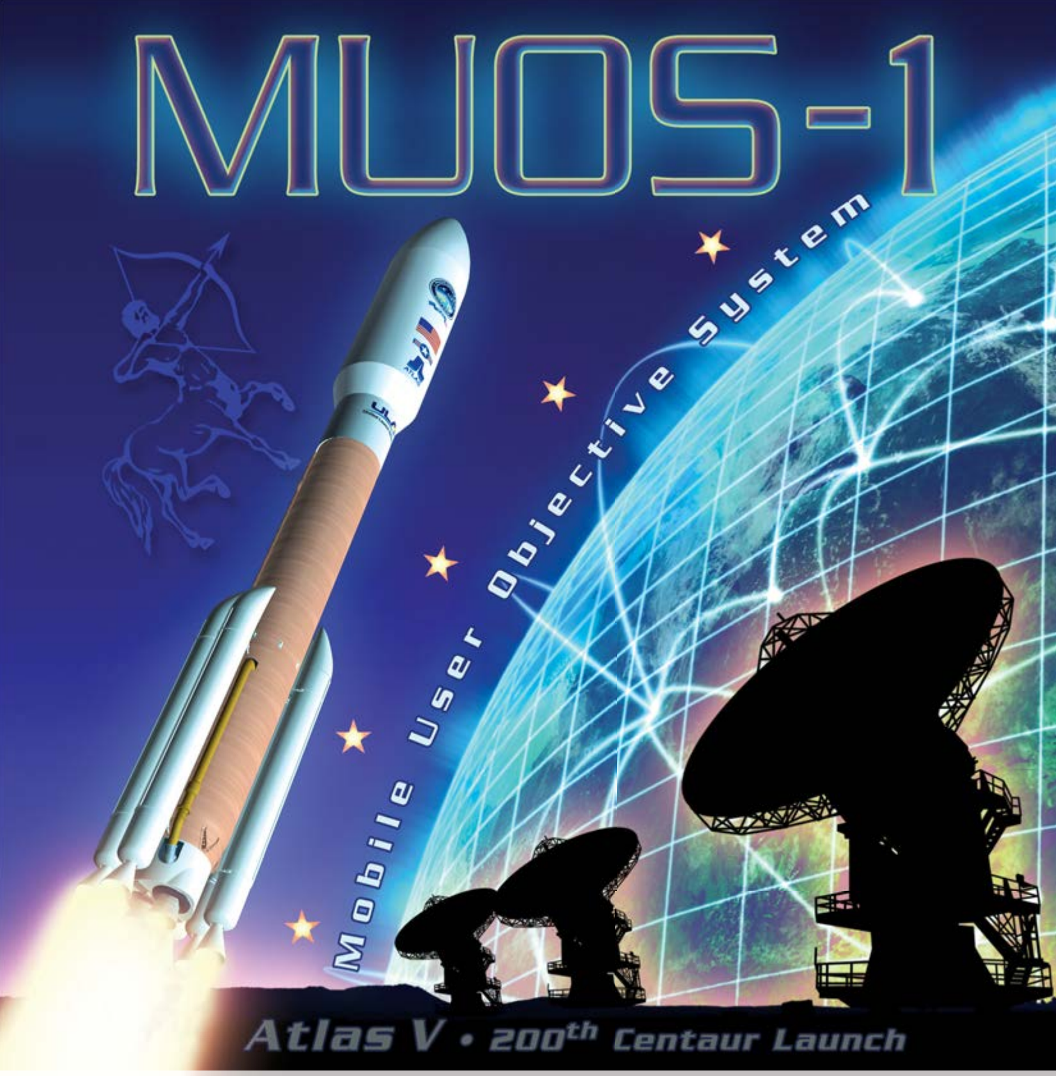


Mission Overview

SLC-41
Cape Canaveral Air Force Station, FL

ULA®
United Launch Alliance

ATLAS®

United Launch Alliance (ULA) is proud to be a part of the deployment of the U.S. Navy's Mobile User Objective System (MUOS) satellite constellation.

The MUOS-1 satellite is the first of a five-satellite constellation to be launched and operated by the Navy's Communications Satellite Program Office, PMW 146. MUOS is the next-generation narrowband tactical satellite communications system designed to significantly improve ground communications to U.S. forces on the move around the globe.

MUOS will fully support legacy UHF SATCOM terminals and Joint Tactical Radio System terminals, ensuring its users receive the technological advancements needed without a gap during necessary system upgrades. The MUOS constellation will also provide enhanced geo-location capabilities.

The ULA team is focused on attaining Perfect Product Delivery for the MUOS-1 mission, which includes a relentless focus on mission success (the perfect product) and also excellence and continuous improvement in meeting all of the needs of our customers (the perfect delivery).

Thank you to the entire ULA team and to our mission partners. Your dedication has made this game-changing mission possible.

Go Atlas, Go Centaur, Go MUOS!

Jim Sponnick
Vice President,
Mission Operations

MUOS-1 SATELLITE | Overview

The MUOS-1 satellite will ensure continued mission capability of the existing Ultra-High Frequency Satellite Communications (UHF SATCOM) system, and represents deployment of the first satellite in the next-generation narrowband tactical satellite communications system which will provide significantly improved and assured communications for the mobile warfighter. MUOS-1 will ultimately replace the current UHF SATCOM system, providing military users with 10 times more communications capability over existing systems, including simultaneous voice (full-duplex), video and data, leveraging 3G mobile communications technology.

