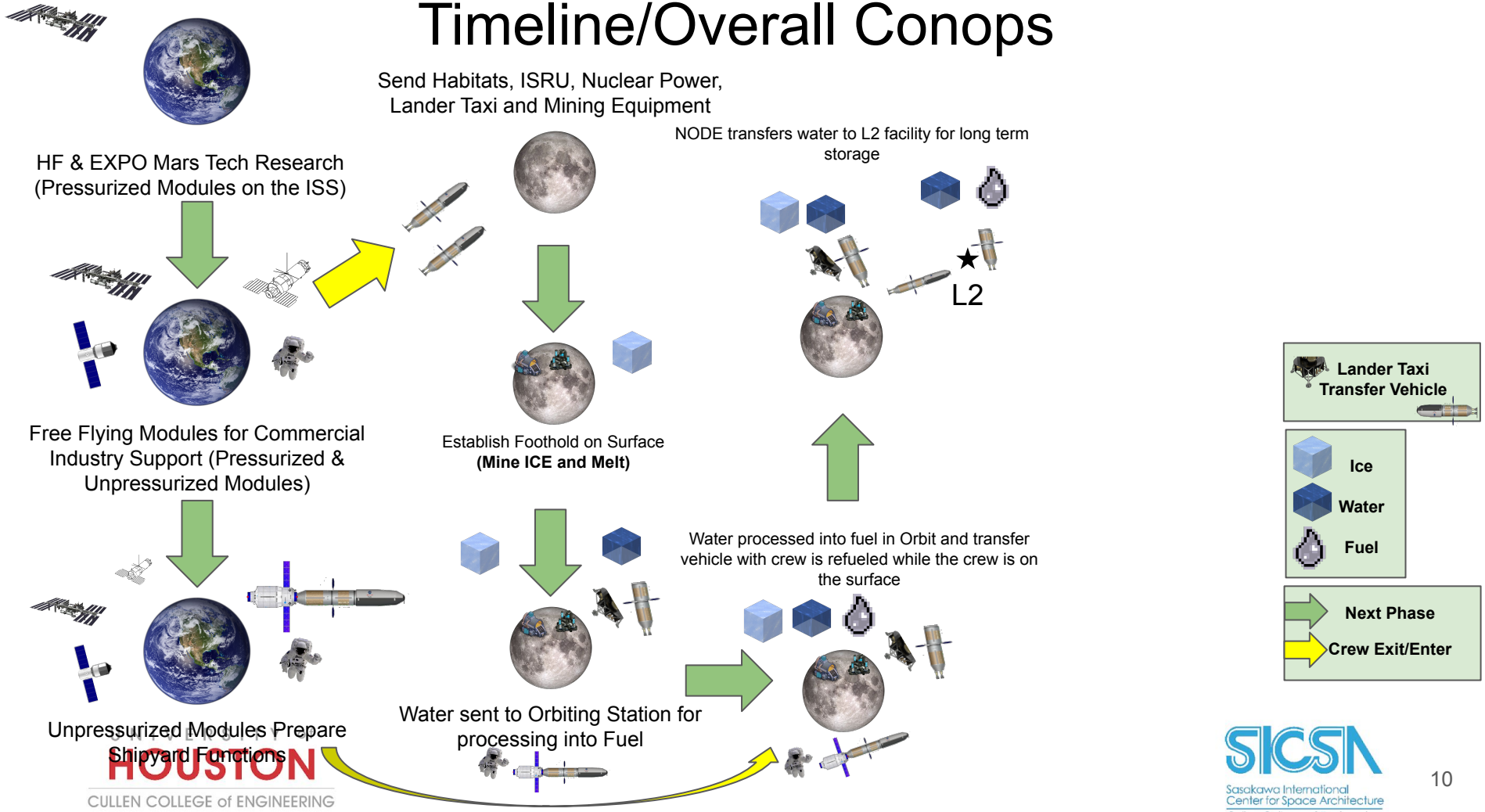


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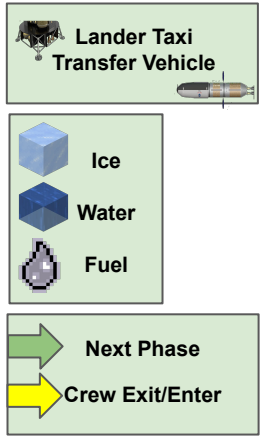
NODE transfers water to L2 facility for long term storage

