



Launch Vehicles Technical Committee Report - 21th Annual Small Payload Rideshare Symposium

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June 2019

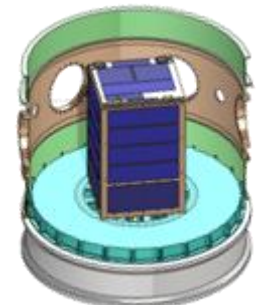
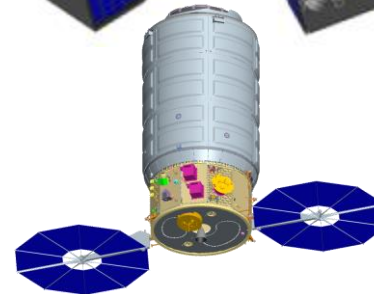
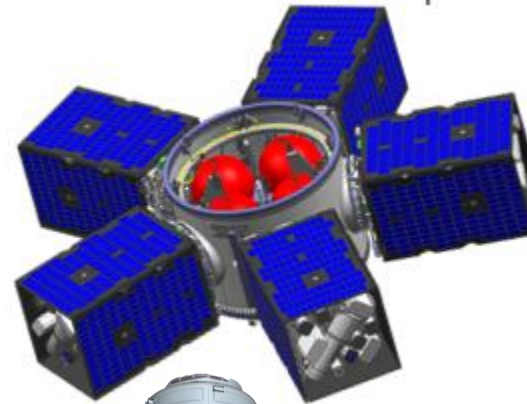
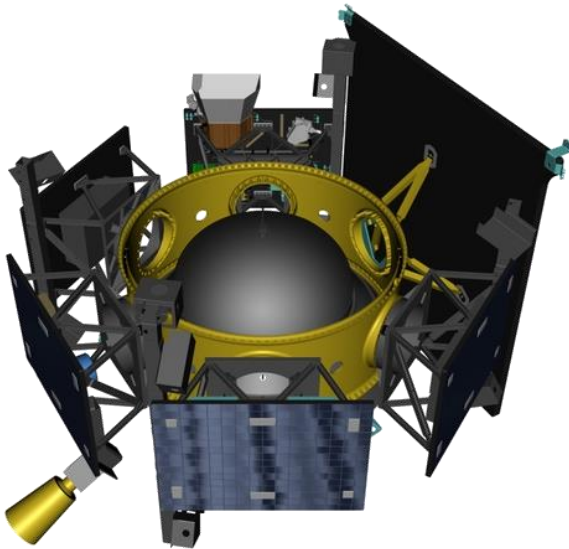
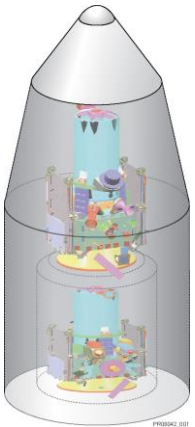
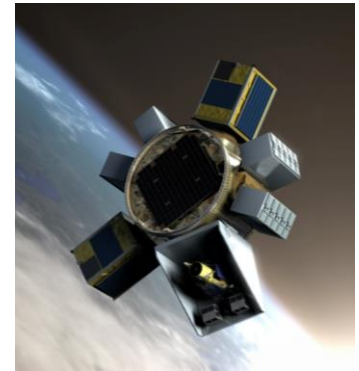
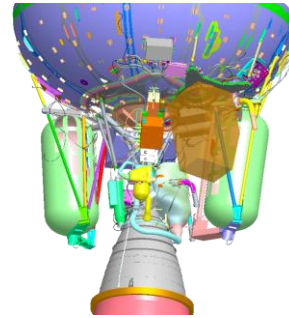
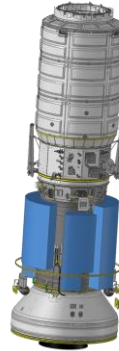
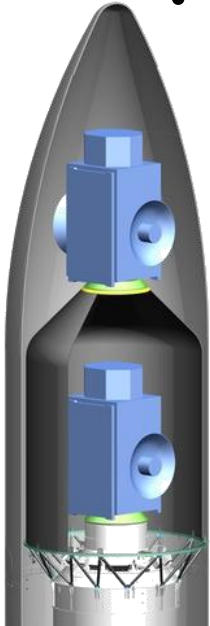


Launch Vehicle Technical Committee Description

- This committee will review the status of the current and pending launch vehicles across the world. The focus should include both the supply side issues as well as the demand side issues. The types of and compatibility with secondary adapters or payload interfaces should be evaluated; the potential availability of secondary opportunities should be discussed; and the issues of access to secondary capability, scheduling, and manifesting should be identified. Issues, concerns, suggestions, and options should be noted, discussed, and summarized based on the collective views of the committee membership.