The Mobile User Objective System will provide Net-Centric use of UHF SATCOM and provides the following enabling capabilities:

- Beyond-line-of-site, communication-on-the-move to the warfighter with focus on usability.
- Global communications to connect any set of users, regardless of location with the exception of polar regions.
- Improved connectivity in stressed environments including urban canyons, mountains, jungle, weather and scintillation.
- “Bandwidth on Demand” architecture that is future upgradeable with “smarts” on the ground and has accessibility to Global Information Grid (GIG), Non-secure Internet Protocol Router Network (NIPRNet), Secure Internet Protocol Router Network (SIPRNet), and Defense Information Systems Network (DISN).

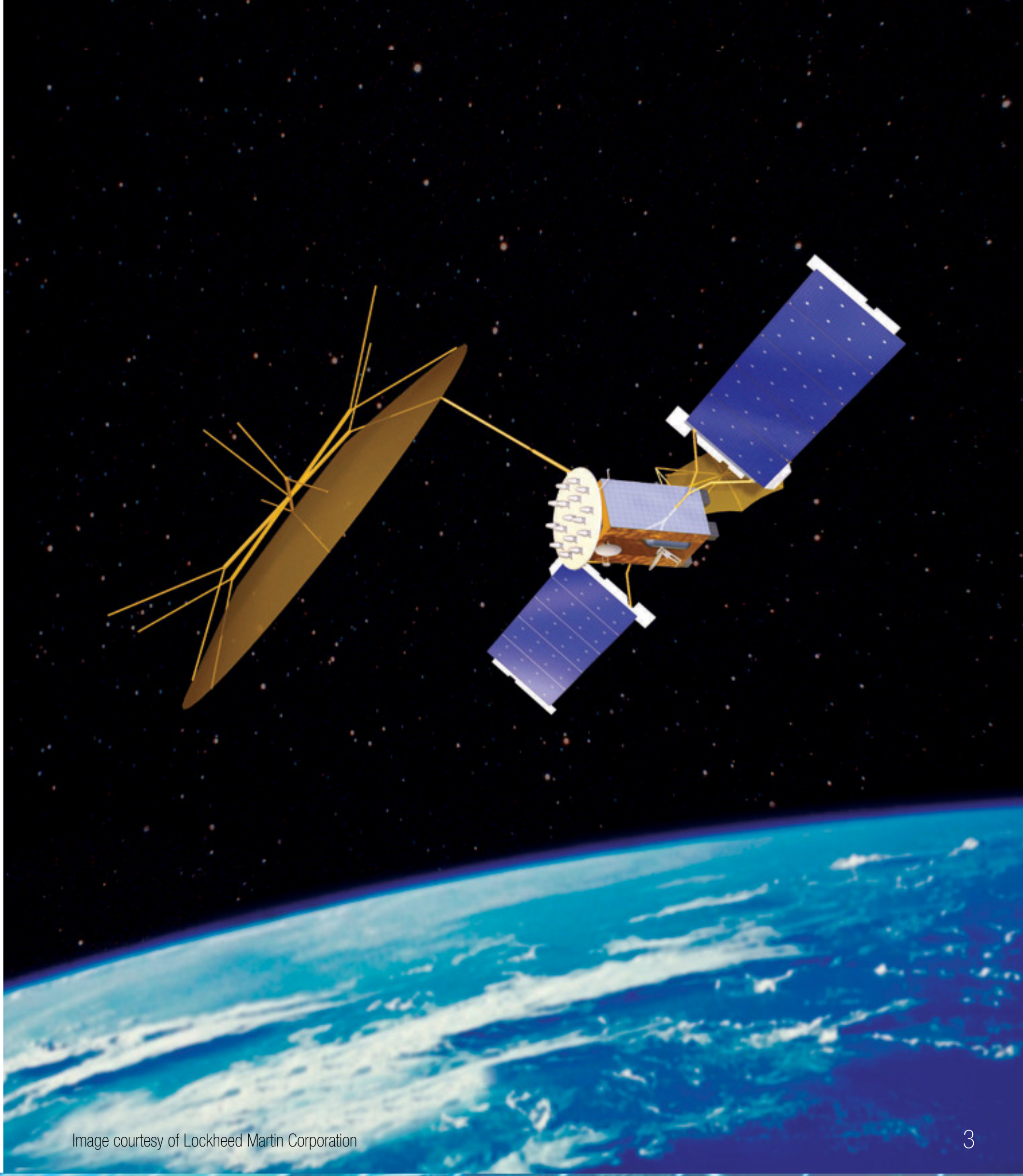


Image courtesy of Lockheed Martin Corporation

ATLAS V 551 LAUNCH VEHICLE | Overview

The Atlas V 551 consists of a single Atlas V booster stage, the Centaur upper stage, five solid rocket boosters (SRB) and a 5-m diameter medium payload fairing (PLF).