L2

Water processed into fuel in Orbit and transfer vehicle with crew is refueled while the crew is on the surface

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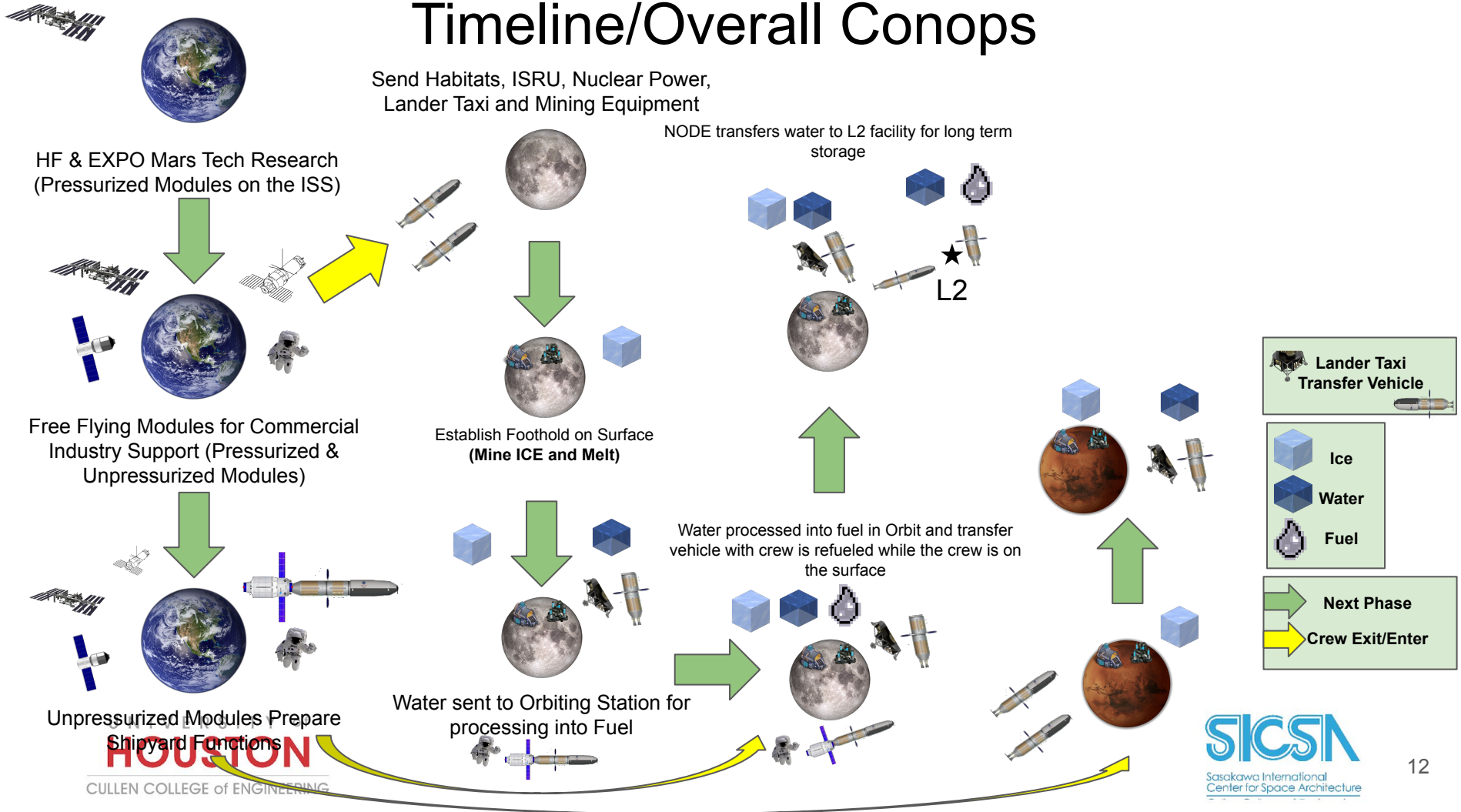


