United Launch Alliance

2012 Cubesat Workshop

ULA Rideshare Update

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Major Travis Willcox
will brief status of the NRO L-36 Mission
On Friday

Rideshare Missions

- ULA's family of expendable launch vehicles has a long history of providing high-value payload accommodations for a variety of customer spacecraft & missions throughout the solar system

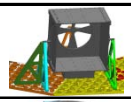
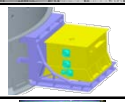
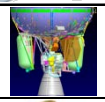
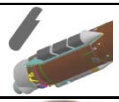
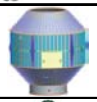
ULA PLANETARY MISSIONS (Since 2001)	VEHICLE	LAUNCH DATE	DESTINATION
Mars Odyssey	Delta II 7925	4/7/2001	Mars
CONTOUR	Delta II 7425	7/3/2002	Comet
Mars Rover A (Spirit)	Delta II 7925	6/10/2003	Mars
Mars Rover B (Opportunity)	Delta II 7925H	7/7/2003	Mars
MESSENGER	Delta II 7925H	8/3/2004	Mercury
Deep Impact	Delta II 7925	1/12/2005	Comet
Mars Reconnaissance Orbiter	Atlas V 401	8/12/2005	Mars
New Horizons	Atlas V 551	1/19/2006	Pluto
STEREO	Delta II 7925	10/25/2006	Sun (Earth orbit)
Phoenix	Delta II 7925	8/4/2007	Mars
Dawn	Delta II 7925H	9/27/2007	Asteroid Belt
Lunar Reconnaissance Orbiter	Atlas V 401	6/18/2009	Moon

- Most of these missions were launched as primary payloads and used the full capability of the launch vehicle, but there are lower-cost alternatives for achieving these science objectives

Rideshare Concept

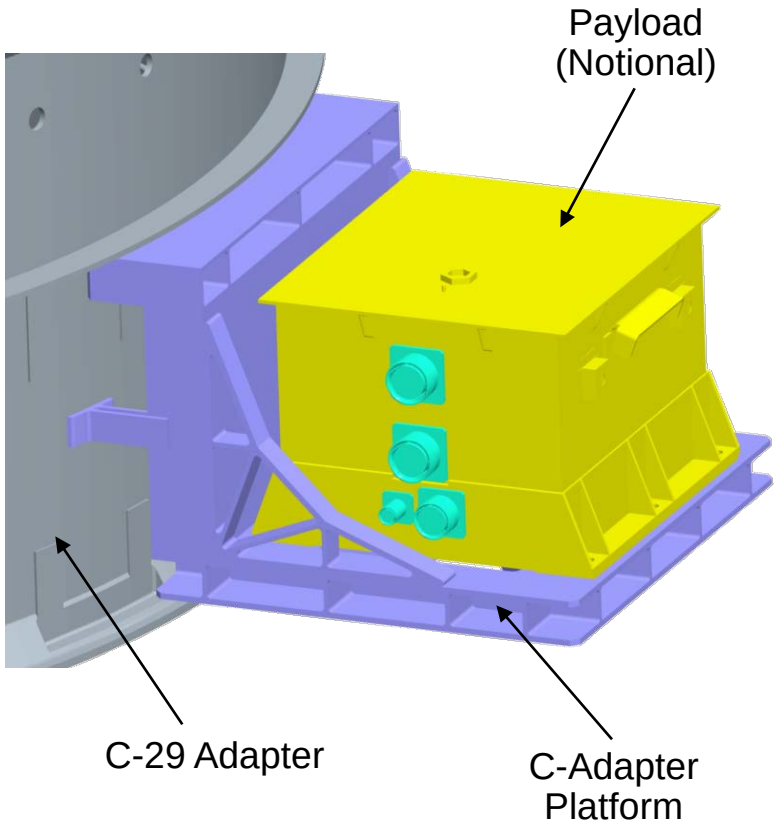
- What is Rideshare?
  - Sharing available performance and volume margin that would otherwise go unused by the primary payload
- Advantages to Rideshare
  - Provides an inexpensive and reliable solution
    - Cost-savings allows more funding to be applied to the science mission
    - Rideshare payload receives the benefits of full-up launch service
- Successfully demonstrated in 2009, with LCROSS was flown as a secondary payload on an Atlas V that launched the LRO
- Difficulties:
  - 1. ownership of the mission margin
  - 2. ULA reluctance to have more than a single contract per mission

