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MTLM
Multi-Task Logistic Module

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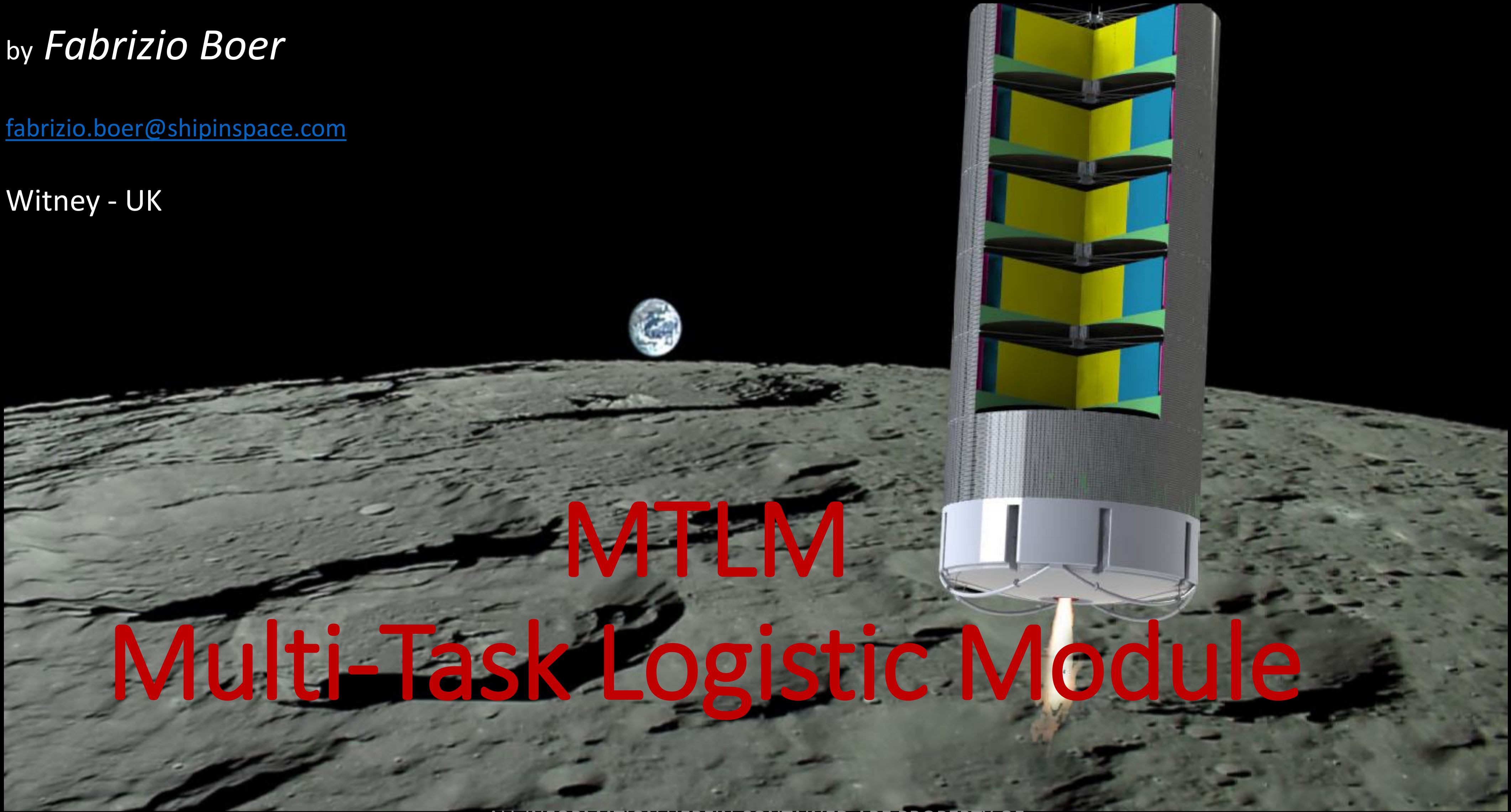

