New Space Elevator Mission Requirements

Updated Mission to Drive New Design & Technologies?

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Outline

- Realities of Humans as Space Fairing Society
- Current Space Elevator Requirements & Design
- Assessing current efforts with today's rockets
- Suggested requirements for elevator community
- Seek new innovative concepts to meet requirements

Space Faring Society Realities

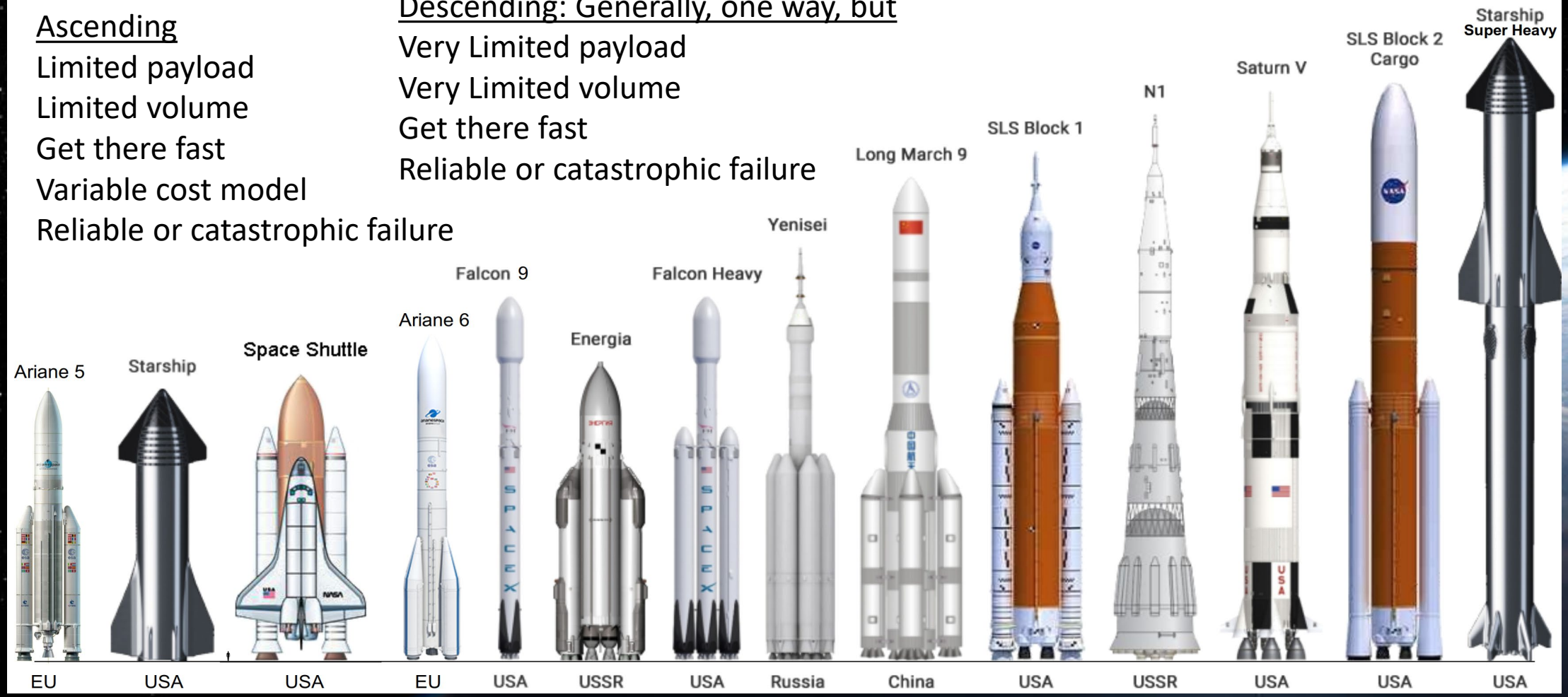
Major Off-World and Down-Earth Transport Needs - Millions of kg (Mkg)						
	Off-World (Mkg)	Down-Earth (Mkg)	# Rockets Equivalent Falcon Heavy	Rocket Cost $ Billions	Time to Complete (1 launch/wk)	Time to Complete (5 launch/wk)
Moon Village	500		29,762	2,024	572 years	114 years
SpaceX Colony Mars	1,000		59,524	4,048	1144 years	228 years
Space Solar Power	5,000		187,000	11,594	3596 years	719 years
L-5 O'Neill Colony	10,500		392,700	24,304	7551 years	1510 years
Sun-Earth L-1 Sun Shade	20,000		748,000	46,376	14384 years	2876 years
Space Tourism	TBD	TBD	TBD			
GEO Manufacturing	TBD	TBD	TBD			
Asteroid 3554 Amun Mining Products		30,000,000	Unknown Vehicle			
Other Asteroids and Space Products Returning to Earth		XXX,000,000	Unknown Vehicle			
Current Total Marketspace Needs	37,000	X30,000,000	1,383,900	$85,758	26,613 years	5,322 years