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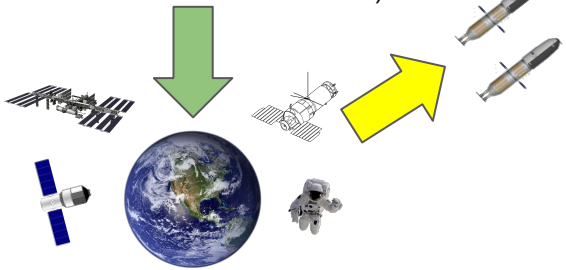

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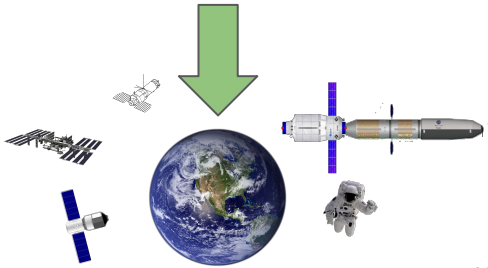

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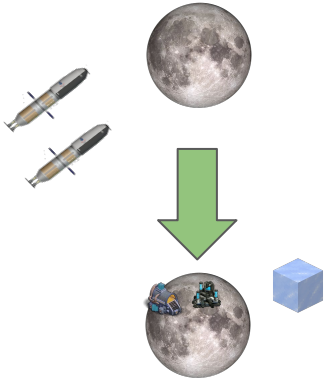

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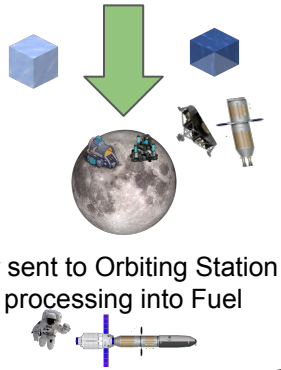

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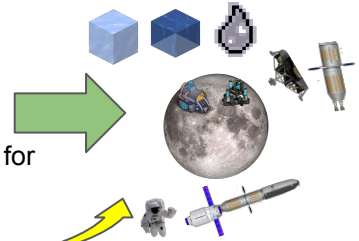

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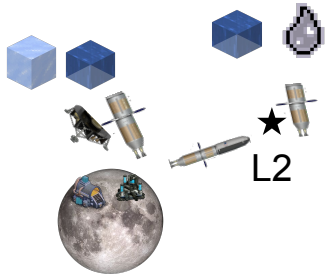