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MTLM Technology overview

- The idea is to use the LBL 4th stage as the baseline to build a Multi-Task Logistic Module able to fit with current Heavy Launchers such as Falcon 9, Falcon Heavy, Ariane 6.
- The MTLM scaled down to the size of existent Launchers will take advantage of the multi-tasking capability of the LBL 4th stage such as being assembled in multiple floors that can be easily changed one another and compounded with the Powered Module, store the Payload cargo by means of Airbags without needing any mechanical I/F.
- The MTLM can be designed to assure a continuous logistics service from LEO to the Moon surface, return to LEO once refuelling is available and picking up (docking) other Payload modules to LEO and back to the Moon again.

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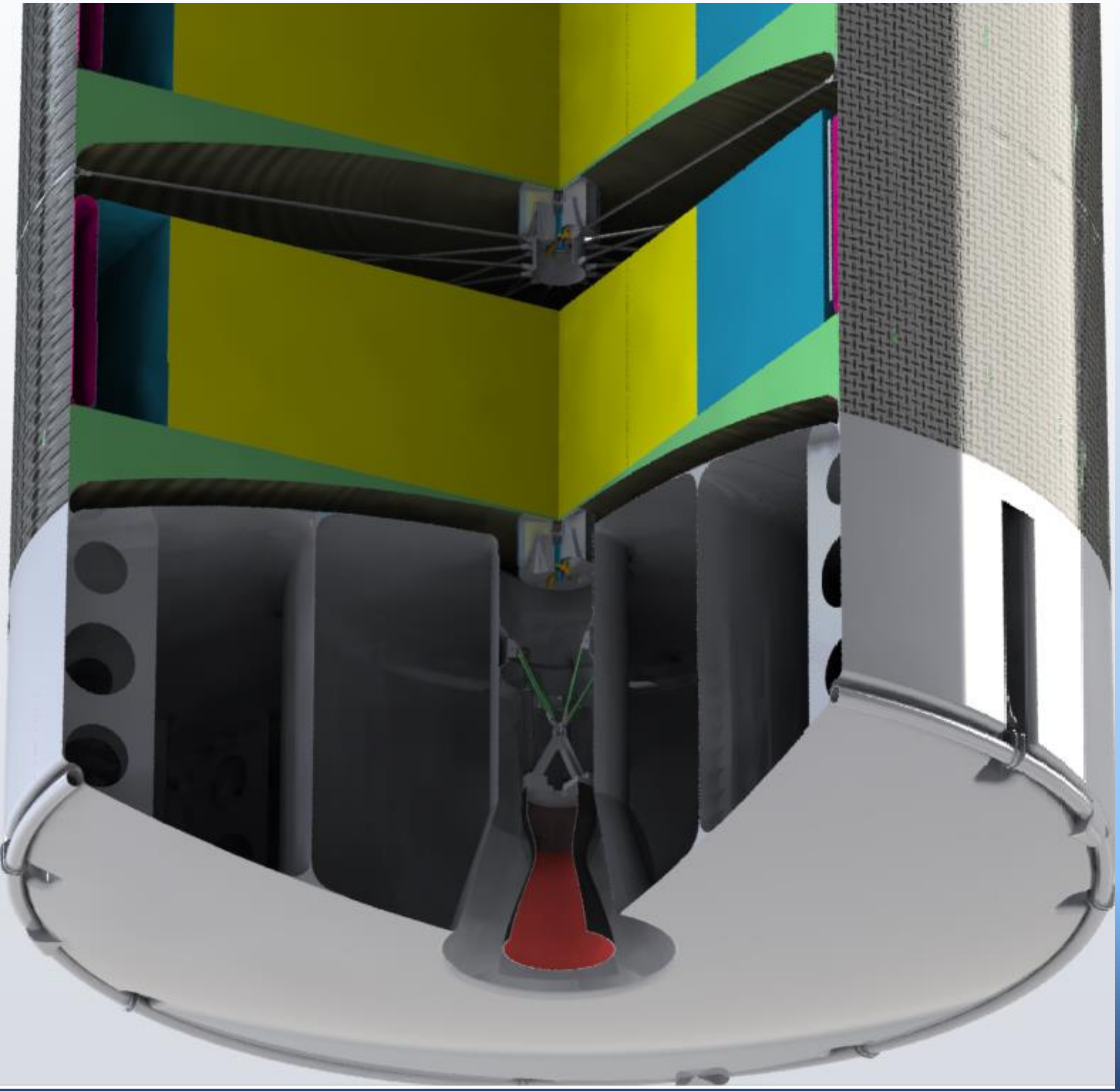
From the LBL 4th stage to the MTLM