Need something with higher payload capacity, reduced cycle times and low cost

14 Largest Heavy Lift Rockets

Ascending
Limited payload
Limited volume
Get there fast
Variable cost model
Reliable or catastrophic failure

Descending: Generally, one way, but
Very Limited payload
Very Limited volume
Get there fast
Reliable or catastrophic failure



Current Space Elevator Approach: Open Study Space Elevators

Previous Space Elevator Comparison with Rockets			
	Rockets	First Space Elevator	Future Space Elevator
Vibrations	Multiple “g’s”	Negligible	Negligible
Launch Capacity	LEO: 20 tons GEO:5 tons Moon, Mars: ??	13-14 tons	Hundreds of Tons
Annual Capacity	----	1500 Tons	30,000 tons/elevator
Envelop Restrictions	Meters on a side	none	none
Cost	LEO: $2k-$10k GEO:$20k-$40k Moon, Mars: ??	Operating: $100/lb	Operating: $20/lb
Safety Issues	Propellants, re-entry, launch environment	Ribbon breakage, climber malfunction	---

Settlement & Economy Mission Needs

- Higher payload capacity,
- Reduced cycle times
- Low cost

Product Development Mantra:
Equal to or better than legacy

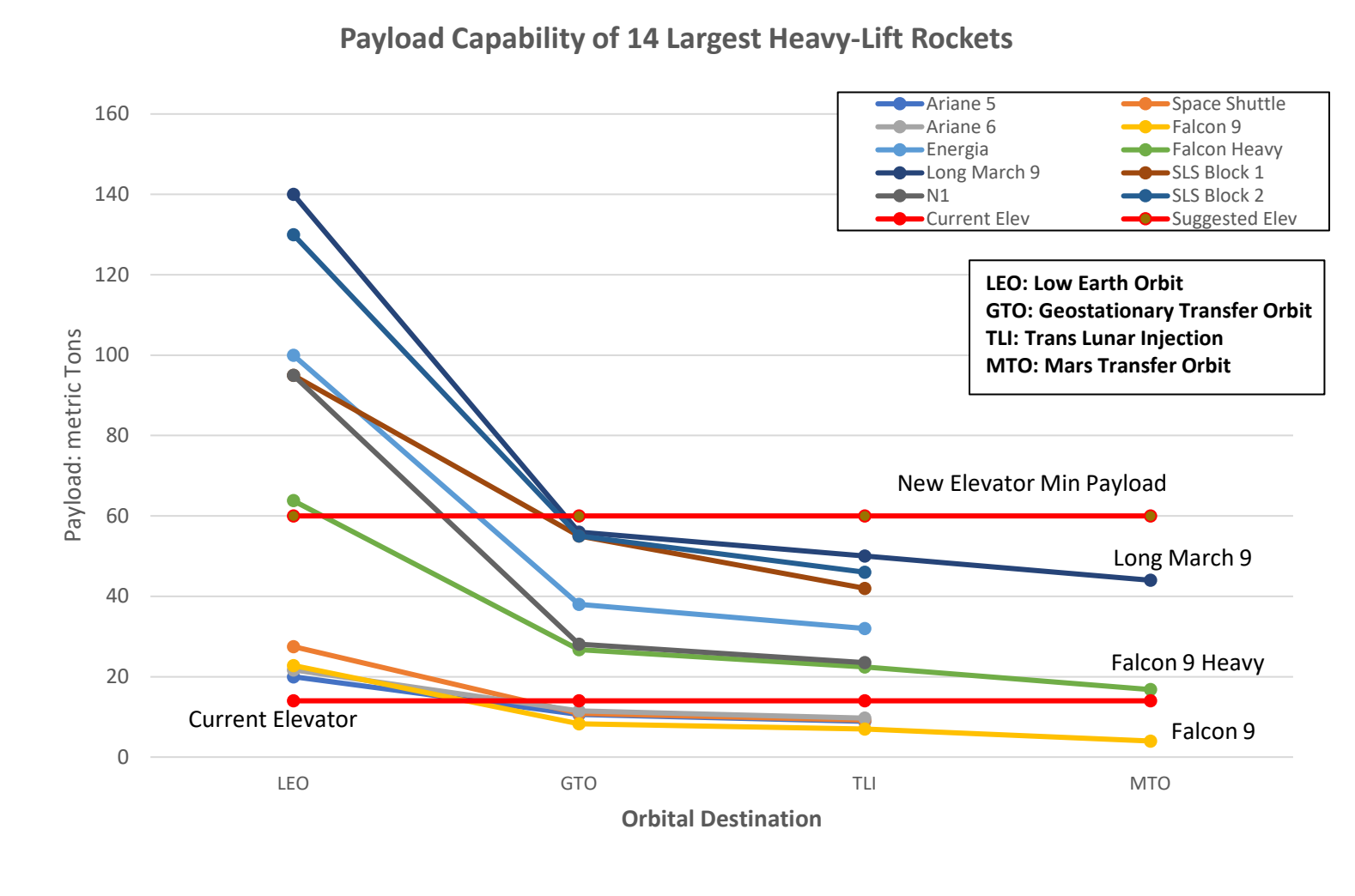
Ascending

- Payload
- Volume
- Speed
- Desired Altitude or Alternative Location
- Cost
- Reliability/finality