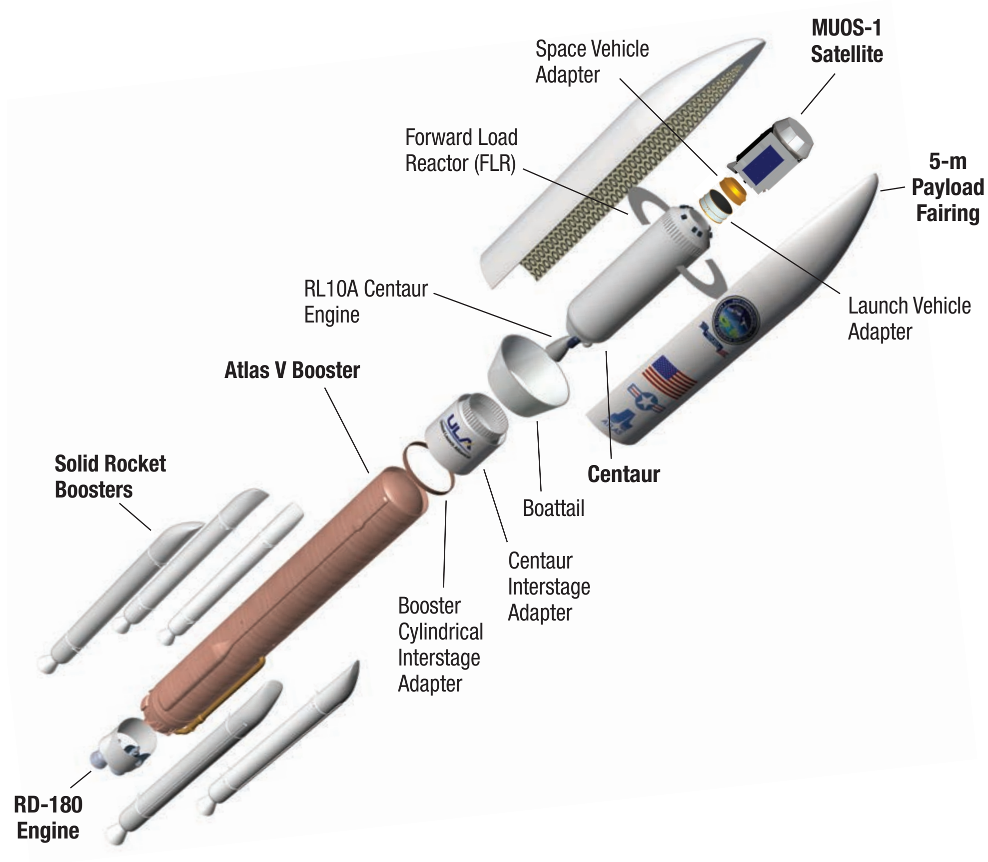
The Atlas V booster is 12.5 ft in diameter and 106.5 ft in length. The booster's tanks are structurally rigid and constructed of isogrid aluminum barrels, spun-formed aluminum domes, and intertank skirts. Atlas booster propulsion is provided by the RD-180 engine system (a single engine with two thrust chambers). The RD-180 burns RP-1 (Rocket Propellant-1 or highly purified kerosene) and liquid oxygen, and delivers 860,200 lb of thrust at sea level. The Atlas V booster is controlled by the Centaur avionics system, which provides guidance, flight control, and vehicle sequencing functions during the booster and Centaur phases of flight.

The SRBs are approximately 61 in. in diameter, 67 ft in length and constructed of a graphite-epoxy composite with the throttle profile designed into the propellant grain. The SRBs are jettisoned by structural thrusters following a 92-second burn.

The Centaur upper stage is 10 ft in diameter and 41.5 ft in length. Its propellant tanks are constructed of pressure-stabilized, corrosion resistant stainless steel. Centaur is a liquid hydrogen/liquid oxygen- (cryogenic-) fueled vehicle. It uses a single RL10A-4-2 engine producing 22,300 lb of thrust. The Centaur forward adapter (CFA) provides the structural mountings for vehicle electronics and the structural and electronic interfaces with the satellite.

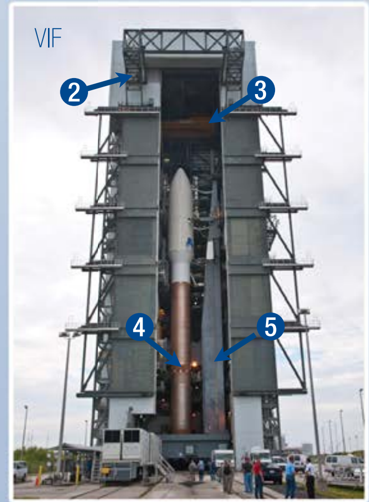
The MUOS-1 satellite is encapsulated in the Atlas V 5-m diameter medium PLF. The PLF is a sandwich composite structure made with a vented aluminum-honeycomb core and graphite-epoxy face sheets. The bisector (two-piece shell) PLF encapsulates both the Centaur and the spacecraft, which separates using a debris-free pyrotechnic actuating system. Payload clearance and vehicle structural stability are enhanced by the all-aluminum Centaur forward load reactor (CFLR), which centers the PLF around the Centaur upper stage and shares payload shear loading. The vehicle's height with the 5-m medium PLF is approximately 206 ft.

ATLAS V 551 LAUNCH VEHICLE | Expanded View



SPACE LAUNCH COMPLEX 41 (SLC-41) | Overview

1 Vertical Integration Facility (VIF) (See inset)
2 Bridge Crane Hammerhead
3 Bridge Crane
4 Launch Vehicle
5 Mobile Launch Platform (MLP)
6 Launch Vehicle
7 Centaur LO_2 Storage
8 Gaseous Helium Conversion Plant
9 High Pressure Gas Storage
10 Booster LO_2 Storage
11 Pad ECS Shelter
12 Pad Equipment Building (PEB)



ATLAS V MUOS-1 | Mission Overview

The MUOS-1 mission is based on an Atlas V 551 ascent profile to geosynchronous transfer orbit (GTO). The mission begins with ignition of the RD-180 engine at approximately 2.7 seconds prior to liftoff. The flight begins with a vertical rise of 85 feet, after which the vehicle begins its initial pitch-over phase, a roll, pitch, and yaw maneuver to achieve the desired flight azimuth. The vehicle then throttles down and begins a nominal zero pitch and zero yaw angle-of-attack phase to minimize aerodynamic loads. Following maximum dynamic pressure and SRB burnout, the RD-180 is throttled back up to 100 percent. Zero pitch and yaw angle-of-attack flight continues until closed-loop guidance takes over at approximately 110 seconds into flight.