- The LBL 4th stage can be scaled down from its current 12 m diameter to 5 m to fit into a current Launcher Fairing.
- The Payload Modules can either be assembled on ground before Launch or in LEO with orbital rendezvous and autonomous docking using AI technology.
- Once fueling will be available on the Moon and in LEO, the Powered Module will be able to return to LEO and pick-up other Payload Modules providing a continuous Logistics service from LEO to the Moon

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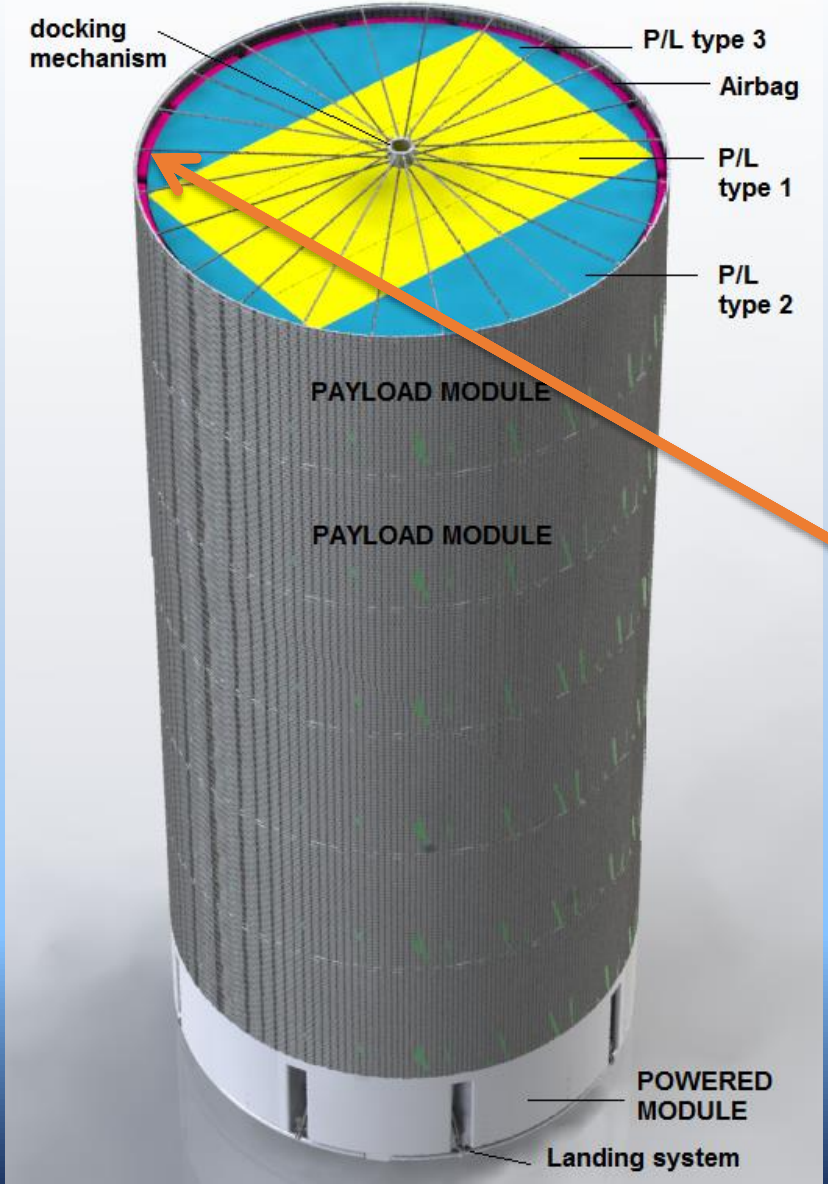
MTLM - Payload accommodation