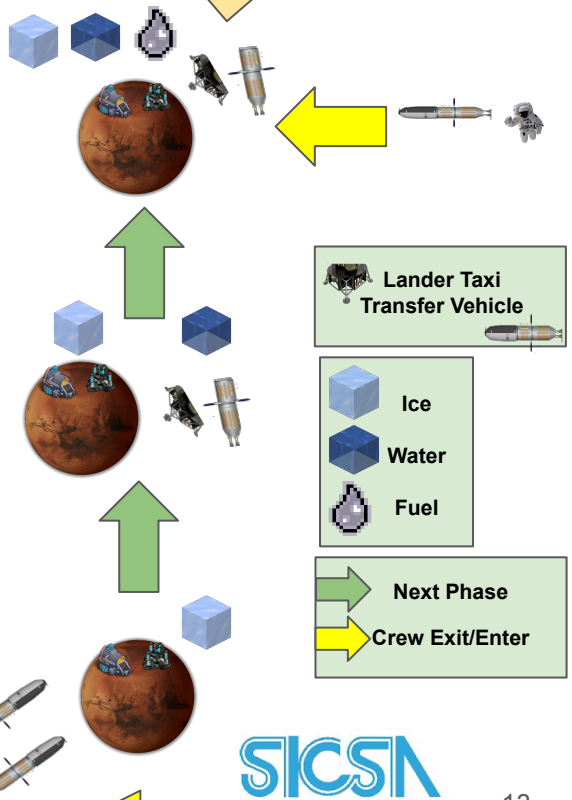

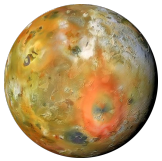




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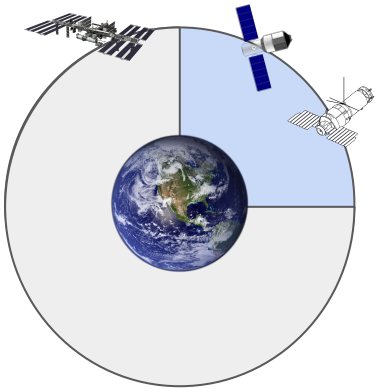
Forward Station Activity

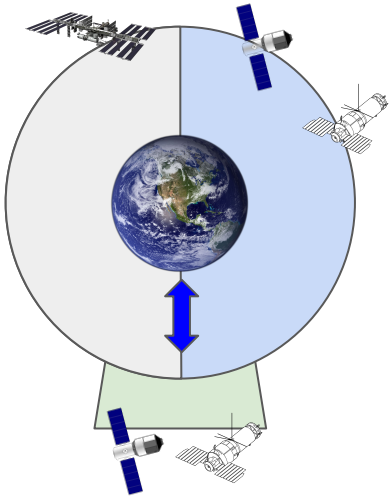
ISS Activity

Lander Taxi between Surface and Forward Station

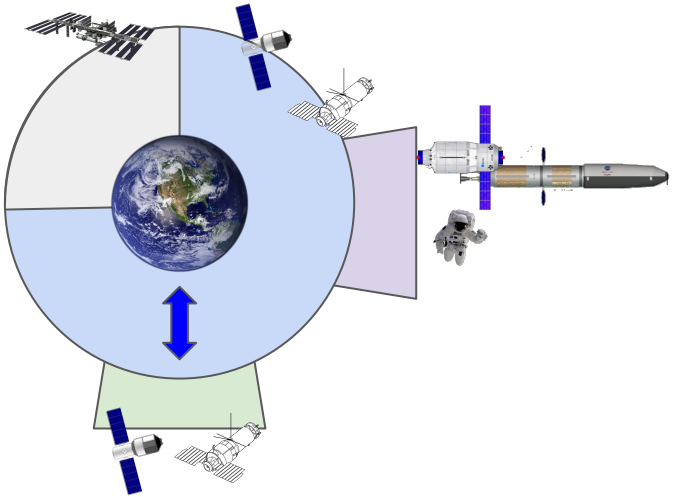
Transfer Vehicles between destinations and Earth



**ISS and Forward Station support growing LEO economy and orbital research**



**Forward station expands its functions through servicing other orbits, refueling and reusable lander**



**In orbit fuel processing tested. Leverage in-space manufacturing to scale itself for larger demands. Forward Station sets sights to the Moon**

# LEO Functions

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## ISS

- ISS Orbit
- Human Factors Research
  Microgravity
  Analog Testing
- Crew Rendezvous
- Testing
  Technology Life Cycle
  Exploration ECLSS Testing
  Technology Demonstrations
- National Laboratory
  Fundamental Science
- Private Research
- In-Space Manufacturing

## ISS

- ISS Orbit
- Crew Rendezvous

## Forward Station

- Accommodate Multinational Launch Sites
- **Refueling Operations Tested**
- **Transfer Vehicle Hangar Testing**
- **Lander Taxi**
- In-Space Manufacturing
- Manufacturing Resupply
- Human Factors Research
  Microgravity
  Analog Testing
- Testing
  Technology Life Cycle
  Exploration ECLSS Testing
  Technology Demonstrations