ULA Rideshare Capability Overview

CAPABILITY	MAXIMUM MASS PER PAYLOAD	VOLUME	INTERFACE	MAXIMUM # / LAUNCH	COMPATIBILITY DII	COMPATIBILITY DIV	COMPATIBILITY AV	STATUS
Delta II Second-Stage Mini-Skirt 	1.0 kg (2.2 lb)	10 cm^3 (4 in^3)	P-POD	6 Cubesats	X			ILC 2011
Delta IV Equipment Shelf 	1.0 kg (2.2 lb)	10 cm^3 (4 in^3)	P-POD (NPSCuL)	24 Cubesats		x		Concept Development
ULA EELV P-POD 	1.0 kg (2.2 lb)	10 cm^3 (4 in^3)	P-POD	24 Cubesats		x	x	Concept Development
CAP (C-Adapter Platform) 	45 kg (100 lb)	23 cm x 31 cm x 33 cm (9 in x 12 in x 13 in)	15" clampband	4		x	x	ILC 2012
ABC (Aft Bulkhead Carrier) 	77 kg (170 lb)	51 cm x 51 x 76 cm (20 in x 20 in x 30 in)	15" clampband or P-POD	1			x	ILC 2012
A-DECK (Auxiliary Payload Deck) ***(Adaptive Launch Solutions)*** 	905 kg (2,000 lb)	152-cm dia. (60-in dia.)	15", 23", 37" clampband	1		x	x	ILC 2012
ESPA (EELV Secondary Payload Adapter) ***(Moog CSA Engineering)*** 	180 kg (400 lb)	61 cm x 71 cm x 96 cm (24 in x 28 in x 38 in)	15" bolted	6		x	x	Operational
IPC (Integrated Payload Carrier) 	910 kg (2,000 lb)	137-cm dia. (54-in dia.)	8", 15", 37" clampband	1		x	x	Operational
XPC (External Payload Carrier) ***(Special Aerospace Services)*** 	1,590 kg (3,500 lb)	20.1 m^3 (710 ft^3)	60" diameter	1			x	PDR 12/2010
DSS-4M (Dual Spacecraft System - 4M) 	2,270 kg (5,000 lb)	254-cm dia. x 127 cm (100-in dia. x 50 in)	37" clampband	1		x	x	ILC 2012
DSS-5M (Dual Spacecraft System - 5M) 	5,000 kg (11,000 lb)	4-m dia. x 6.1 m (13.1-ft dia. x 20 ft)	62" bolted	1		x	x	Concept Development

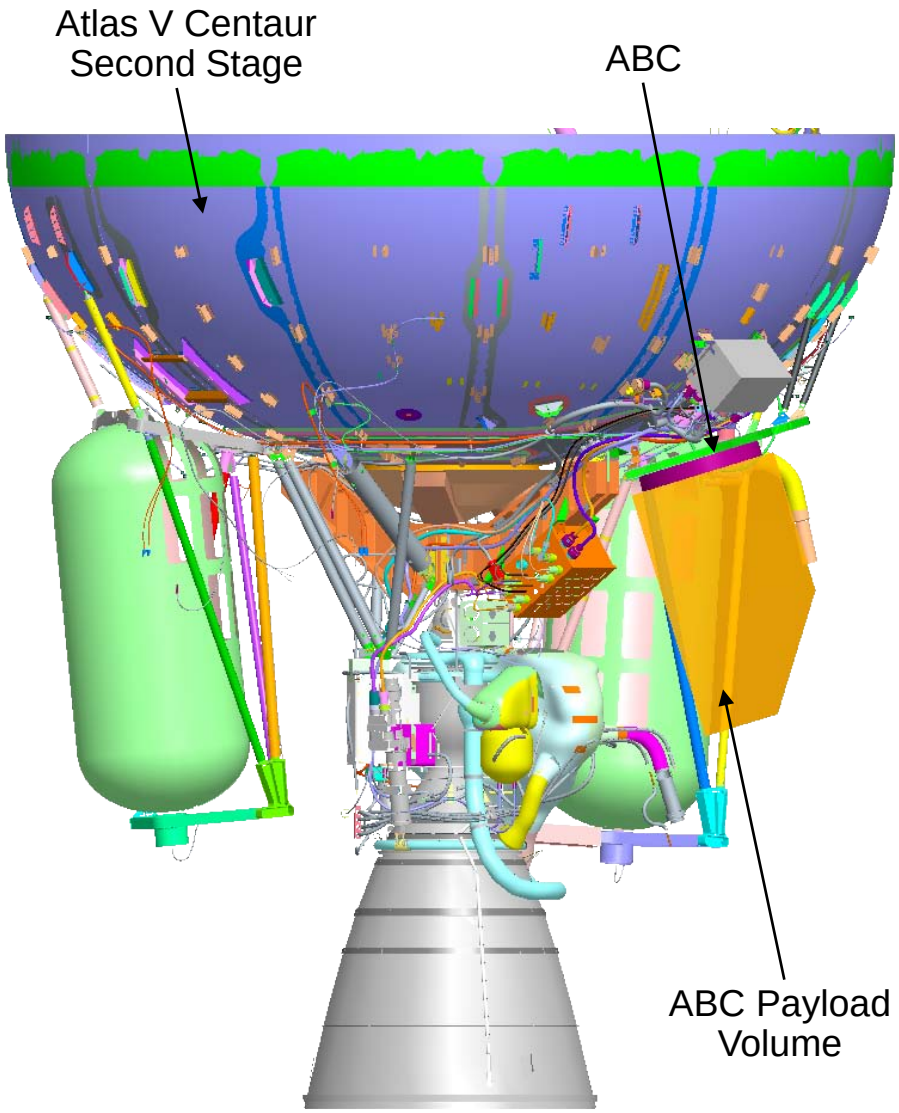
C-Adapter Platform (CAP)