Booster flight continues in this guidance-steered phase until propellant depletion. Payload fairing jettison occurs at approximately 202 seconds, based on thermal constraints. When the vehicle reaches 4.6 Gs the RD-180 engine is throttled to maintain this G-level. The boost phase of flight ends with Atlas/Centaur separation at a nominal time of 6.0 seconds after Booster Engine Cutoff (BECO).

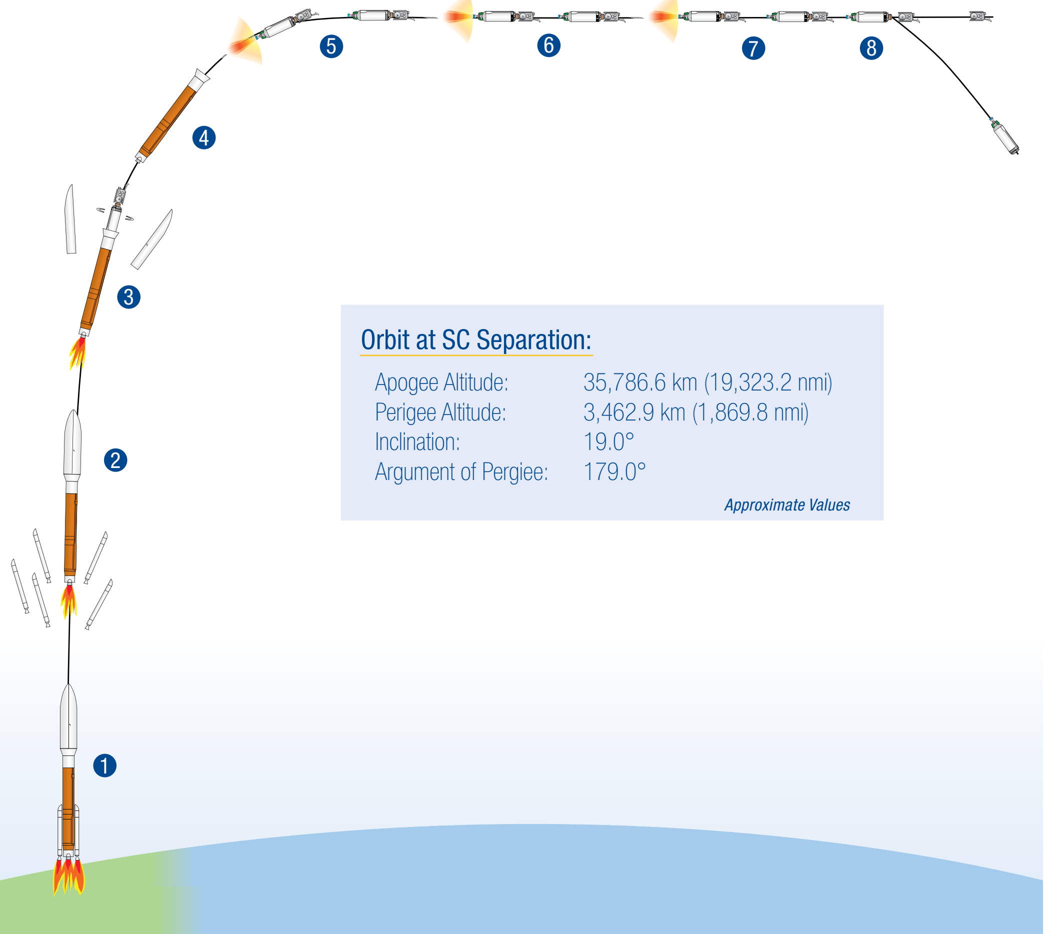
Following Atlas/Centaur separation, the Centaur stage ignites its main engine or Main Engine Start 1 (MES-1). The 462-second Centaur first burn concludes with Main Engine Cutoff 1 (MECO-1), injecting the vehicle into a low-Earth parking orbit.

Following MECO-1, the Centaur and spacecraft (SC) enter an 8.4-minute coast period. Based on a guidance-calculated start time, the Centaur is re-started (MES-2) then steered into an intermediate transfer orbit. The second Centaur burn duration is 361 seconds and concludes with Main Engine Cutoff (MECO-2), initiated by guidance command once the targeted orbital parameters are achieved.

The Centaur and spacecraft next enter a 2.5-hour coast period. Based on a guidance-calculated start time, the Centaur is re-started (MES-3) then steered into the spacecraft separation transfer orbit. The third Centaur burn duration is 54 seconds and concludes with Main Engine Cutoff (MECO-3), initiated by guidance command once the targeted orbital parameters are achieved.

Spacecraft separation is initiated 219 seconds after MECO-3, at 3 hours, 1 minute, 23.2 seconds after liftoff.