## ISS

- ISS Orbit
- Crew Rendezvous
- Exploration ECLSS Testing

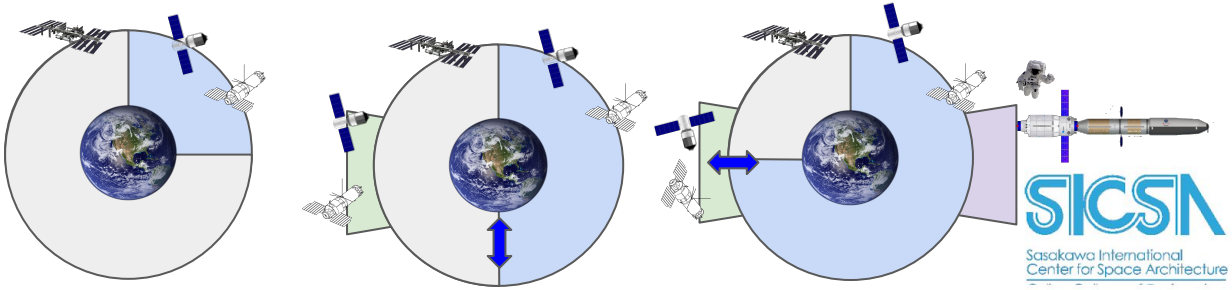
## Forward Station

- Accommodate Multinational Launch Sites
- **Fully Operational Orbit Refueling**
- **Transfer Vehicle Hangar Testing**
- Unknown Private Research
- In-Space Manufacturing
- Manufacturing Resupply
- **Station scales itself through in-space manufacturing advancements**
- National Laboratory
  Fundamental Science
- ISRU, Power, Habitat and **Lander Taxi** Habitat sent to the Moon

US Government

Transition

Commercial



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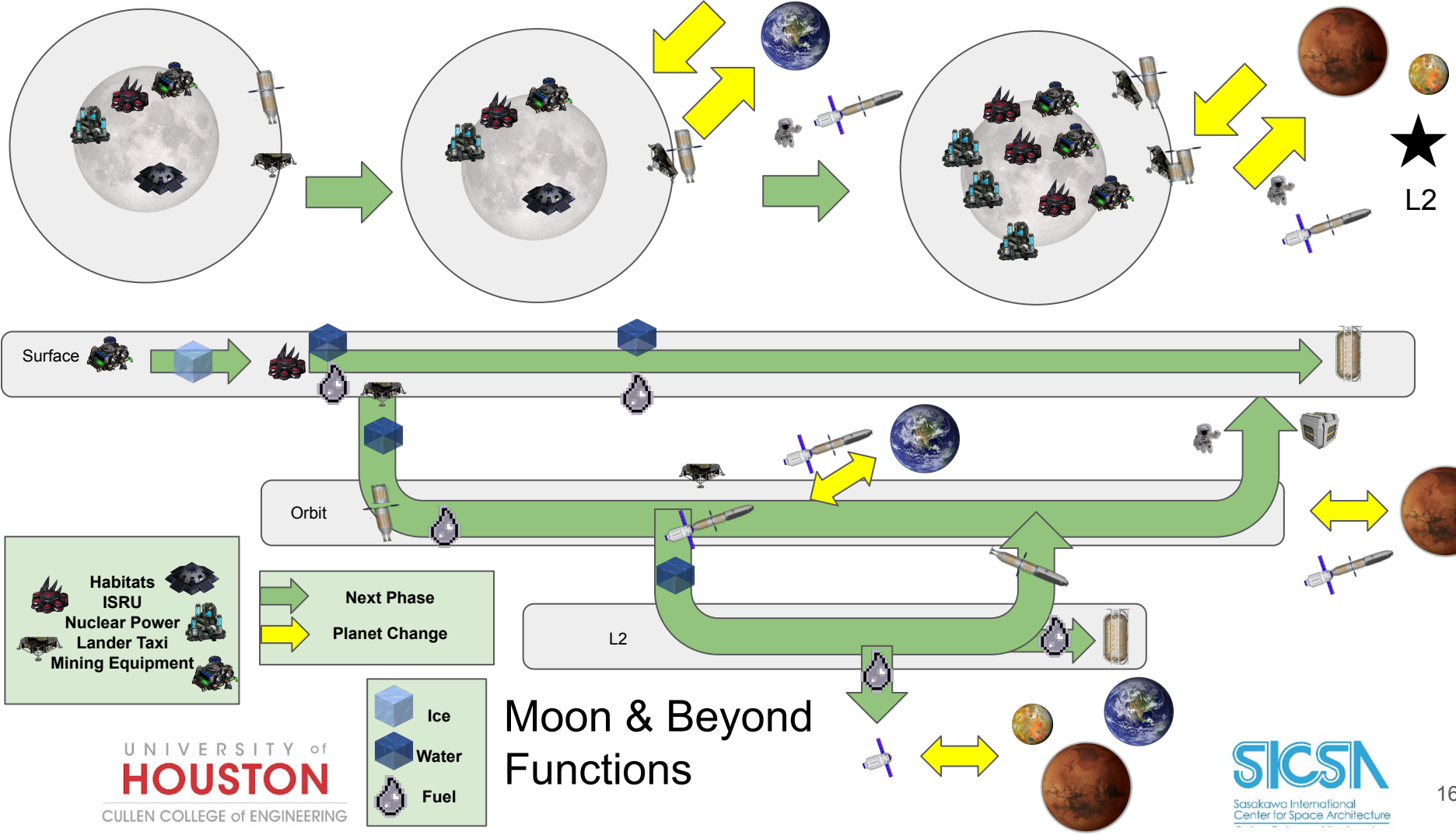