- Description
  - A cantilevered platform attached to the side of a C-adapter to accommodate secondary payloads
  - Alt config: flat plate using same brackets w/ 15 in. sep ring
- Capabilities
  - Mass: 45 kg (100 lb)
  - Volume: 23 cm x 31 cm x 33 cm (9 in x 12 in x 13 in)
  - Interface: 15-in clampband
  - Capacity: 4 slots
  - Vehicle: Atlas V, Delta IV
- Status
  - First launch 2012
- Why?
  - Can be used to advance TRL for electronics into the Van Allen Belt



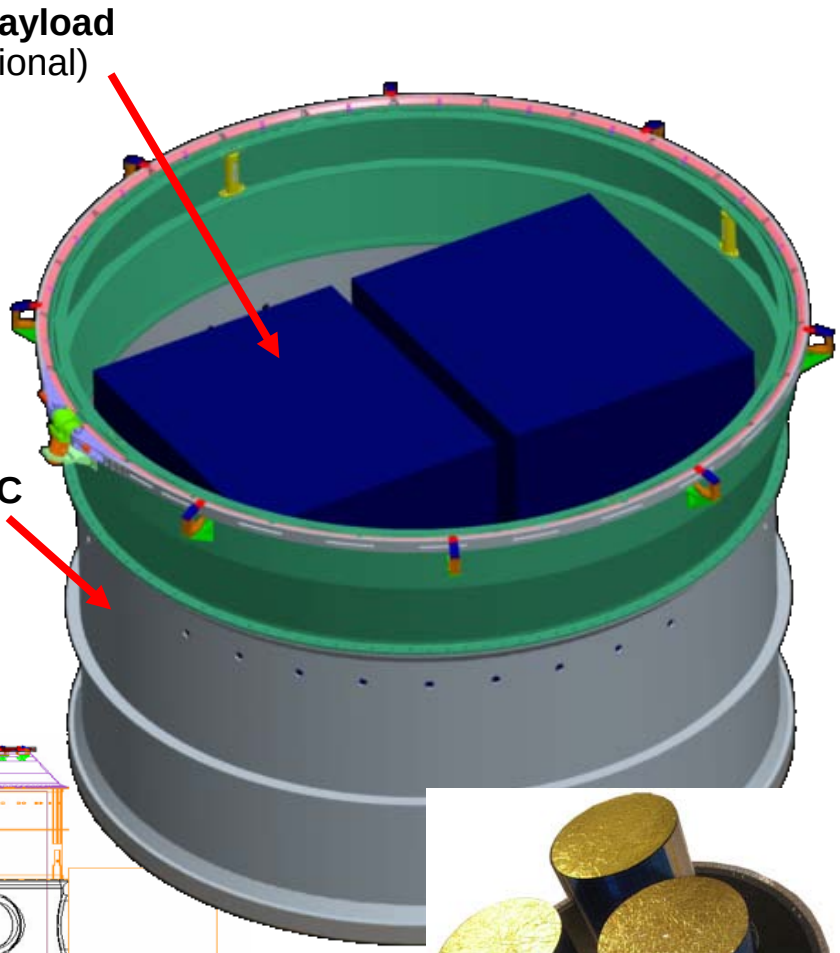
Aft Bulkhead Carrier (ABC)