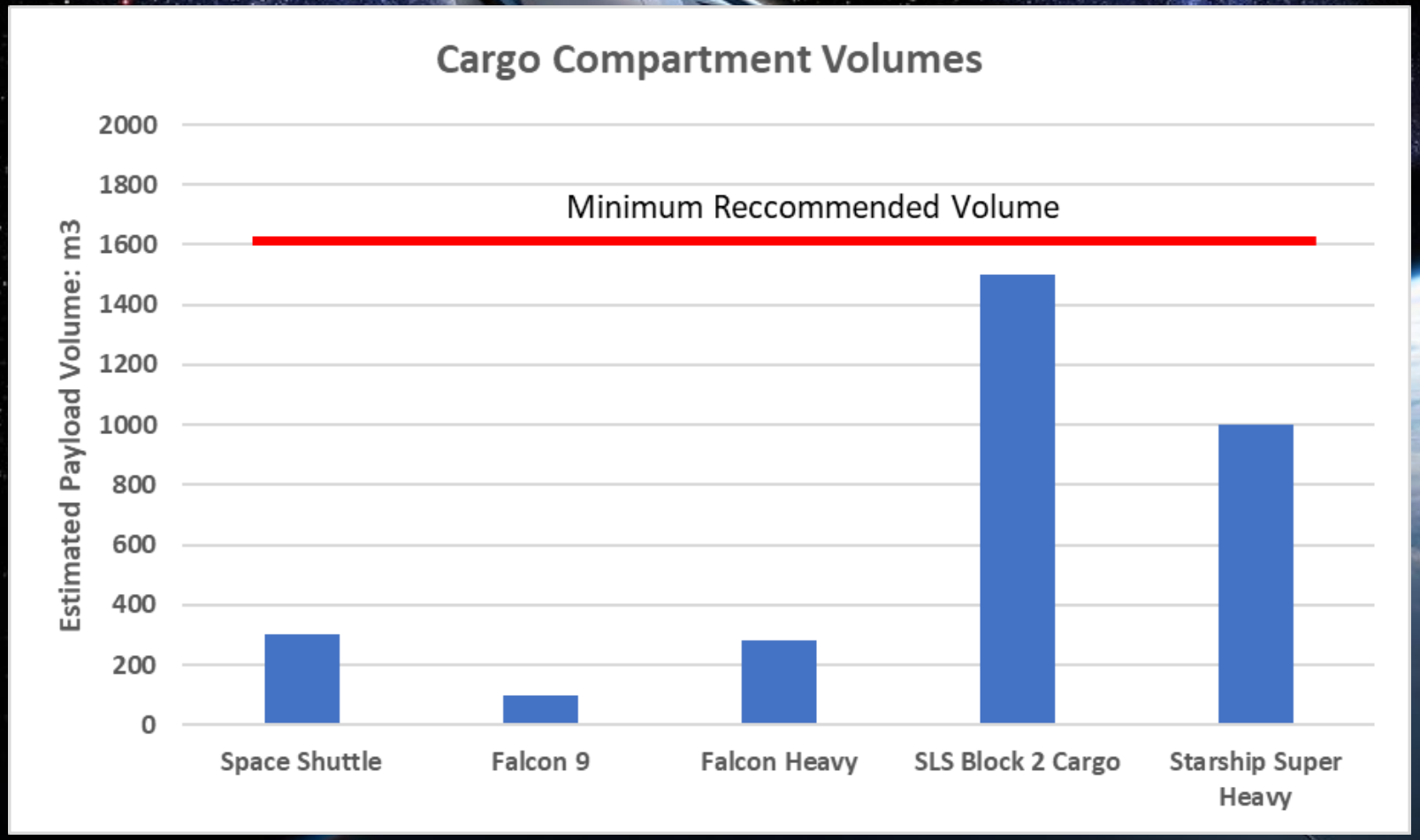
Descending

- Recoverability
- Down-Earth capability (payload/volume)

