## ATLAS V MUOS-4 MISSION

The U.S. Navy's fourth Mobile User Objective System (MUOS-4) satellite is the latest addition to an advanced network of orbiting satellites and relay ground stations that is revolutionizing secure, tactical UHF communications for mobile military forces. Users with operational MUOS terminals can seamlessly connect around the globe with new smart phone-like capabilities, including simultaneous crystal-clear voice, and video and mission data, on a high-speed Internet Protocol-based system. The next generation of narrowband communications, MUOS continues support for the legacy UHF satellite system, but once fully operational, will provide users with 10 times more communications capacity over the legacy system.

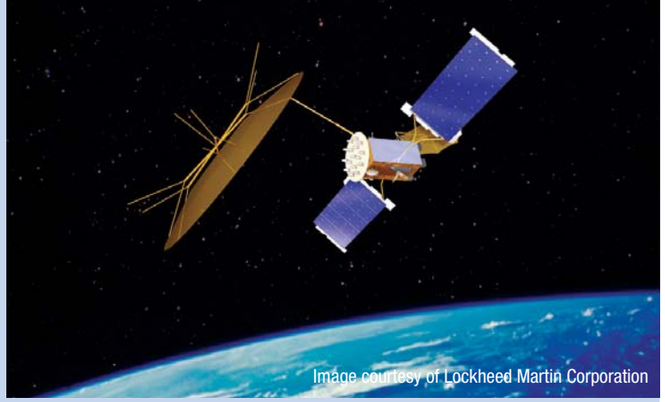
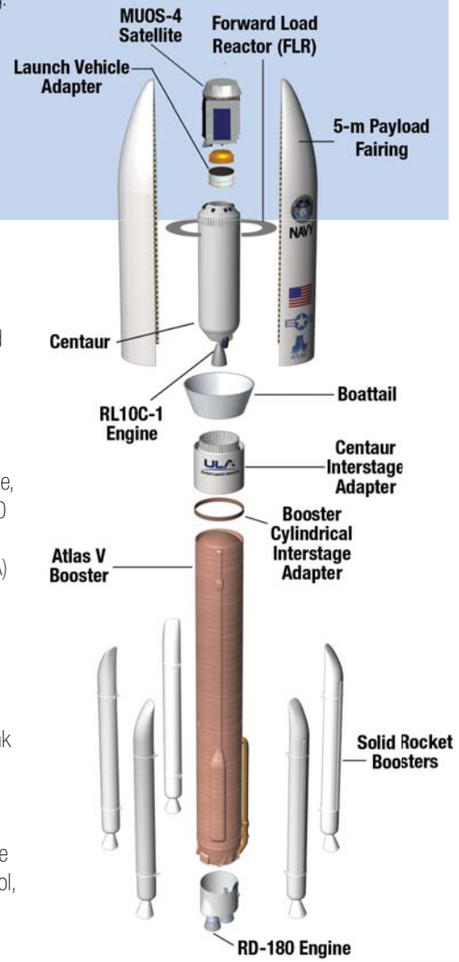


Image courtesy of Lockheed Martin Corporation

The MUOS-4 satellite, with its 14-meter diameter reflecting mesh antenna, will complete the MUOS network's near global coverage. Lockheed Martin is the MUOS prime contractor and system integrator.

Some new MUOS features include:

- MUOS network users will be able to talk direct to, text and transfer mission data amongst any other MUOS users around the world beyond line-of-sight. Previously UHF satellite communication systems users could 'talk' as long as they are under the coverage footprint of the same satellite.
- The MUOS advanced waveform allows improved connectivity in stressed environments including urban canyons, mountains, jungle, weather and scintillation.
- MUOS extends UHF communications further into polar regions than ever before, surpassing its original 65 degree latitude north/south requirement, reaching as far as 89.5 degrees latitude north – about 30 miles from the pole – during testing.
- Once MUOS is declared operational, the number of MUOS users is expected to grow rapidly. Already, more than 55,000 currently fielded radio terminals can be upgraded to be MUOS-compatible, with many of them requiring just a software upgrade.
- MUOS-4 joins the MUOS-1, MUOS-2 and MUOS-3 satellites already on orbit and all required ground stations. MUOS-5, an orbital spare satellite, is expected to launch in 2016. MUOS full operational capability is expected in 2017.