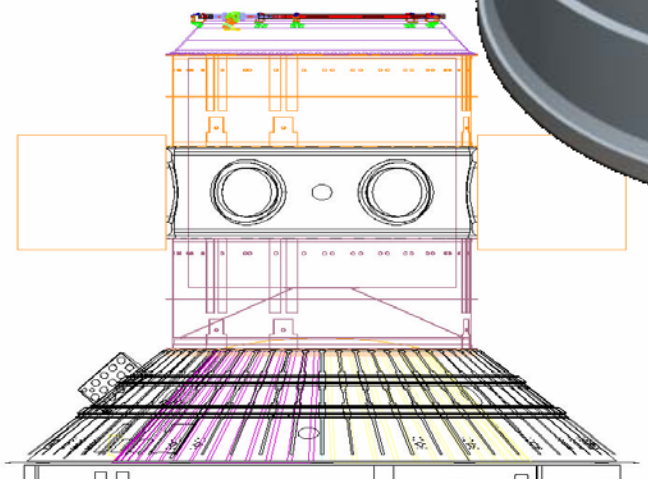
- Description
  - I/F located at the aft-end of the Atlas V Centaur second-stage
- Capabilities
  - Mass: 80 kg
  - Volume: 51 cm x 51 cm x 76 cm (20 in x 20 in x 30 in)
  - Interface: 15-in clampband or P-POD dispenser
  - Capacity: 1 slot
  - Vehicle: Atlas V
- Status
  - First launch 2012 (NROL-36)
  - ABC Users Guide available 9/12
- Why?
  - Sep from primary – release any time, no contamination, no re-contact, no security

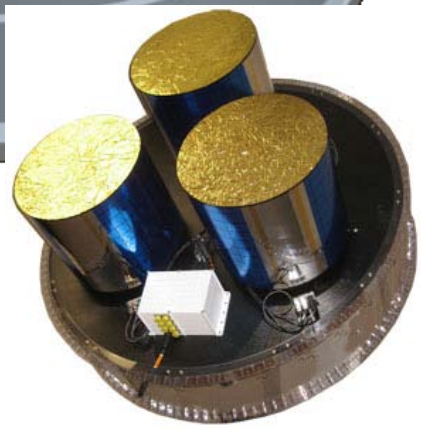


Integrated Payload Carrier (IPC)

- Description
  - A flexible **stack of ring segments**
  - Config: **conic or A-Deck**
- Capabilities
  - Mass: 910 kg (2,000 lb)
  - Volume: 137-cm dia. (54-in dia.)
  - Vehicle: Atlas V, Delta IV
- Status
  - Operational
- Why?
  - Large volume
  - on centerline
  - treated as single SC
  - height up to 7 ft

