ENGINEERING LIMITLESS POSSIBILITIES

John Elbon

10.24.18

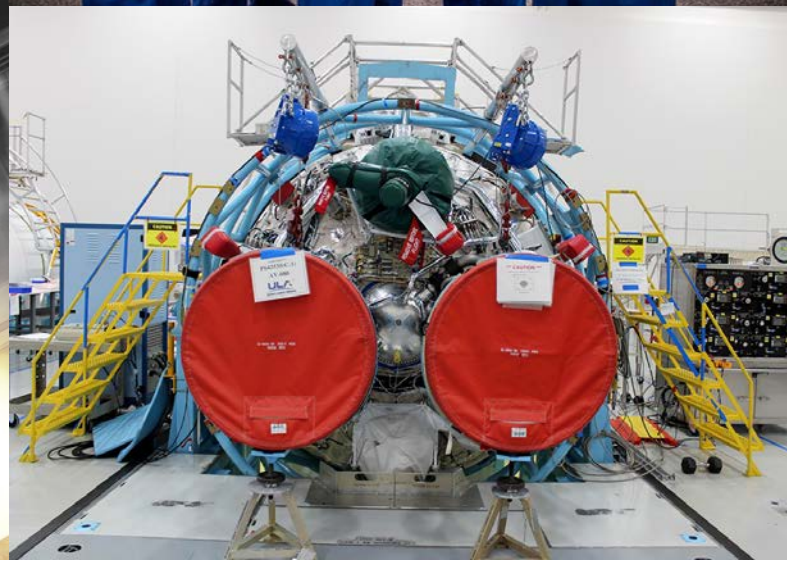
WE'VE HELPED
OUR CUSTOMERS
SAVE LIVES

WE'VE HELPED OUR CUSTOMERS EXPLORE THE UNIVERSE

WE'VE HELPED OUR CUSTOMERS CONNECT THE WORLD

131 SUCCESSFUL LAUNCHES

RETURNING HUMANS TO SPACE FROM U.S. SOIL




DEVELOPING A
NEXT GENERATION
ROCKET
VULCAN CENTAUR

ULA DIFFERENTIATORS

Reliability

- **100% Mission Success** with **131** launches since ULA formation
- **Atlas: Unmatched reliability** with **154** consecutive, successful flights since 1993
- **Atlas V: Launched 79 consecutive, successful missions** including first flight in 2002

Schedule Certainty

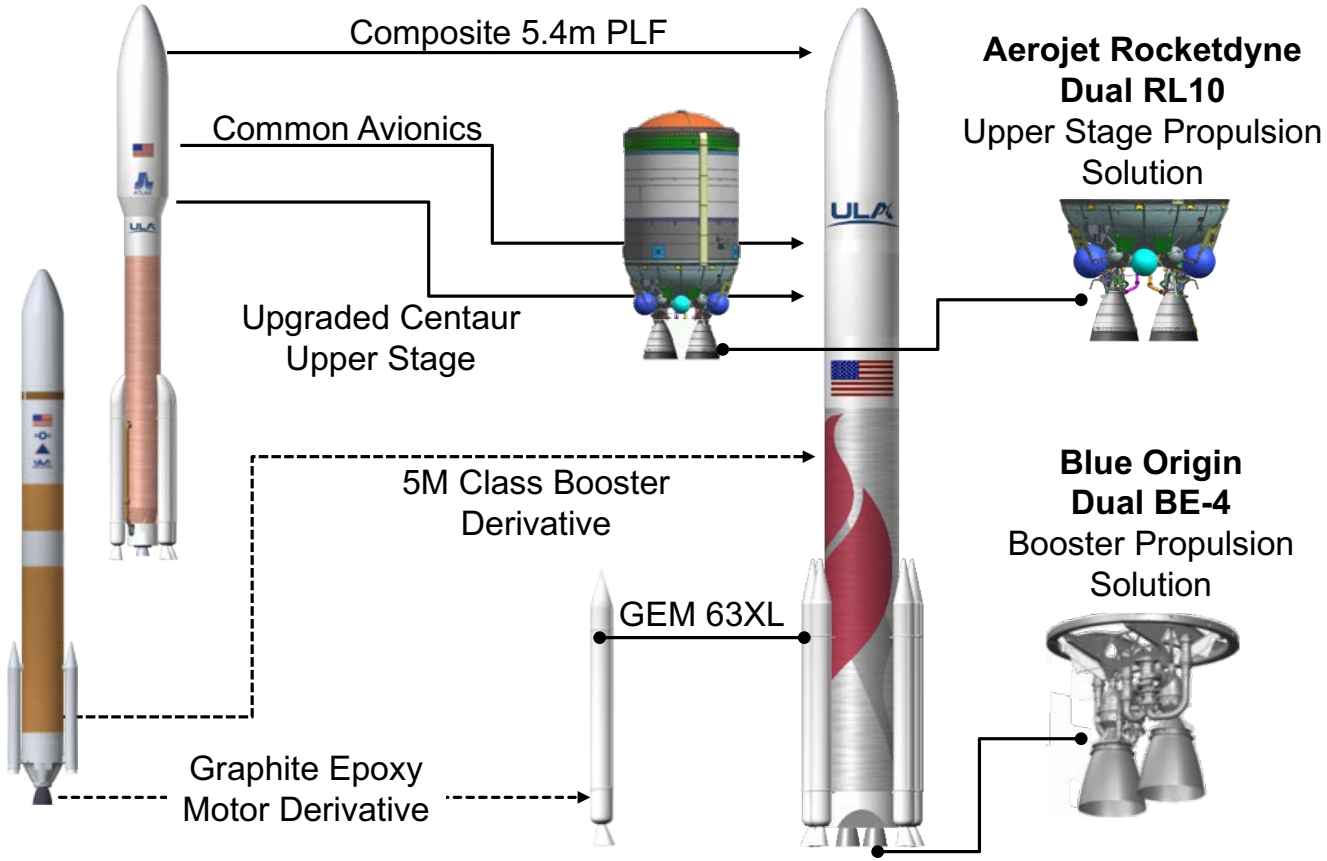
- **Total Command** of the Manifest – Less than 2 weeks avg. launch delay
- **Flexible** flight software and ConOps increasing day of launch certainty