# Moon & Beyond Functions

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EXPO ECLSS & ISRU Testing

Leo Lander Taxi

In Orbit Refueling

Transfer Vehicle Hanger

Crew Rendezvous

Ice Mining & ISRU

Moon Habitat Deployment

Moon Lander Taxi

In Orbit & Surface Refueling

Surface Water Storage

Vehicle Hanger

Emergency Crew Shelter

Communication & Navigation Infrastructure Support

Cargo Transfer

In-Orbit Fuel Processing

In-Space Manufacturing

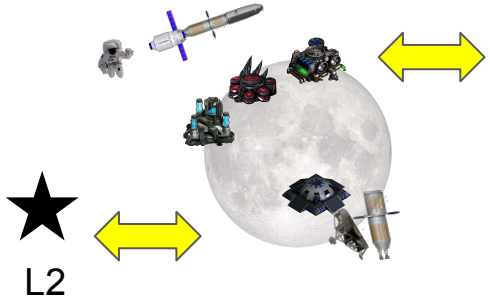
Propellant Depot

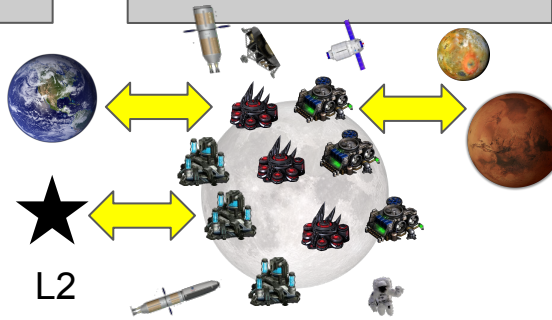
Unknown Moon Economy

Boil-off Protection Storage

Additional Facilities to Scale Production

Lunar Economy

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Moon, L2 & Beyond Functions for Forward Station

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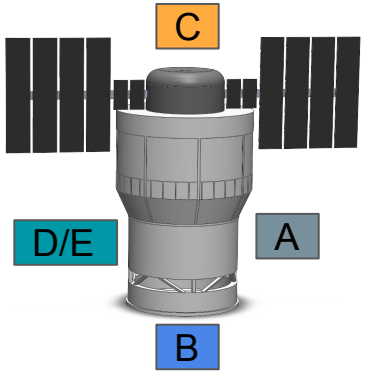
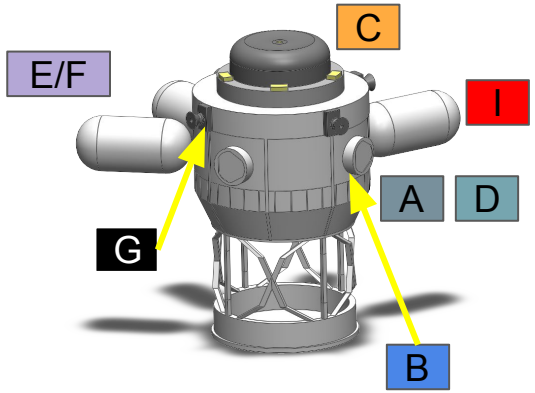
# Forward Station Functions