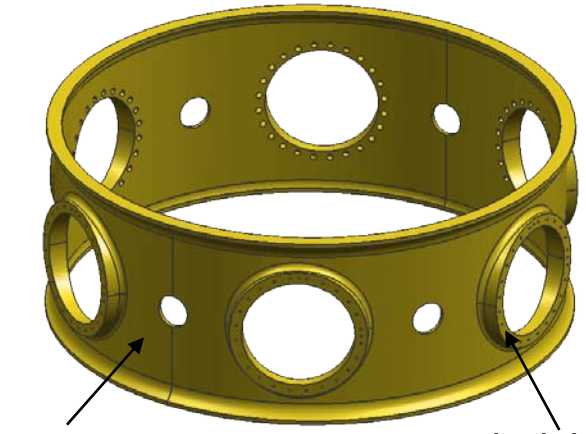


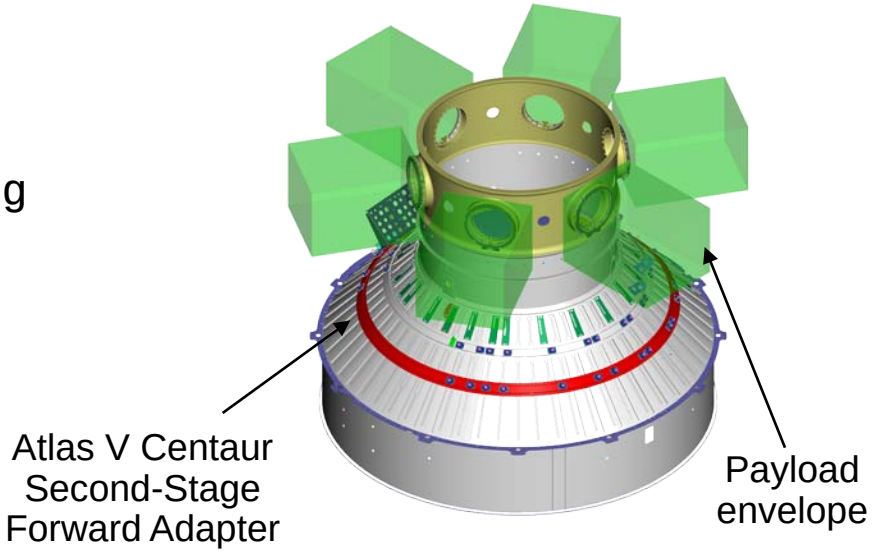




EELV Secondary Payload Adapter (ESPA)

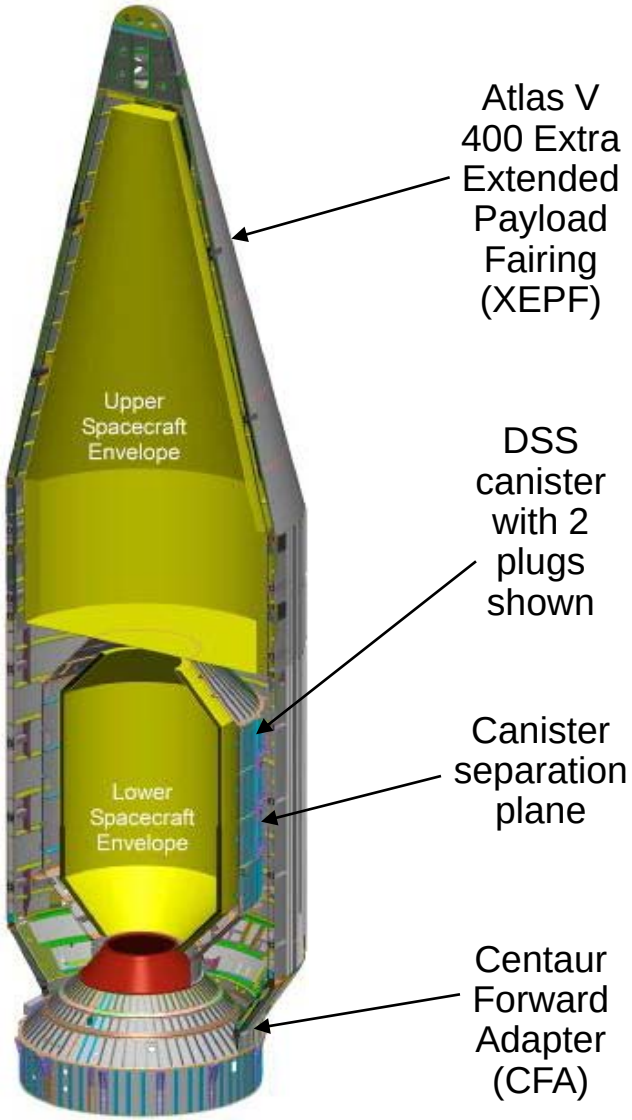
- Description
  - An adapter located between the second-stage and the primary payload, which can accommodate up to six secondary payloads
- Capabilities
  - Mass: 180 kg (400 lb)
  - Volume: 61 cm x 71 cm x 96 cm (24 in x 28 in x 38 in)
  - Interface: 15-in bolted
  - Capacity: 6 slots
  - Vehicle: Atlas V, Delta IV
  - Developer: Moog CSA Engineering
- Status
  - Operational
  - ESPA Rideshare Users Guide currently available