Secondary Payload Accommodations

- Numerous – Too Many to List



RideShare Proliferation

- Data from Jonathan's Space Report, which Lists Every Satellite Ever Launched, and which Rocket it Launched on, Where from, and the Data Source, from the Very First (Sputnik, Oct 4, 1957, 1928:34, UTC from NIIP-5, LC1) to Most Recent (updated bimonthly)
- From 1957 until June, 2019, JSR Lists 11,652 satellites launched Snapshots, in 10 year increments:

Year	# of Missions (Failures)	# of Satellites Launched	Number of Multi-Manifest Launches	# of Launches with Secondaries
2018-9	96 (6)	617	45	22
2008-9	70 (4)	125	24	5
1998-9	74 (4)	172	36	7
1988-9	108 (4)	236*	31	5

* 143 Russian Kosmos Satellites

Medium/Large Launch Vehicles US

- Medium/Intermediate/Heavy (Multiple Definitions)
- Evolved Expendable Launch Vehicle (EELV) has become National Security Space Launch (NSSL) Vehicle
- 5 Flying (*Launched in Last Year*)
 - Antares (108, 57)
 - Atlas V
 - Delta II (5) – **LAST FLIGHT**
 - Delta IV
 - Falcon (4, 10*, 67, 9, 10*, 3, 60*)

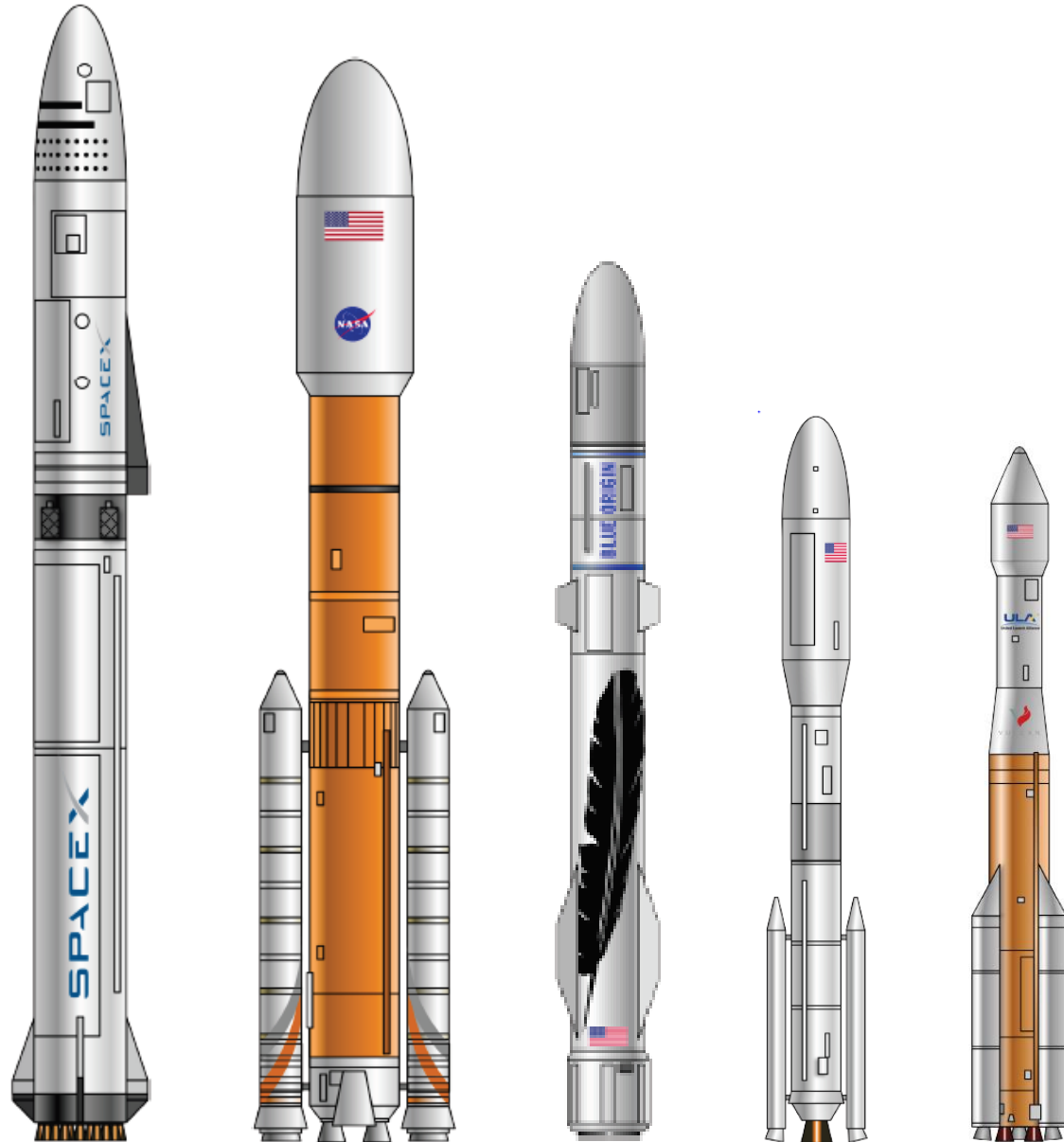
(Number of Satellites on Multi Manifest Missions)
 * Single Customer Multi-Manifest Missions