Current Design Requirements vs Rockets



What About Volume

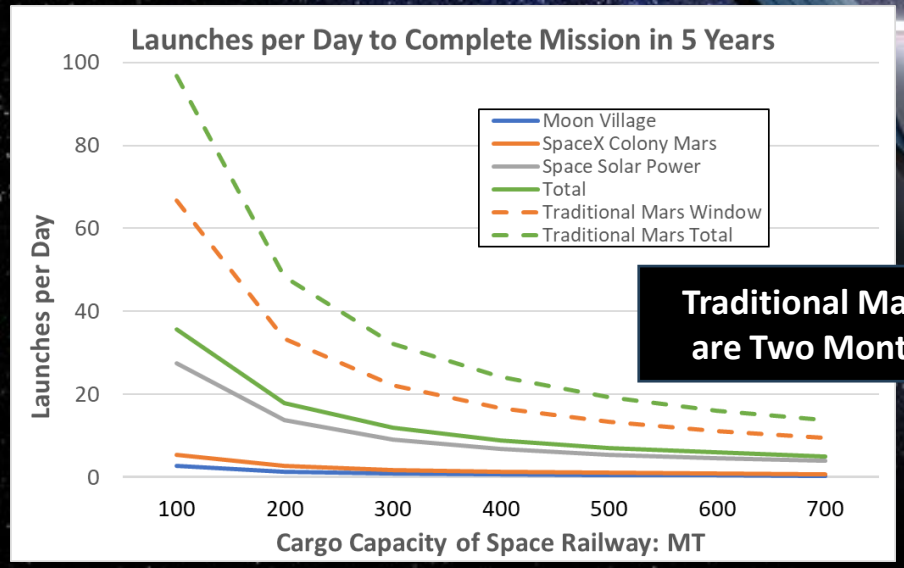


Space Faring Society Possibilities

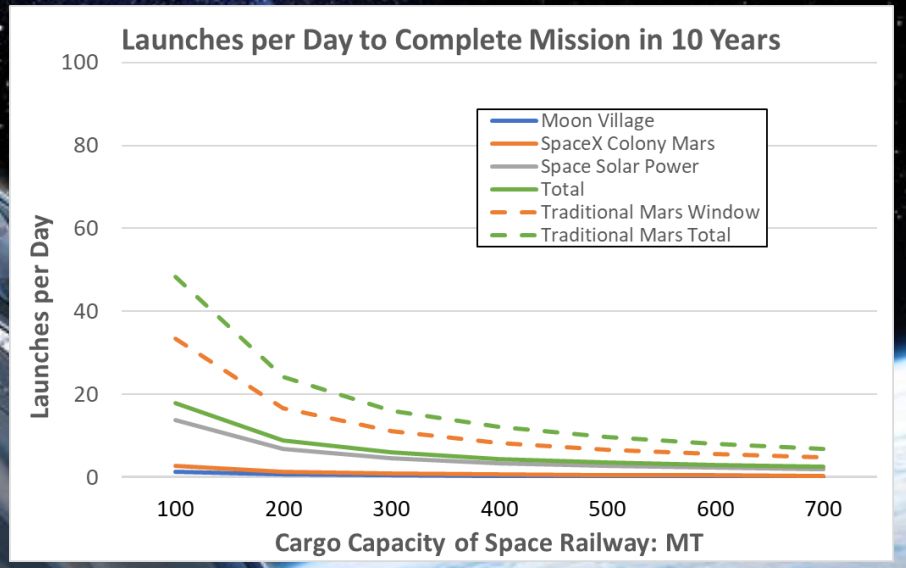
Major Off-World and Down-Earth Transport Needs - Millions of kg (Mkg)							100 mt Elevator	
	Off-World (Mkg)	Down-Earth (Mkg)	# Rockets Falcon Heavy	Rocket Cost $ Billions	Time to Complete (1 L/wk)	Time to Complete (5 L/wk)	Time to Complete (1 L/day)	Time to Complete (5 L/day)
Moon Village	500		29,762	2,024	572 years	114 years	13.7 years	2.74 years
SpaceX Colony Mars	1,000		59,524	4,048	1144 years	228 years	27.4 years	5.48 years
Space Solar Power	5,000		187,000	11,594	3596 years	719 years	137 years	27.4 years