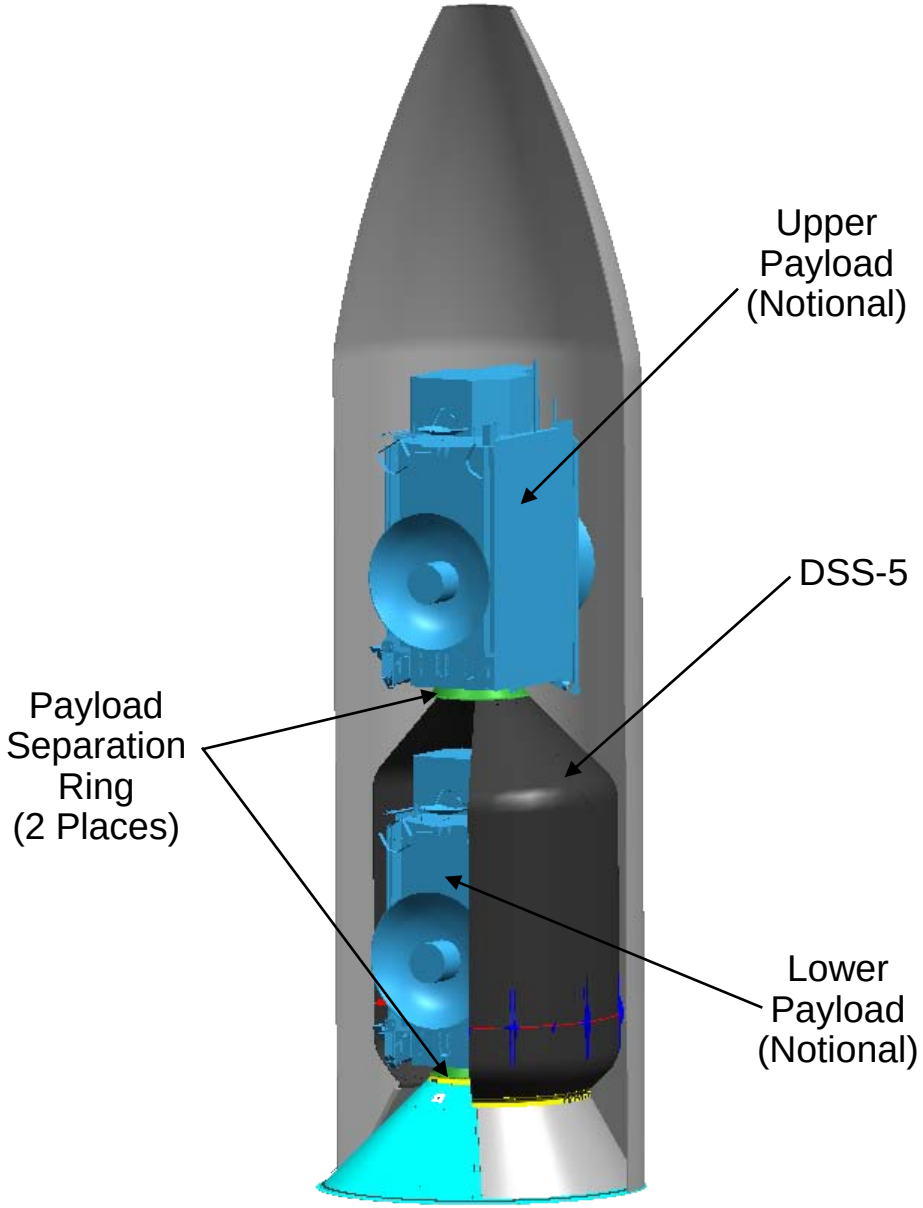
Dual Spacecraft System, 4-m (DSS-4)

- Description
  - A modular dual-manifest launch capability for 4m fairings, using Centaur Forward Assembly hardware
- Capabilities
  - Mass: 2,270 kg (5,000 lb)
  - Volume: 254-cm dia. x 127 cm (100-in dia. x 50 in)
  - Interface: Variable
  - Capacity: 1 slot
  - Vehicle: Atlas V, Delta IV
- Status
  - CDR Dec 2009
- Why?
  - Can lift 2 Delta-II class S/C, variable stack height, 10,000 lb upper w/ 5,000 lb lower