Images Courtesy of
 Phil Smith, Bryce

Medium/Large Launch Vehicles US

- 5 Incoming
 - New Glenn
 - OmegaA
 - Starship
 - SLS
 - Vulcan



Medium/Large Launch Vehicles Non-US

- Multiple Flying (Launched in Last Year)
 - PSLV (2, 31, 2, 30)
 - GSLV
 - Soyuz (3, 28, 6*, 4)
 - Proton
 - Ariane 5 (4*, 4*, 2*, 2*, 2*)
 - Angara
 - Long March (too numerous to list)
 - Vega
 - HII (7, 6)
 - Rokot (3*, 4*)
 - Epsilon (7)
- Multiple Incoming
 - Ariane 6
 - Vega-C
 - Angara 5
 - Long March 5+
 - H-III

RideShare Operational Success

- ESPA Inclusion on Missions is Succeeding
 - Planned for Many/Most USAF and NASA Missions
 - Included as NSSL requirement
- Rideshare Users Guide (2016) has been Released, Formalizing Secondary's on EELV's:
 - Secondary's are “Auxiliary Payloads” (APL's)
 - CubeSat Accommodations (3 and 6U sizes)
 - 10 to 20 kg (Dispenser mass included)
 - Aft Bulkhead Carrier (Atlas only) – to become V or Launcher Unit Class?
 - 85 kg
 - ESPA
 - 180 kg
 - ESPA Grande
 - 320 kg
 - A-Deck
 - 1000 kg
- ELANA Program Actively Placing CubeSat Mission on Many LV's



RideShare Operational Success

- Launch Brokers Commercially Successful and Proliferating
 - ISIS
 - Precious Payloads
 - SpaceFlight Services
 - TriSept
 - Tyvak
 - Others
- Government Organizations Again Resurfacing
 - USAF Multi Manifest Office
 - NASA Shared Ride Office

Small Launch Vehicles

- And Yet, the number of Small Launch Vehicles Continues to Grow:

Organization	Vehicle Name	Country	Latest Launch Date
Gloyer-Taylor Laboratories	ACE	USA	2021
PLD Space	Arion 2	Spain	3Q 2021
Astra Space			
Bagaveev Corporation			
zero2infinity			
Stofiel Aerospace	One Space Technology	OS-M1	China
CubeCub	Stratolaunch	Pegasus (Strato)	USA
LEO Launcher	SpaceLS	Prometheus-1	United Kingdom
Cloud IX	Orbex	Orbex	United Kingdom
Scorpius Space Launch Company	ISRO		
Gilmour Space Technologies	Launcher	Aerojet Rocketdyne	Hera II
Firefly Aerospace	Space Ops	Aevum	Ravn
Aphelion Orbitals	ABL Space Systems	Airbus	Unknown
iSpace	Celestia Aerospace	ArianeGroup	Orbits
Rocketcrafters	Skyrora	Avio SpA	
Virgin Orbit	ESA	B2Space	Leaf Space
Interorbital Systems	RocketStar	Blue Origin	LEO Aerospace
Linkspace Aerospace Technology Group	CONAE	bluShift Aerospace	MT Aerospace
Orbital Access	SpinLaunch	Cloud Aerospace	New Ascent
	VALT Enterprises	Dawn Aerospace	New Rocket Technologies
	Vector Space Systems	Deimos	Odyne Space
	Departamento de Ciencia e Tecnologia Aeroespacial	Eclipse Orbital	Onera
	Equatorial Space Industry	FORE Dynamics	Pangea Aerospace
	Ispace	Heliq Advanced Eng	Pipeline2Space
	LandSpace	Hylmpulse	Roketsan
		Independence-X Aero	Rose Galactic
		InterStellar Technolog	SMILE
		JAXA	Space Walker
		JP Aerospace	StratoBooster
		Isar Aerospace Techn	Thor Launch Systems
		KB Yuzhnoye	TiSpace
		Kiwi Orbitals	U. Hawaii, Aerojet Rocketdyne, Sandia
			Super Strypi
			United Frontiers LLC
			Oceanic Orbital Launch Vehicle
			UP Aerospace
			Spyder
			Vanguard Advanced Systems
			Athena
			UK
			Vogue Aerospace
			Vogue RLV
			USA/Italy
			X-Arc Aerospace
			PQXI-1
			United Kingdom

140+!*

* See Carlos Niederstrasser for Details...