- The Payload are packaged into boxes staking them in the same way they are stored inside a shipping container, any item packed in a box designed with materials that can assure the minimum mass.
- The items packed in standard sized boxes geometry are then stored one next the other as in a shipping container. The walls of the MTLM will act as retention of the compressive loads that will arise while inflating the airbags. This makes the fundamental difference with any other Vehicle.

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What is the issue our solution addresses

- Building a permanent settlement for humans on the Moon and bringing fuel deposits in LEO will be the focus of the Space economy by 2030. Morgan Stanley had predicted a $1T market by 2040 before Covid-19, a figure that will likely increase with the shrinkage of the Aerospace economy after Covid-19 and Investors shifting towards newSpace ventures.
- The SiS ambition with the MTLM is to become a leader of this newSpace future market focusing **only** on the Logistics service to send **cargo** from LEO to the Moon delivering material, machinery, equipment,...a service aimed at occupying a role in the market that is missing at the moment being the Vehicle of the “Artemis” program mainly focused on Astronauts transportation.
- Focusing only on cargo with airbag technology to retain the Payload and offering services from LEO up to the Moon surface the MTLM will be cheaper than any other vehicle.

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MTLM – Initial performance evaluation

- By reducing the external diameter from 12 m to 5.2 m and by maintaining the same geometry proportion between powered module and payload module we are able to calculate the new Payload mass.
- The delta-V from LEO to the Moon surface is 6.12 Km/s.
- Being the maximum Payload mass to LEO for i.e. Ariane 6 limited to 21,650 Kg it appears that by applying the Tsyolkowski equation ΔV=g x Isp x ln (Mi/Mf) the final mass of the MTLM must be:

$$6120= 9.81 \times 375 \times \ln(21650/Mf)$$
$$Mf= 4100 \text{ Kg}$$

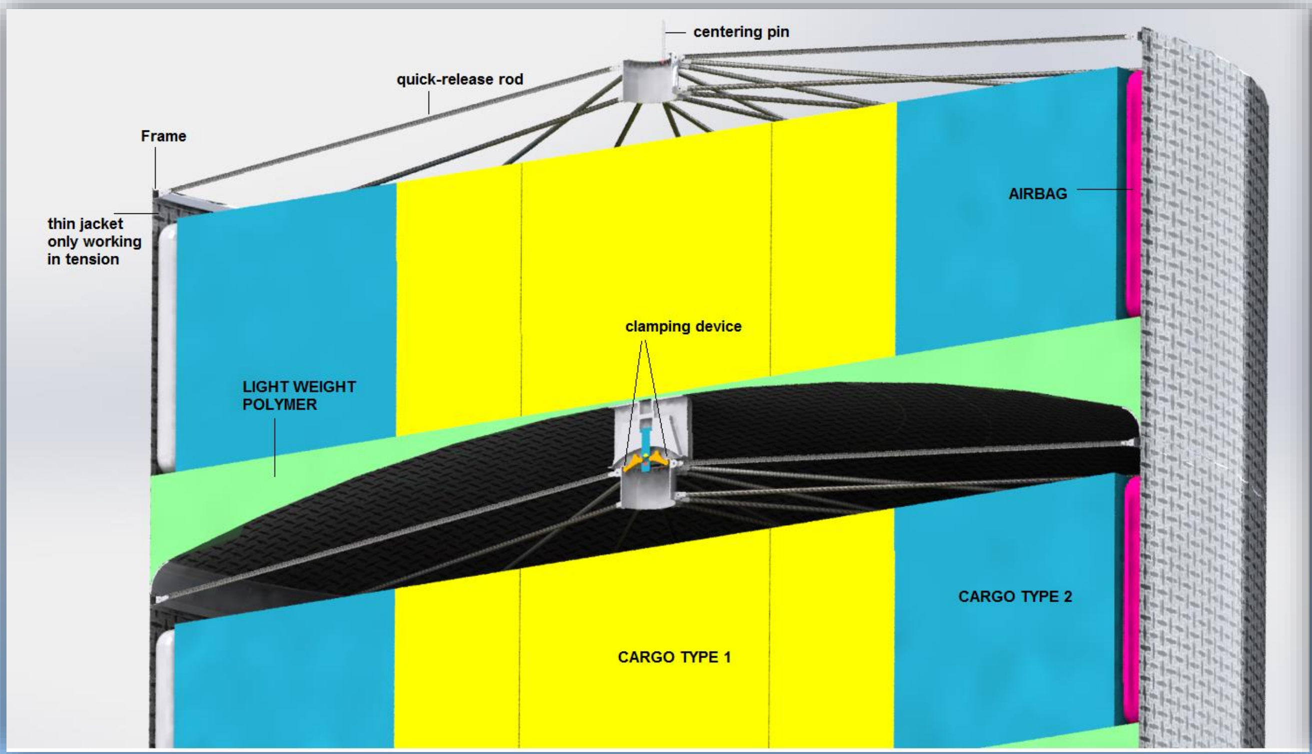
- By assuming a structural mass ratio equal to 6% by using airbag technology that helps stabilize the structure against buckling (just 1 mm CFRP wall thickness is necessary) this equals to circa 1300 Kg, hence a