Full Mission Capability

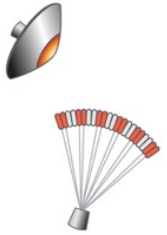
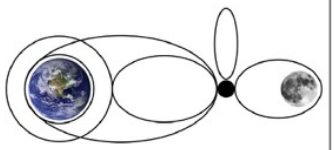
- **Cryogenic, restartable,** upper stage technology
  - Orbits unreachable by others, faster to spacecraft operations
- Sophisticated **Trajectory Optimization**
  - Extended spacecraft life & improved mission performance

Any Payload, **Any** Orbit, **Any** Time, **Confidently**

VULCAN CENTAUR EVOLUTION



PRODUCT ROAD MAP

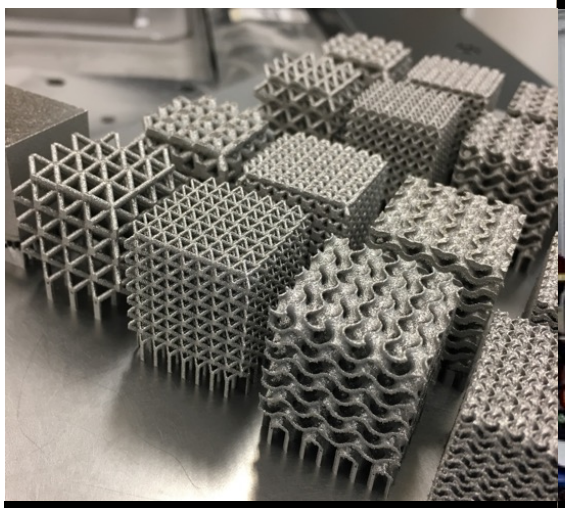
	CURRENT 2018	STEP ONE 2020	STEP TWO ~2023	STEP THREE 2023	STEP FOUR 2024	STEP FIVE 2024+
ATLAS V	20t Class  0-5x	RD-180 Engine Retired				
DELTA IV	30t Class  Delta IV Medium Retired	30t Class 	Delta IV Heavy Retired			
VULCAN CENTAUR/ACES		**Vulcan Centaur** 25t Class  2-6x	**Vulcan Centaur** 35t Class  2-6x Single Core Heavy Capability	**Vulcan ACES**  2-6x Enhanced On-orbit Capability	**SMART Reuse** 	**In CisLunar Space Transport and Refueling** 

BE-4 Replaces the RD-180, Retires Delta IV Heavy

MASSIVE CAPITAL IMPROVEMENTS COMPLETE

UP TO 20 VULCAN CENTAUR VEHICLES PER YEAR

Universal Weld System (UWS)



Additive Manufacturing (AM)

Circumferential Friction Stir Welding (CFSW)

STRATEGIC PARTNERS FOCUS MORE CAPABLE AND COST-EFFICIENT HARDWARE

GEM 63 Structural Test Article Case Wind, **Longest** monolithic SRB case ever produced