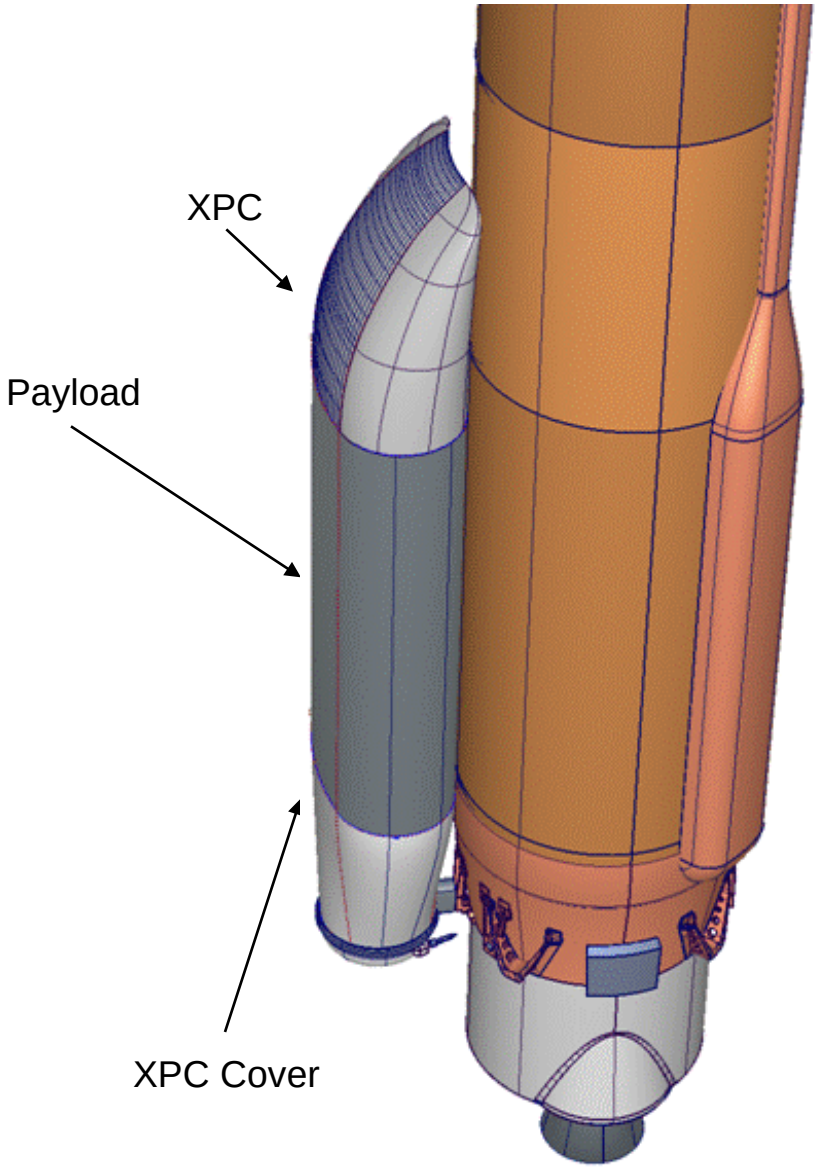
Dual Spacecraft System, 5-m (DSS-5)

- Description
  - A dual-manifest launch capability for 5-m fairings, using newly designed composite structure
- Capabilities
  - Mass: 5,000 kg (11,000 lb)
  - Volume: 4-m dia. x 6.1 m (13.1-ft dia. x 20 ft)
  - Interface: 62-in Bolted
  - Capacity: 1 slot
  - Vehicle: Atlas V, Delta IV
- Status
  - Concept Development
- Why?
  - Can support 2 GPS III S/C



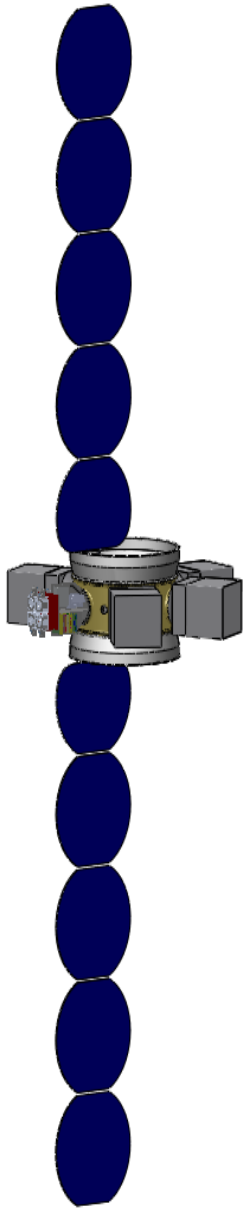
eXternal Payload Carrier (XPC)

- Description
  - An inert Solid Rocket Motor to hold small payloads for injection into a hypersonic suborbital trajectory
- Capabilities
  - Mass: 8000 lb
  - Volume: 60" diameter x 70 ft
  - Payload: ~3500 lb
  - Capacity: 1 SRM slot
- Status
  - Tailored PDR
- Why?
  - XPC goes ballistic w/ the booster
  - 900,000 ft going Mach 14,
  - ideal for Mars re-entry or SCRAMjet technology,
  - will have 6 min. of 0-g



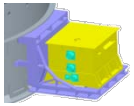
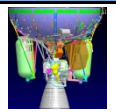
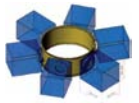
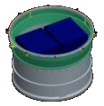
Electric 3rd-Stage