L-5 O'Neill Colony	10,500		392,700	24,304	7551 years	1510 years	287.7 years	57.54 years
Sun-Earth L-1 Sun Shade	20,000		748,000	46,376	14384 years	2876 years	548 years	109.6 years
Space Tourism	TBD	TBD	TBD					
GEO Manufacturing	TBD	TBD	TBD					
Asteroid 3554 Amun Mining Products		30,000,000	Unknown Vehicle					
Other Asteroids and Space Products Returning to Earth		XXX,000,000	Unknown Vehicle					
Current Total Marketspace Needs	37,000	X30,000,000	1,383,900	$85,758	26,613 years	5,322 years	1013.7 years	202.74 years

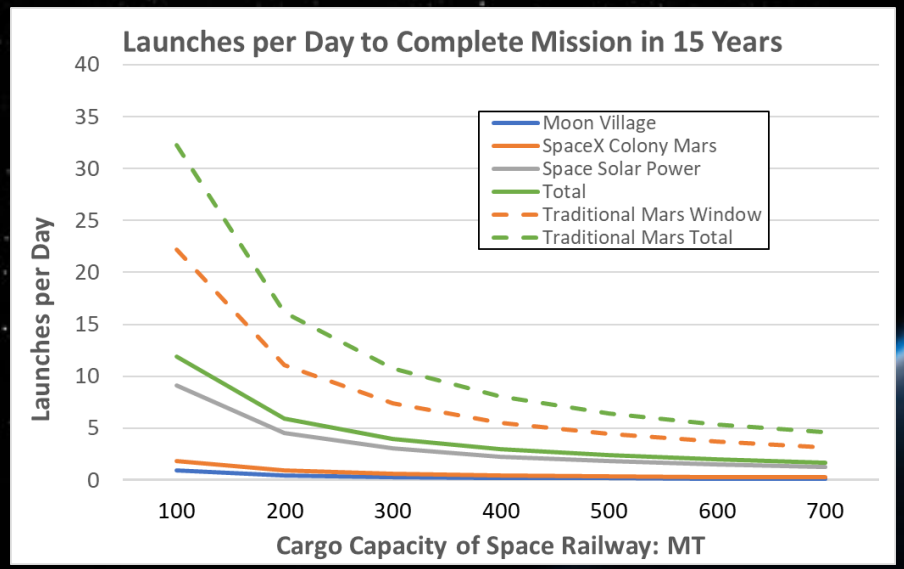
Data suggests at least 100 mt payload with five launches a day