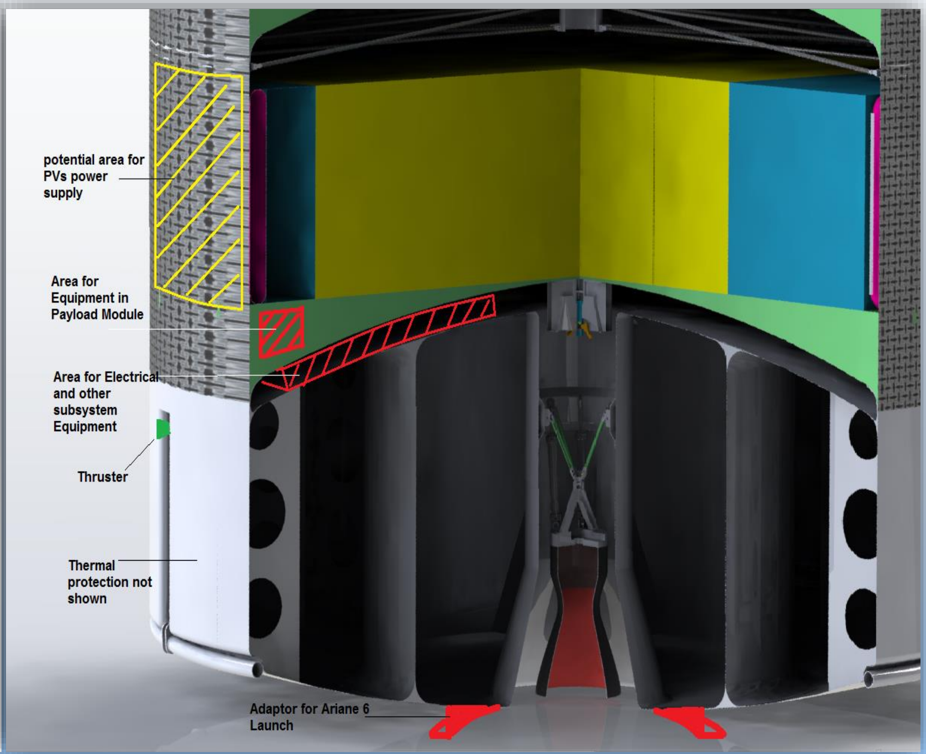
Payload mass of 2800 Kg

By supposing to have 21,650 Kg budget just dedicated to the Powered Module and docking in LEO with the Payload Modules we have available 20350 Kg of propellant. This will bring to have a:

Payload mass of 5060 Kg

The MTLM flexibility using orbital rendezvous docking





The MTLM will be able to dock its Payload Modules in LEO using advanced autonomous AI operations. This will permit a continuous service between LEO and the Moon

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What is the size of the market opportunity

- Building a Moon Colony, a declared goal of NASA and ESA will require hundreds of Tons of cargo to be sent even before humans can possibly live permanently. A min figure of 300 Tons makes a Launch price bid of $15B at $50k/Kg, with current (best) SLS cost figures for a Moon mission.
- The MTLM Launch cost using a reused Falcon 9 first stage is $44M, this means **$9,565/Kg Payload** for a brand new fully assembled MTLM in its first mission to the Moon. This cost drops to **$6,962/Kg** mating separate Payload Modules in LEO and goes down to (44,000,000/(22800-1300)) = **$2046/Kg** once refuelling will be available on the Moon and LEO.
- This figure does not include the fuel cost but we can assume that the cost of producing fuel from lunar regolith with autonomous operations and amortized equipment will not be a consistent part of the costs, likely around $165/Kg according to some experts estimation.

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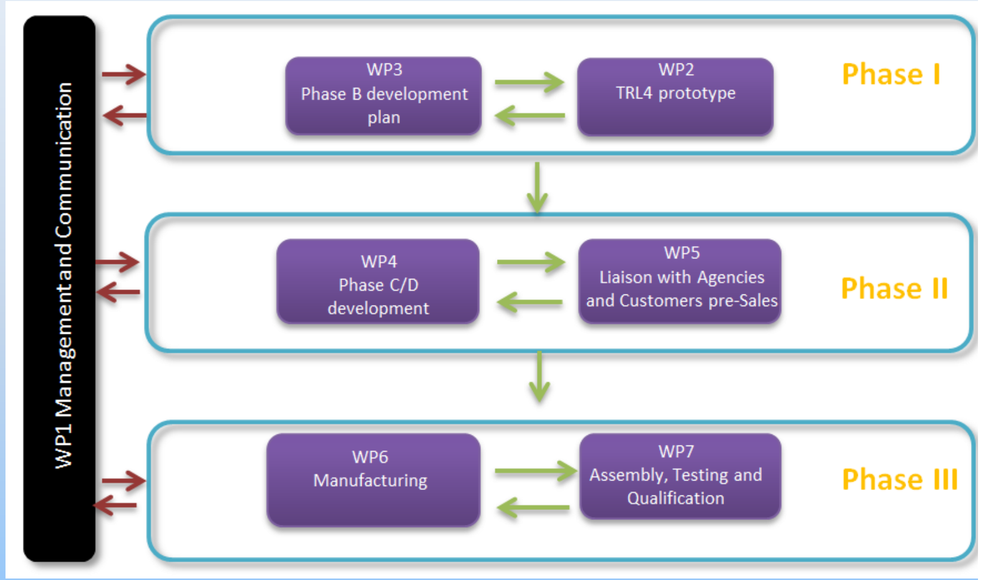
Competitive landscape

- Worldwide it doesn't exist a Vehicle specifically designed to send Payload cargo from LEO to the Moon and capable to return to LEO to pick up other Payload for a continuous Logistics service. Ongoing Lander projects such as Blue Origin Blue Moon are designed to start operating from LLO to the Moon not from LEO. Starship of Space X is not optimized for a mission to the Moon and involves a mix of Astronauts/cargo which complicates the mission.
- The MTLM design can benefit of the advantages offered by docking multi-Payload modules launched to LEO with a variety of Launchers and send them to any Moon latitude.
- Recent claims by private Companies such as the American Caterpillar to invest in Moon mining assets reinforces the competition and the requirement to send hundreds of Tons of machines/equipment to the Moon at the lowest price. The MTLM can be the perfect choice for this goal.