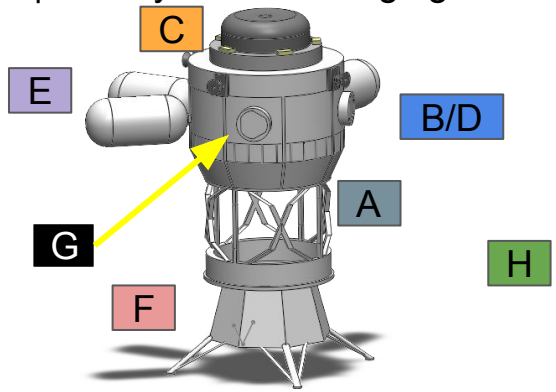
Staging Point for Future Development | Common Infrastructure Expansion | Gravity Well Leveraging




A - Pressurized Shell
B - Autonomous docking and berthing Systems
C - Solar Panels & Radiators
D- In-Space manufacturing facility
E - In-Space manufacturing resupply




A - Small Pressurized Section with Unpressurized Surfaces to attach storage to
B - Autonomous docking and berthing Systems
C - Nuclear Power System & Radiators
D - In Space manufacturing expansion
E - In-orbit Refueling
F - In-orbit ISRU
G - Advanced Propulsion System that allows Orbit Transfers
H - Water Storage




A - Entirely Unpressurized Station with pressurized storage sections
**B/D - Autonomous docking, berthing, self-expanding, stationkeeping and daily tasks**
C - Nuclear Power System with power output capabilities
E - In-orbit Refueling, ISRU, Boil off proof storage
F - Cargo deployment, transfer and delivery capable Lander
G - Advanced Propulsion System
H - GPS and Comm supporting equipment

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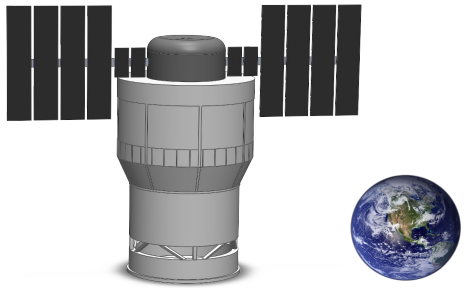
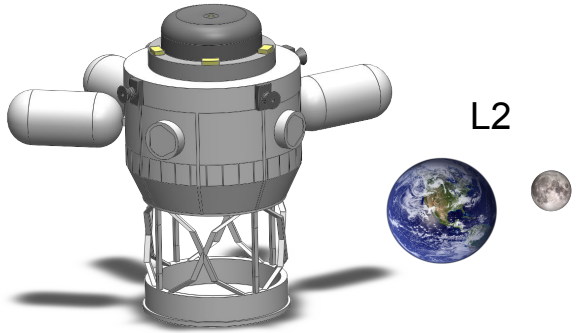
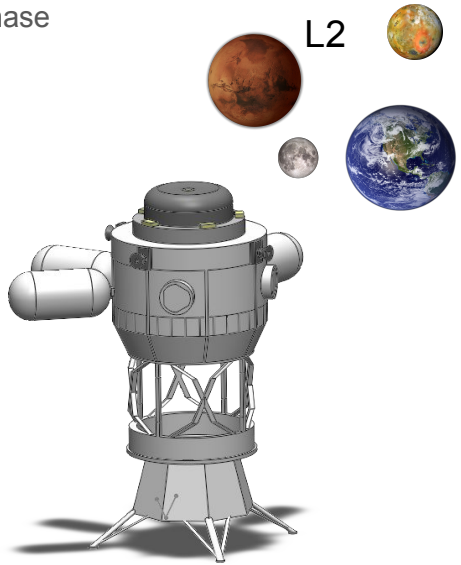
# Summary

- Applied analogous logic and reasoning from non space logistic endeavors
- How the functions of each destination evolves
- How the station functions evolves to meet the needs of each destination and the transitional phase
- Provide a mission architecture for a station that evolves with the functions of each destination



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