FLIGHT PROFILE | Liftoff to Spacecraft Separation



Orbit at SC Separation:

Apogee Altitude:	35,786.6 km (19,323.2 nmi)
Perigee Altitude:	3,462.9 km (1,869.8 nmi)
Inclination:	19.0°
Argument of Pergiee:	179.0°

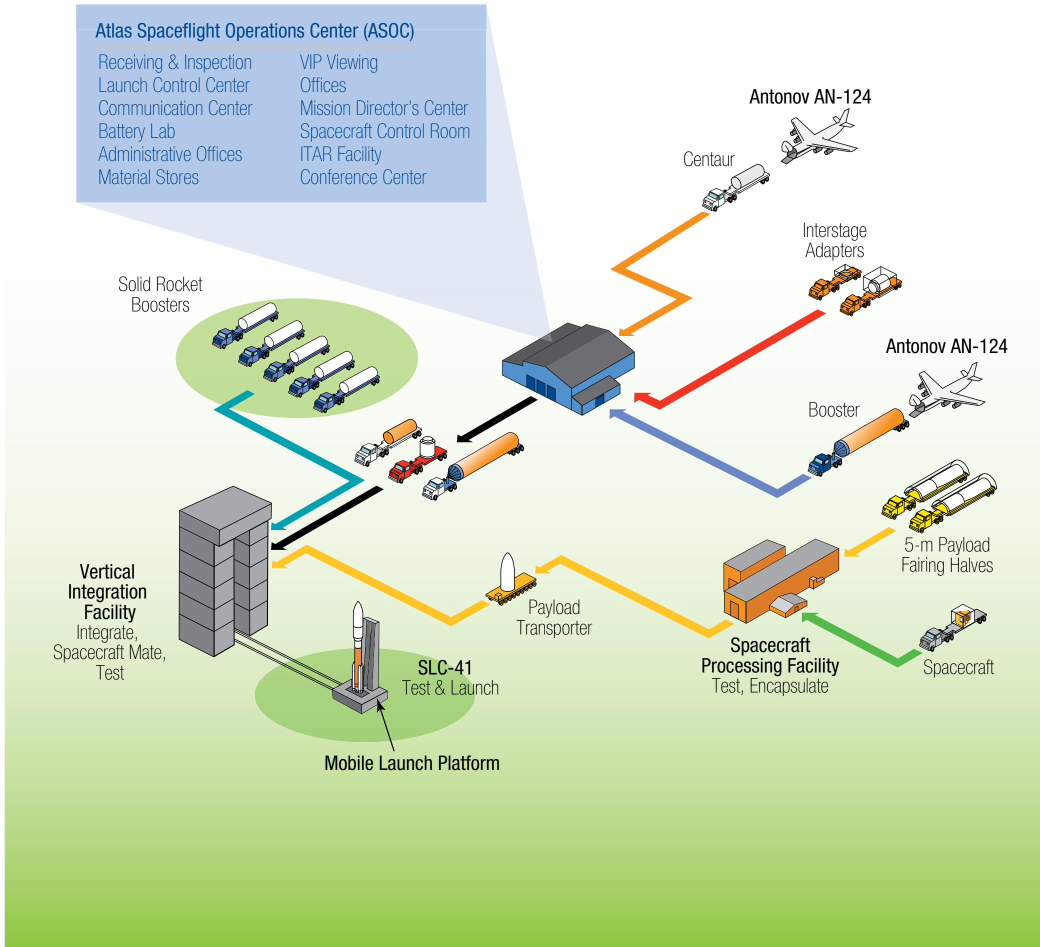
Approximate Values

SEQUENCE OF EVENTS | Liftoff to Spacecraft Separation

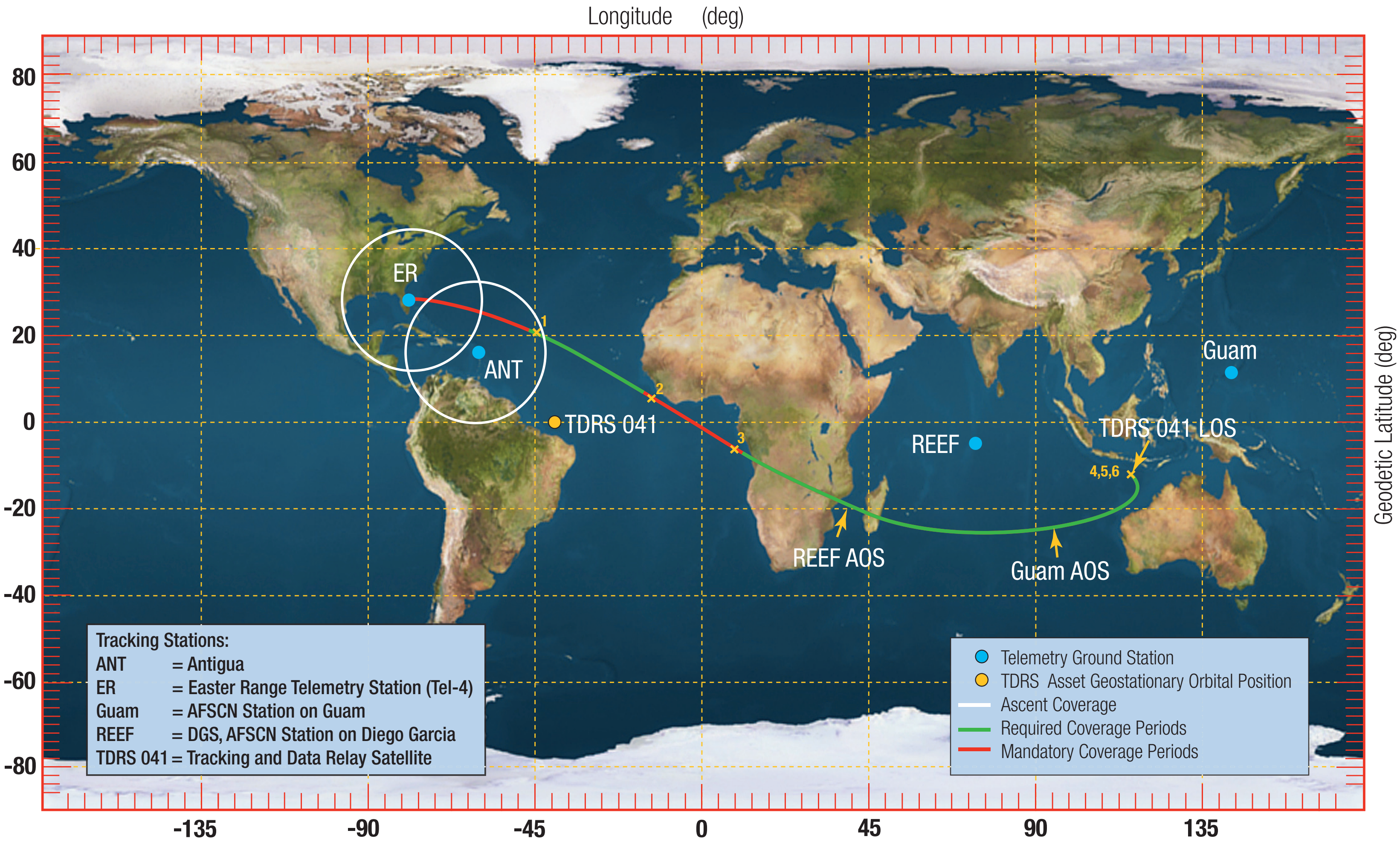
	Event	Time (seconds)	Time (hr:min:sec)
1	RD-180 Engine Ignition	-2.7	-0:00:02.7
	T=0 (Engine Ready)	0.0	0:00:00
	Liftoff (Thrust to Weight > 1)	1.1	0:00:01.1
	Full Thrust	2.1	0:00:02.1
	Begin Pitch/Yaw/Roll Maneuver	3.9	0:00:03.9
	Mach 1	34.8	0:00:34.8
	Maximum Dynamic Pressure	45.2	0:00:45.2
2	Solid Rocket Booster 1,2 Jettison	104.6	0:01:44.6
	Solid Rocket Booster 3,4,5 Jettison	106.1	0:01:46.1
3	Payload Fairing Jettison	202.2	0:03:22.2
	Centaur Forward Load Reactor Jettison	207.2	0:03:50.0
	Begin 4.6 G-Limiting	230.0	0:03:50.0
4	Atlas Booster Engine Cutoff (BECO)	264.1	0:04:24.1
	Atlas Booster/Centaur Separation	270.1	0:04:30.1
5	Centaur First Main Engine Start (MES-1)	280.1	0:04:40.1
	Centaur First Main Engine Cutoff (MECO-1)	741.0	0:12:21.0
6	Centaur Second Main Engine Start (MES-2)	1,248.9	0:20:48.9
	Centaur Second Main Engine Cutoff (MECO-2)	1,610.1	0:26:50.1
7	Centaur Third Main Engine Start (MES-3)	10,610.4	2:56:50.4
	Centaur Third Main Engine Cutoff (MECO-3)	10,664.2	2:57:44.2
8	Spacecraft Separation	10,883.2	3:01:23.2