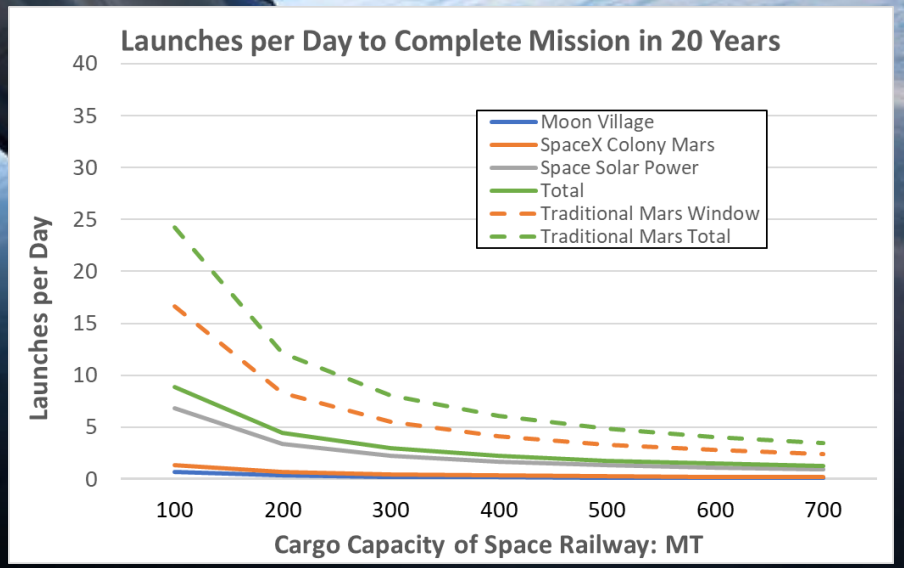
Tonnage vs Launch Cycles



Traditional Mars Launch Windows are Two Months Every Two Years

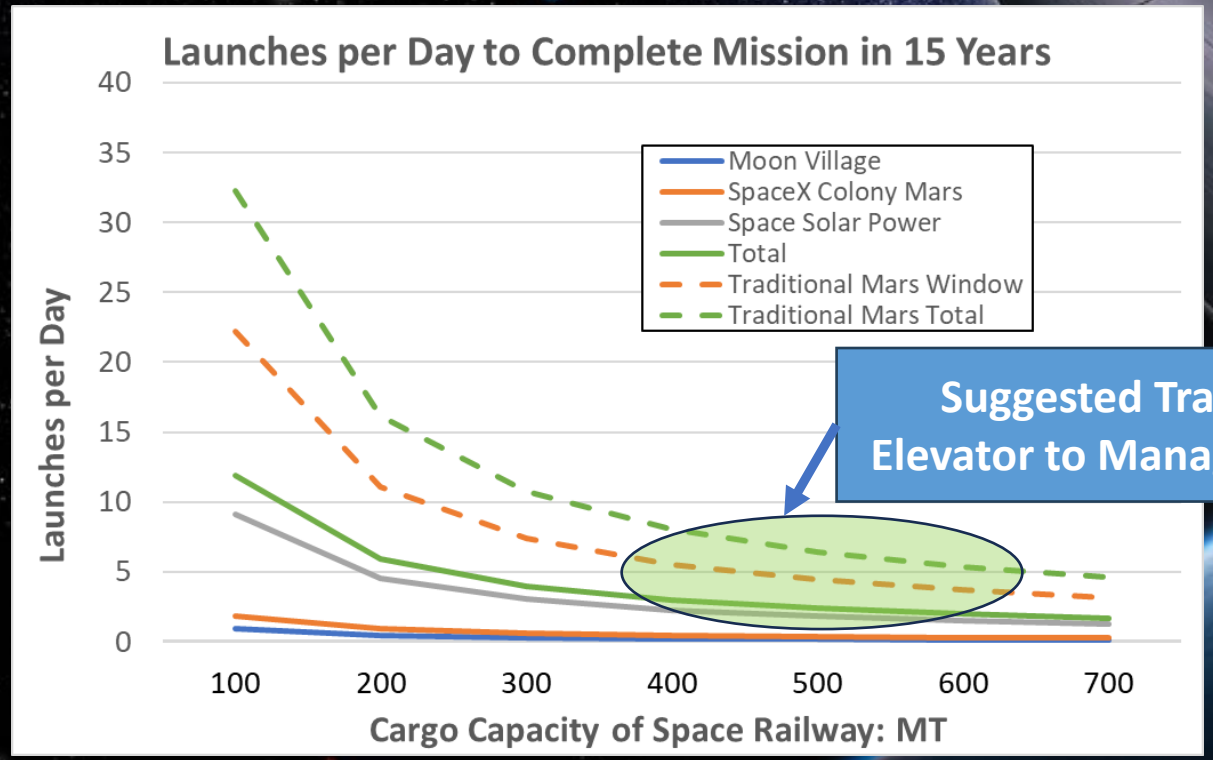


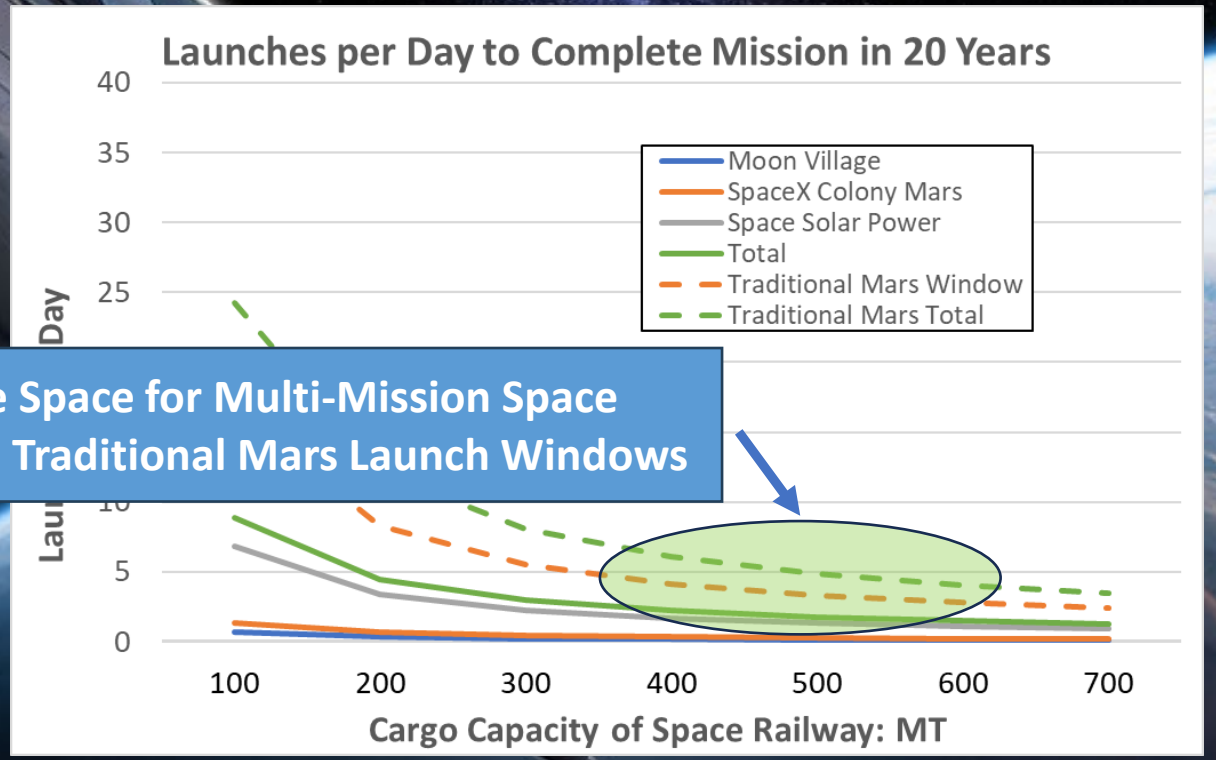




Tonnage vs Launch Cycles

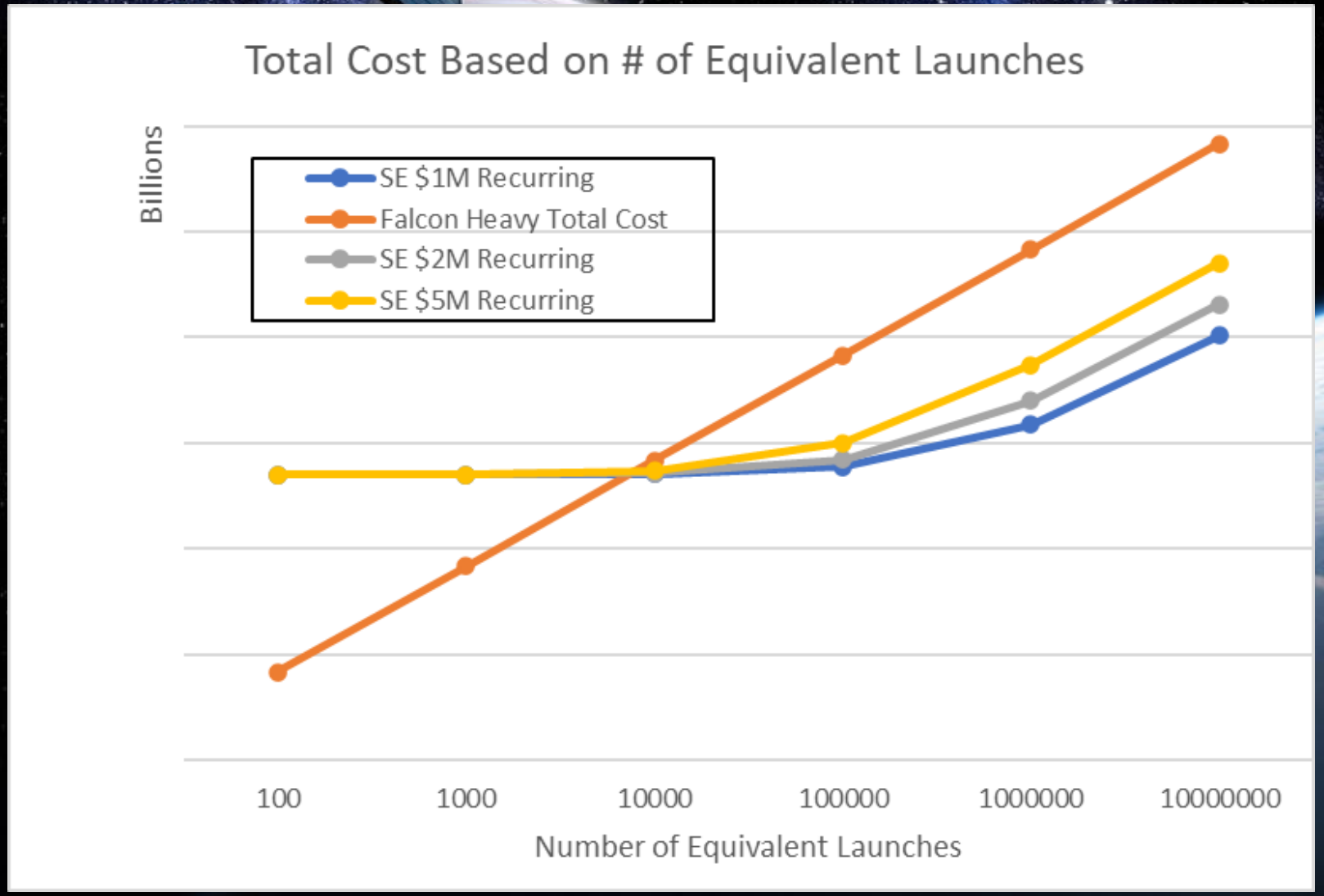
Multi-Mission Capability Suggests Beyond 100 MT Vehicles are Needed





Suggested Trade Space for Multi-Mission Space Elevator to Manage Traditional Mars Launch Windows

Different Cost Structure



Current Open Design Parameters

Current Space Elevator Design Criteria		
	First Space Elevator	Current Assessment
Theme	• Unmatched Efficiency	• Total system solution and cost for obtaining GEO & beyond. Dead weight impact on lift capability.