GEM 63 Static Test Fire

First Made-in-America **Out of Autoclave** Composite Payload Fairing

PAD MODIFICATIONS UNDERWAY
FIRST VULCAN CENTAUR FLIGHT IN 2020

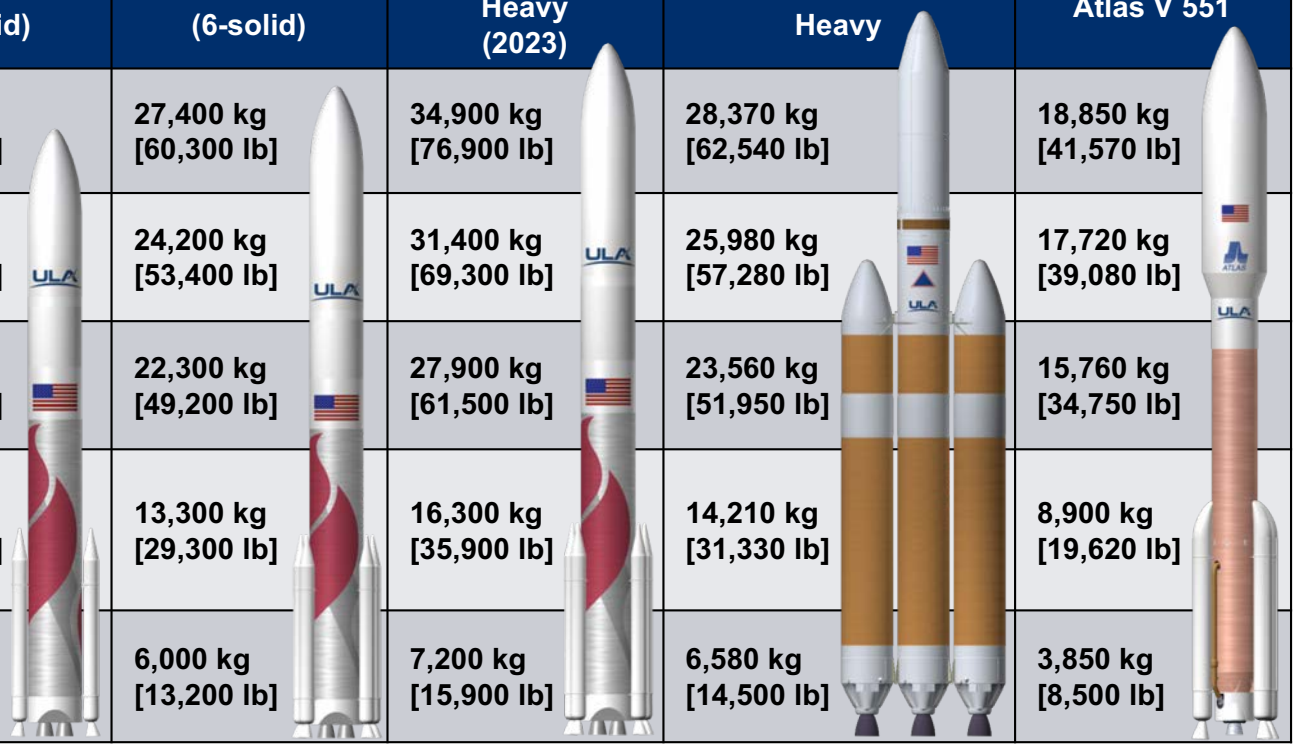
Retrofitted Launch Facilities

First Multi-Rocket Pad

Vertical Payload Integration; Both Coasts, All Vehicles

VULCAN CENTAUR PERFORMANCE

Orbit * \ Vehicle	Vulcan Centaur (2-solid)	Vulcan Centaur (6-solid)	Vulcan Centaur Heavy (2023)	Delta IV Heavy	Atlas V 551
LEO ER 28.7° (Ref.) 200 km circular	**17,800 kg [39,200 lb]**	**27,400 kg [60,300 lb]**	**34,900 kg [76,900 lb]**	**28,370 kg [62,540 lb]**	**18,850 kg [41,570 lb]**
LEO ER 51.6° (ISS) 407 km circular	**15,300 kg [33,800 lb]**	**24,200 kg [53,400 lb]**	**31,400 kg [69,300 lb]**	**25,980 kg [57,280 lb]**	**17,720 kg [39,080 lb]**
LEO WR 90° (Polar) 200 km circular	**14,300 kg [31,500 lb]**	**22,300 kg [49,200 lb]**	**27,900 kg [61,500 lb]**	**23,560 kg [51,950 lb]**	**15,760 kg [34,750 lb]**
GTO 1800 m/s 35,786 km x 185 km @ 27.0 deg	**7,400 kg [16,400 lb]**	**13,300 kg [29,300 lb]**	**16,300 kg [35,900 lb]**	**14,210 kg [31,330 lb]**	**8,900 kg [19,620 lb]**
GEO 35,786 km circular @ 0 deg	**2,050 kg [4,500 lb]**	**6,000 kg [13,200 lb]**	**7,200 kg [15,900 lb]**	**6,580 kg [14,500 lb]**	**3,850 kg [8,500 lb]**



*Performance values should be considered for reference and are subject to change.

Heavy Performance in a Single-Stick Rocket

CONFIDENCE IN VULCAN CENTAUR DEVELOPMENT

Qualification and First Flight Hardware in Fabrication

THANK YOU