Small Launch Vehicles

- The Operational Small Launch Vehicles Are Launching Multiple Payloads:
 - Pegasus (8*)**
 - Electron (7, 14, 5)
 - Minotaur I (30)**
 - Minotaur IV (4)**

** - Last Mission - Not in last 12 Months



Small Payload Ride Share Association

Small Launch Vehicles

- And 140 LV Concepts (all sizes) are now Ranked by “Legitimacy” by SpaceFund
- Not all are LV’s
 - List Includes Balloons, Planes, and SpacePlanes

Company	SFR	Payload (kg)	Launch Cost (\$M)	Price (\$/kg)	Funding (\$M)	Launch Class
Airstar Aerospace	9	2,700	0	0	0-	Small, Medium
Avio/Arianespace	9	20,000	170	8,500	Public	Medium, Heavy
Blue Origin	9	45,000	0	0	0-	Small, Heavy
ExPace (by CASIC)	9	1,500	0	10,000	181.99	Small
Northrop Grumman	9	8,000	80	10,000	Public	Small, Medium
Rocket Lab	9	225	4.9	21,778	257.31	Small
SpaceX	9	63,800	90	1,411	2740	Heavy, Super Heavy
Swedish Space Corp	9	2,000	0	0	0-	Small
United Launch Alliance	9	17,800	99	5,562	Joint Venture	Medium, Heavy
UP Aerospace	9	36	0	0	0.72	Small
World View	9	4,500	0	0	48.68	Small, Medium
Sierra Nevada	8	5,000	0	0	0-	Medium
Stratolaunch	8	1,000	0	0	0-	Small
The Spaceship Company/Virgin Galactic	8	372	1.5	4,032	Joint Venture	Small
Vector	8	290	4.5	0	103	Small
Virgin Orbit/VOX Space	8	500	12	24,000	-	Small
Firefly Aerospace	7	1,000	15	15,000	23.16	Small
Phantom Express (by Boeing/DARPA)	7	1,361	5	3,674	Joint Venture	Small
Zero 2 Infinity	7	100	4	40,000	13.83	Small
One Space	6	200	3.2	16,000	116	Small
PLD Space	6	300	0	0	18.94	Small
Relativity Space	6	1,250	10	8,000	44.54	Small
Sea Launch/S7	6	6,160	0	0	0-	Medium
iSpace	5	1,900	0	0	92.92	Small
Landspace	5	4,000	0	0	115.30	Small, Medium
Maritime Launch Services	5	5,000	45	9,000	-	Medium
Masten	5	0	0	0	3.27	-
Orbex	5	220	0	0	39.53	Small
PD Aerospace	5	6,000	0	0	6.75	Medium
Reaction Engines	5	17,000	0	860	95.37	Medium
Starchaser	5	186	0	0	0-	Small
Thor Launch Systems (by 8 Rivers)	5	0	0	0	0-	-
ABL Space Systems	5	1,200	12	10,000	-	Small
Astra Space	5	100	0	0	0-	Small
Exos Aerospace	5	100	0	0	8.81	Small
Generation Orbit	5	45	2.5	55,556	-	Small
Interstellar Technologies	5	100	0.44	4,400	0.35	Small
Copenhagen Suborbitals	4	62	0	0	0-	Small
CosmoCourse	4	434	1.5	0	0-	Small
Dawn Aerospace	4	0	0	0	4.54	-
Gilmour Space Technologies	4	400	0	25,000	17.62	Small
Green Launch	4	5	0	0	0.50	Small
Leaf Space	4	0	2.27	0	1.59	Small
LinkSpace	4	200	4.5	22,500	-	Small
Microcosm (Scorpius)	4	160	4	25,000	-	Small
MT Aerospace	4	50	0	0	43.81	Small
Rocket Crafters	4	500	9	18,000	2.00	Small
Skyroot Aerospace	4	720	0	0	0-	Small
Skyrora	4	500	12.6	25,200	4.85	Small
Space Darts	4	100	0.1	1,000	15.00	Small



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