- **MULE (Multi-payload Utility Lite Electric) stage** provides high deltaV to perform delivery of ESPA class payloads to a variety of orbits and Earth Escape missions
  - Delivery to Earth Escape (Lunar, NEO, Mars)
  - Delivery of a constellation suite
  - Delivery to GSO
  - High delta-V
  - Solar Electric propulsion
  - Based on the ESPA Ring structure
  - Supports on-orbit operations for a year or more



Potential Rideshare Opportunities

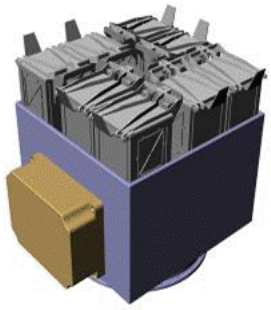
- All potential mission opportunities will need to be:
  - Assessed for technical compatibility
  - Coordinated and approved by the primary payload customer

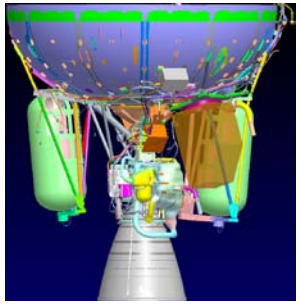
MISSION	TIMEFRAME	ORBIT TYPE	PROSPECTIVE CAPABILITY MATCHUPS				
			 P-POD	 CAP	 ABC	 ESPA	 IPC
AEHF	2011-2020	GTO	X		x		
DMSP	2012-2015	LEO (WR)	X	X	X	X	
GPS IIF	2010-2015	MEO	X	X	X	X	X
GPS III	2014-2020	MEO	X	X	X		
SBIRS	2011-2020	GTO	X	X	X		
LDCM	2012	LEO (WR)	TBD				
MMS	2014	GTO	TBD				
RBSP	2012	GTO	X	X	X	X	
TDRS	2012-2017	GTO	X	X	X		
CLS 1	2013	LEO	X	X	X	X	X
CLS 2	2014	LEO	X	X	X	X	X

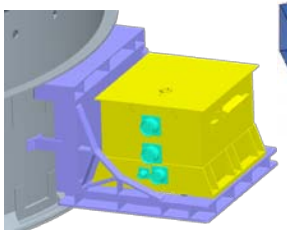
Rideshare Spectrum of Capabilities

A range of capabilities address differing size, mass, and other requirements and provide individual operational advantages

3







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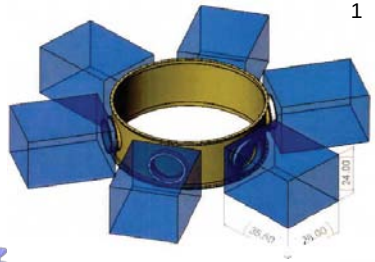

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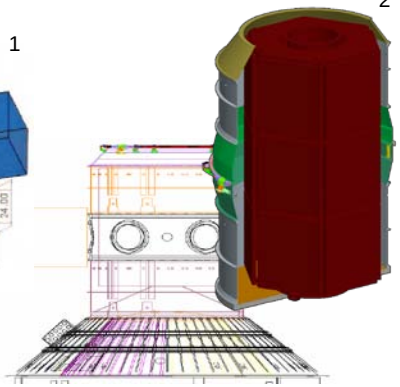

P-Pod°	ABC	CAP+	ESPA*	IPC	DSS
Poly PicoSat Orbital Deployer	Aft Bulkhead Carrier	C-Adapter Platform+	EELV Secondary P/L Adapter	Integrated Payload Carrier	Dual Satellite System
10 kg	**80 kg**	**100 kg**	**200 kg/ea.**	**500+kg**	**5000 kg**
R&D Development	Releasable in LEO	2-4 Slots per Launch	ESPA Way Fwd Progress	Mix and Match H/W Internal and External P/L	All Flight Proven H/W
Dynamically Insignificant	Isolated from Primary S/C	Less obtrusive than ESPA	STP-1 Flew 2007	SP to 60 in. diameter	Sp to 100 in diam.
First flight ILC 2011	First flight ILC 2010	First flight Fist Flight 2010	SERB List from the DoD Space Test Program	Last Flight LRO/LCROSS	CDR 4Q 2009 ILC 2011

Delivering a Wide Range of Small Spacecraft with the Appropriate Conops and Technical Accommodations

1 ESPA Graphic courtesy of CSA Engineering, Inc
2 COTSAT courtesy of NASA/AMES
3 NPSCuL courtesy of NPS