ATLAS V PRODUCTION & LAUNCH | Overview

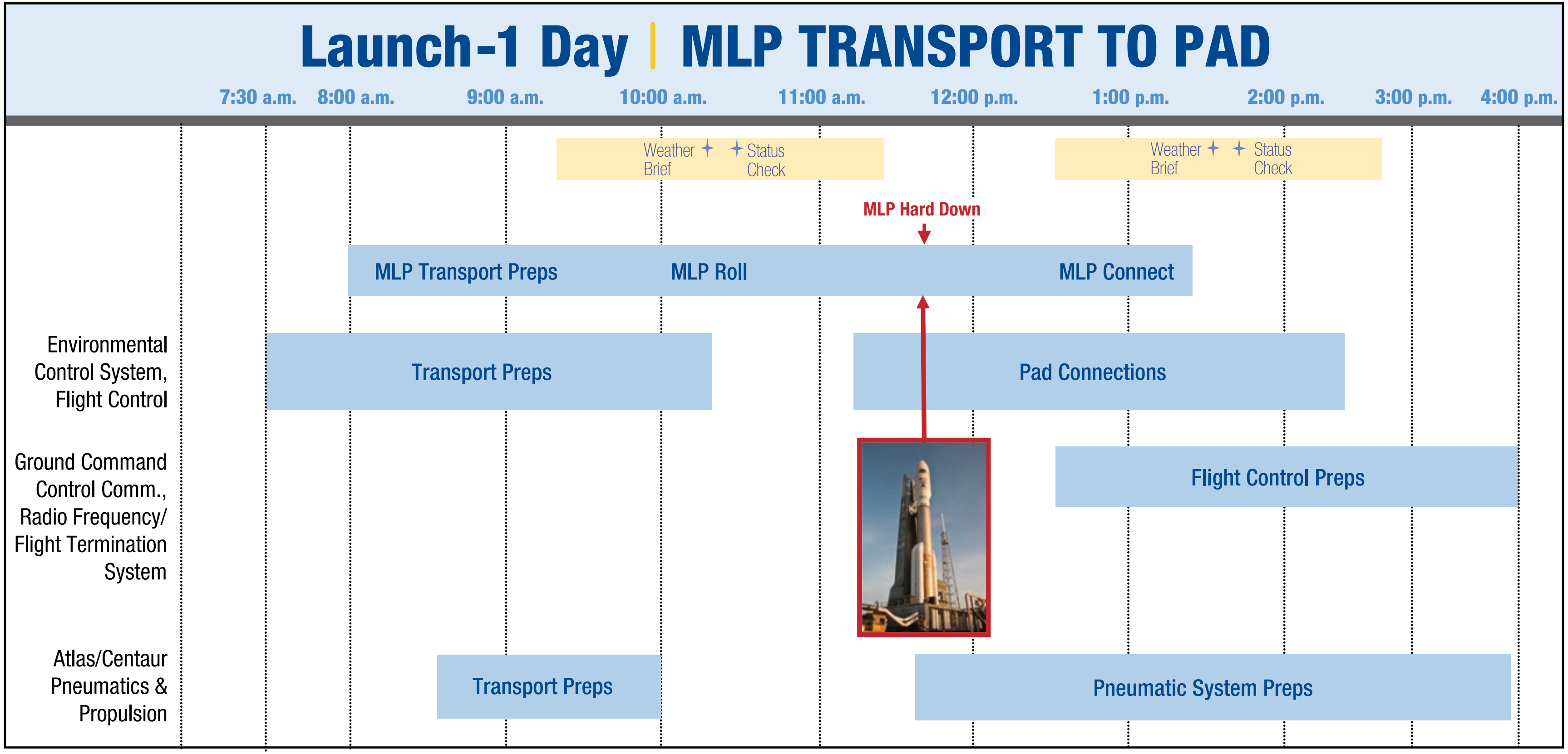
ATLAS V PROCESSING | Cape Canaveral

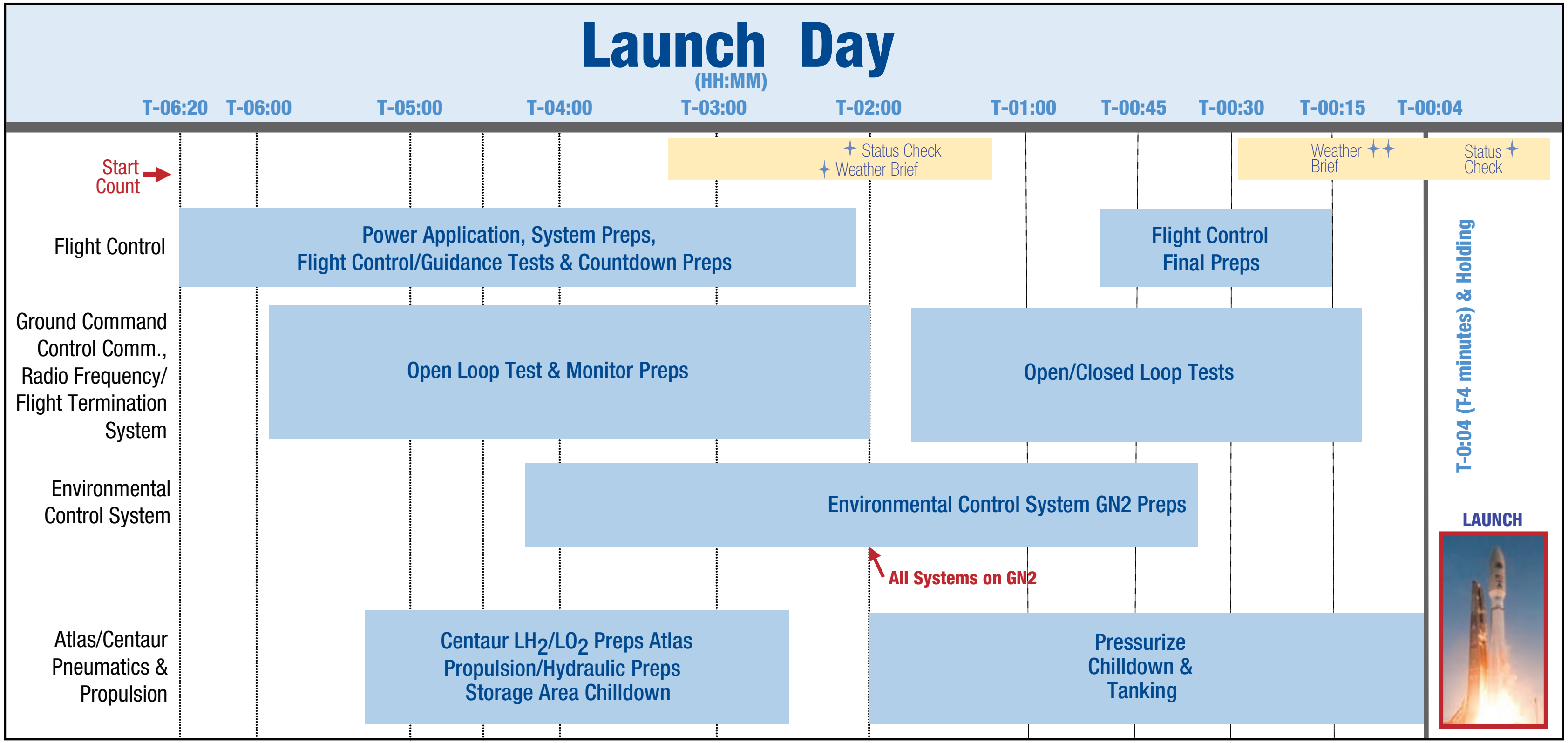


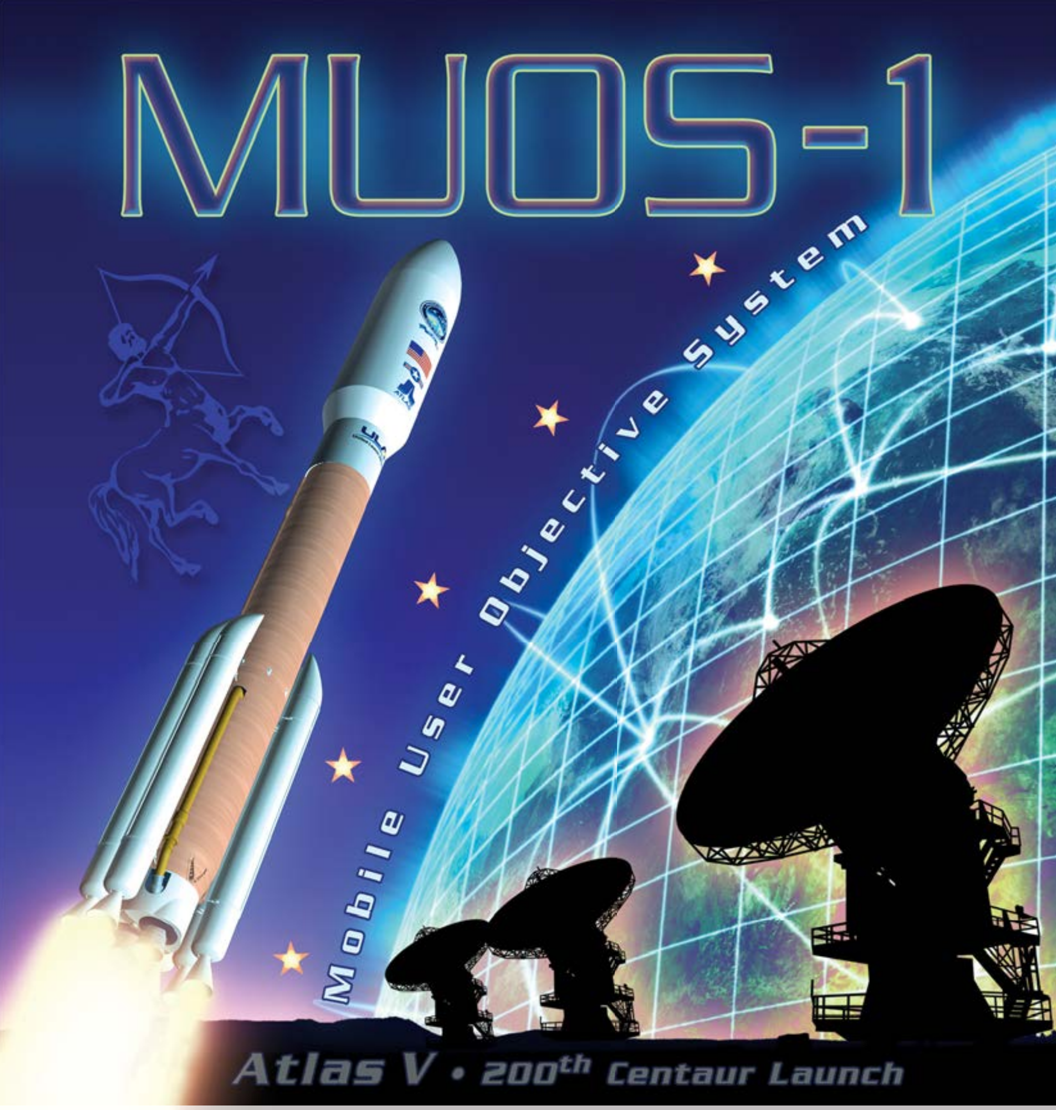
GROUND TRACE | Liftoff to Spacecraft Separation



1 = MECO-1 (0:12:21.0) | **2 =** MES-2 (0:20:48.9) | **3 =** MECO-2 (0:26:50.1) **4 =** MES-3 (2:56:50.4) | **5 =** MECO-3 (2:57:44.2) | **6 =** SC Sep (3:01:23.2)


Launch-1 Day | MLP TRANSPORT TO PAD
7:30 a.m.
8:00 a.m.
9:00 a.m.
10:00 a.m.
11:00 a.m.
12:00 p.m.
1:00 p.m.
2:00 p.m.
3:00 p.m.
4:00 p.m.
Weather Brief
Status Check
Weather Brief
Status Check
MLP Hard Down
MLP Transport Preps
MLP Roll
MLP Connect
Environmental Control System, Flight Control
Transport Preps
Pad Connections
Ground Command Control Comm., Radio Frequency/ Flight Termination System
Flight Control Preps
Atlas/Centaur Pneumatics & Propulsion
Transport Preps
Pneumatic System Preps


Launch Day
(HH:MM)
T-06:20
T-06:00
T-05:00
T-04:00
T-03:00
T-02:00
T-01:00
T-00:45
T-00:30
T-00:15
T-00:04
Start Count
Status Check
Weather Brief
Weather Brief
Status Check
Flight Control
Power Application, System Preps, Flight Control/Guidance Tests & Countdown Preps
Flight Control Final Preps
Ground Command Control Comm., Radio Frequency/ Flight Termination System
Open Loop Test & Monitor Preps
Open/Closed Loop Tests
T-0:04 (T-4 minutes) & Holding
Environmental Control System
Environmental Control System GN2 Preps
All Systems on GN2
LAUNCH
Atlas/Centaur Pneumatics & Propulsion
Centaur LH2/LO2 Preps Atlas Propulsion/Hydraulic Preps Storage Area Chilldown
Pressurize Chilldown & Tanking



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