### Payload Fairing (PLF)

The MUOS-4 satellite is encapsulated in a 5-m (14-ft) diameter medium payload fairing. The 5-m 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 satellite. The vehicle's height with the 5-m medium PLF is approximately 206 ft.

### Centaur

The Centaur second 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 cryogenic vehicle, fueled with liquid hydrogen and liquid oxygen. It uses a single RL10C-1 engine producing 22,900 lb of thrust. The cryogenic tanks are insulated with a combination of helium-purged insulation blankets, radiation shields, and spray-on foam insulation (SOFI). The Centaur forward adapter (CFA) provides the structural mountings for the fault-tolerant avionics system and the structural and electrical interfaces with the spacecraft.

### Booster

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. Five solid rocket boosters (SRB) generate the additional power required at liftoff, with each SRB providing 348,500 lb of thrust. 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.

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.

MUOS-4 is the fourth of a five-satellite constellation to be launched and operated by PMW 146, the Navy's Communications Satellite Program Office. MUOS is a next-generation narrowband tactical satellite communications system designed to significantly improve ground communications to U.S. forces on the move around the globe.

The MUOS satellites are the heaviest payloads to ride into space atop any of ULA's Atlas V launch vehicles. The Atlas V generates more than two and half million pounds of thrust at liftoff in order to meet the demands of lifting the nearly 7.5-ton satellites.

The ULA team is focused on attaining Perfect Product Delivery for the MUOS-4 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, Atlas and Delta Programs

**America's Ride to Space**

With more than a century of combined heritage, United Launch Alliance is the nation's most experienced and reliable launch service provider. ULA has successfully delivered more than 90 satellites to orbit that provide critical capabilities for troops in the field, aid meteorologists in tracking severe weather, enable personal device-based GPS navigation and unlock the mysteries of our solar system.

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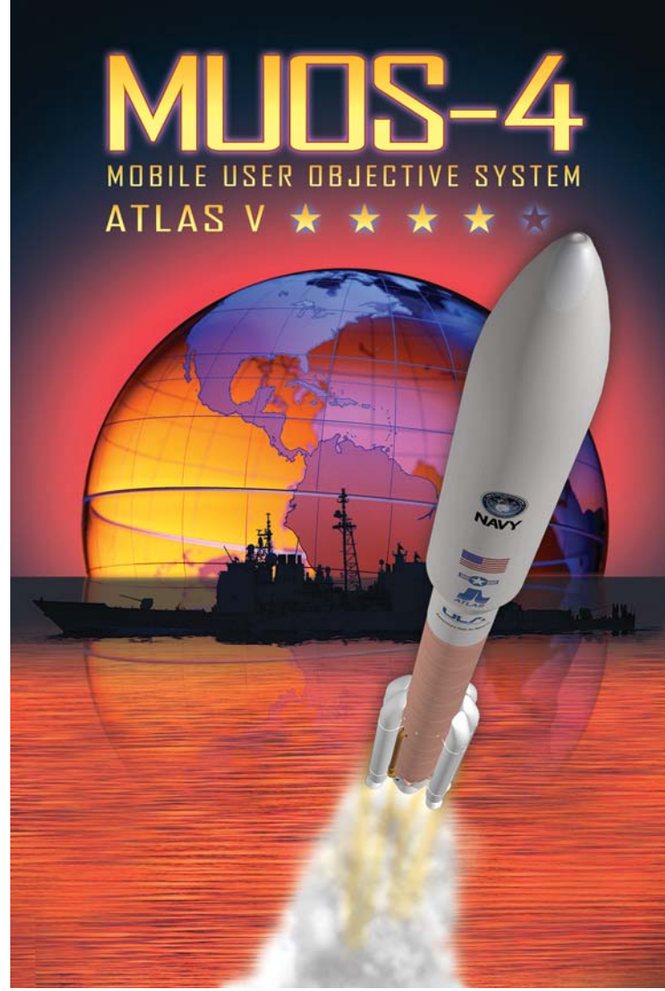