Elevator Type	• Mechanically gripping tether	• Wear and tear on tether • Requires continual adjustment for variable thickness tether
Launch Capacity	• 14-ton payload • 20-ton vehicle Including cargo • 7 vehicles on tether between Earth & GEO	• Far below current Falcon Heavy (29 tons) and Starship Super Heavy (XXX tons)
Speed	• 150 km/hr near Earth • 300 km/hr further out	• 120 hrs to reach GEO
Tether	• Graphene based	• Tensile strength to density ration is in the ballpark • Material characterization of this type of application
Power Source	• Solar panels hanging down from elevator	• Solar panel weight impact to payload • Solar panel impacting tether
	• Ground based lasers hitting targets on elevator	• Total system continuous wave on target for 5+ days • Seven independent laser systems • Laser impact of tether due to tether movement—7 vehicles practicality?
Timeframe	• 2038 cargo only • 2053 people & cargo capable	• Delays human space settlement by 30 years

Challenge to Space Elevator Community

- Are you using the right requirements to remain relevant
- Is your design approach the right one
- What design solutions would you pursue based on suggested requirements
- What new technologies are missing
- Does your technology suite have alternative uses

Feasible but Challenging

Space Railway Corporation’s preferred concept and technology development pursuits meet or exceed the new requirements identified in this briefing

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