Route to Market



Timeline

Task N°	Title	Y0	Y1	Y2	Y3	Y4	Y5	Y6
WP1	Management and Communication activities							
1.1	Coordination activities	KO						
1.2	Communication activities							
WP2	TRL 4 Prototype							
2.1	Airbag technology, load and mass analysis			D2.1				
2.2	Analysis of the impact for structural parts when inflating Airbags			D2.2				
2.3	Mechanical design of a 1:2 scale simplified Prototype			D2.3				
2.4	Prototype manufacturing			D2.4				
2.5	Testing in Space Laboratory (high dynamic test)			D2.5				
WP3	Phase B Development Plan							
3.1	Development, PA, FMEA, Validation plans			D3.1				
3.2	Structural design configuration for the Powered Module and Payload Module			D3.2				
33	Thermal protection for the cryo tanks structure			D3.3				
3.4	Propulsion susbsystem			D3.4				
3.5	The Telemetry Tracking and Command and On-Board Data Handling subsystem preliminary design			D3.5				
3.6	The GNC subsystem			D3.6				
3.7	Definition of Electrical power subsystem			D3.7				
WP4	Phase C/D development							
4.1	Manufacturing drawings for Powered and Payload Modules					D4.1		
4.2	PA, FMEA, Validation plans					D4.2		
4.3	Thermal protection drawings for the cryo tanks structure					D4.3		
4.4	Propulsion mechanical I/Fs and piping drawings					D4.4		
4.5	The Telemetry Tracking and Command and On-Board Data Handling subsystem drawings					D4.5		
4.6	The GNC subsystem drawings					D4.6		
4.7	Electrical power subsystem drawings					D4.7		
WP5	Liaison with Agencies and Customers pre-Sales							
5.1	Lobbying activities with ESA and NASA and grants approval				D5.1			
5.2	RFI and pre-Sales commitments with Private Companies					D5.2		
5.3	Payload accommodation specification					D5.3		
5.4	Packaging types procurement					D5.4		
WP6	Manufacturing							
6.1	Powered Module and Payload Module structural parts manufacturing						D6.1	
6.2	Subsystems parts manufacturing						D6.2	
6.3	Assembly procedures						D6.3	
6.4	Procurement parts						D6.4	
WP7	Assembly, Testing and Qualification							
7.1	Powered Module, Payload Module assembly							D7.1
	MTLM systems qualification							D7.2

£3m Funding Run

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The MTLM Sales potential

- Setting up a refueling system will be one of the first accomplishments and priorities among the many that have to occur to build basic infrastructures for a permanent Colony on the Moon. This will likely happen in correspondence of the Moon poles where ice has been detected. The technology already exists to extract H_2 and O_2 with a process called electrolysis using PV power equipment and cryo pumping tanks can be used to store them in liquefied conditions.
- Assuming that a minimum mass of 300 metric tons will be needed to build basic infrastructures this makes $15B of bill for Agencies like NASA and ESA at the NASA SLS Launcher price of $50,000/Kg.
- Clearly, since the bill is rather significant the Agencies will look at alternative solutions if available. The MTLM with its potential permanent service between LEO and the Moon and a cargo payload price set at $10,000/Kg (10000/2046= 4.88 profit margin) can represent the ideal solution for Space Agencies to reduce the overall bill and extend the Colony development plan.

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Funding needs, use of funds and growth potential

- The Company needs £3m from a Partner Investor (for TBD equity) to reach TRL4 and Phase B of development for the MTLM Project. TRL4 will consist by building a 1:2 scale prototype of the MTLM to be tested in Space laboratory. Phase B will define all the structure and S/S's spec.
- After this milestone, VC firms can support funding for the MTLM development that will require in the region of £300m-£1b to reach full qualification depending on the engine retrofitting/new development.
- Because the NASA's heavy Launcher SLS is absolutely not competitive in sending cargo at an acceptable price the MTLM shall be viewed by VC firms as the ideal Vehicle for this kind of mission and then support to reach TRL9.