## MISSION OVERVIEW

– 6th Atlas V 551 Configuration

– 56th Atlas V Launch

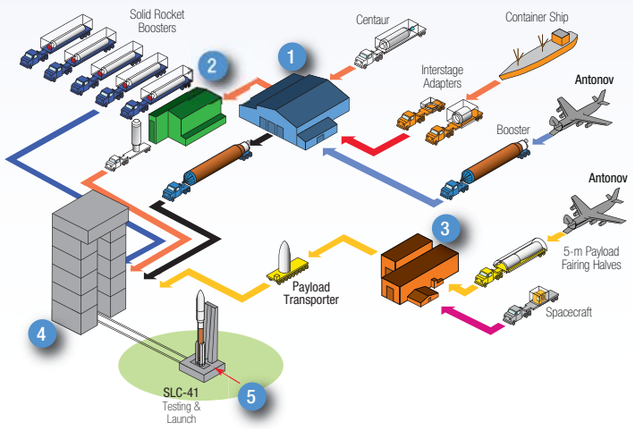
– 99th ULA Launch

America's Ride to Space

## ATLAS V PRODUCTION AND LAUNCH

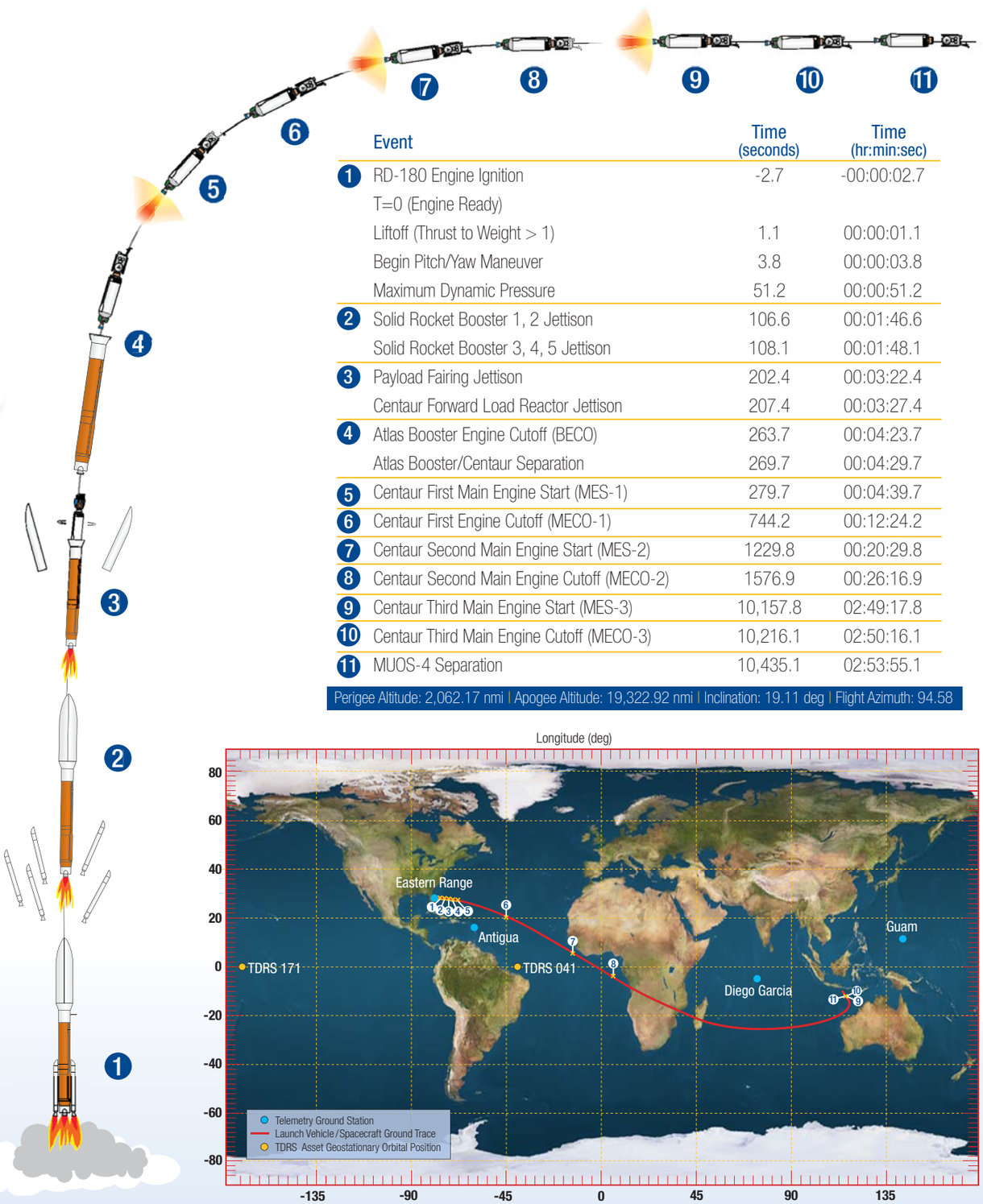
1. **Sacramento, CA**
   – Solid Rocket Booster Fabrication at Aerojet Rocketdyne
2. **Denver, CO**
   – ULA Headquarters & Design Center Engineering
3. **Harlingen, TX**
   – Payload Adapter, Booster and Centaur Fabrication
4. **Decatur, AL**
   – Booster Fabrication & Final Assembly
   – Centaur Final Assembly
5. **West Palm Beach, FL**
   – RL10C-1 Engine Fabrication at Aerojet Rocketdyne
6. **Khimki, Russia**
   – RD-180 Engine Fabrication at NPO Energomash
7. **Zurich, Switzerland**
   – 5-m Payload Fairing Fabrication at RUAG Space

1. **Atlas Spaceflight Operations Center (ASOC)** | Receiving & inspection, communication center, spacecraft control room, launch control center, mission director's center, ITAR facility
2. **Delta Operations Center (DOC)** | Offsite Vertical Integration (OVI) in Cell 4
3. **Spacecraft Processing Facility** | Spacecraft processing, testing and encapsulation
4. **Vertical Integration Facility** | Launch vehicle integration and testing, spacecraft mate and integrated operations
5. **Mobile Launch Platform**




1. **Vertical Integration Facility (VIF)**
2. **Launch Vehicle**
3. **Centaur $LO_2$ Storage**
4. **High Pressure Gas Storage**
5. **Booster $LO_2$ Storage**
6. **Pad Equipment Building (PEB)**
7. **Pad ECS Shelter**


## MISSION PROFILE AND GROUND TRACE



| | Event | Time (seconds) | Time (hr:min:sec) |
|---|---|---|---|
| 1 | RD-180 Engine Ignition | -2.7 | -00:00:02.7 |
| | T=0 (Engine Ready) | | |
| | Liftoff (Thrust to Weight > 1) | 1.1 | 00:00:01.1 |
| | Begin Pitch/Yaw Maneuver | 3.8 | 00:00:03.8 |
| | Maximum Dynamic Pressure | 51.2 | 00:00:51.2 |
| 2 | Solid Rocket Booster 1, 2 Jettison | 106.6 | 00:01:46.6 |
| | Solid Rocket Booster 3, 4, 5 Jettison | 108.1 | 00:01:48.1 |
| 3 | Payload Fairing Jettison | 202.4 | 00:03:22.4 |
| | Centaur Forward Load Reactor Jettison | 207.4 | 00:03:27.4 |
| 4 | Atlas Booster Engine Cutoff (BECO) | 263.7 | 00:04:23.7 |
| | Atlas Booster/Centaur Separation | 269.7 | 00:04:29.7 |
| 5 | Centaur First Main Engine Start (MES-1) | 279.7 | 00:04:39.7 |
| 6 | Centaur First Engine Cutoff (MECO-1) | 744.2 | 00:12:24.2 |
| 7 | Centaur Second Main Engine Start (MES-2) | 1229.8 | 00:20:29.8 |
| 8 | Centaur Second Main Engine Cutoff (MECO-2) | 1576.9 | 00:26:16.9 |
| 9 | Centaur Third Main Engine Start (MES-3) | 10,157.8 | 02:49:17.8 |
| 10 | Centaur Third Main Engine Cutoff (MECO-3) | 10,216.1 | 02:50:16.1 |
| 11 | MUOS-4 Separation | 10,435.1 | 02:53:55.1 |

Perigee Altitude: 2,062.17 nmi | Apogee Altitude: 19,322.92 nmi | Inclination: 19.11 deg | Flight Azimuth: 94.58




*All Values Approximate*