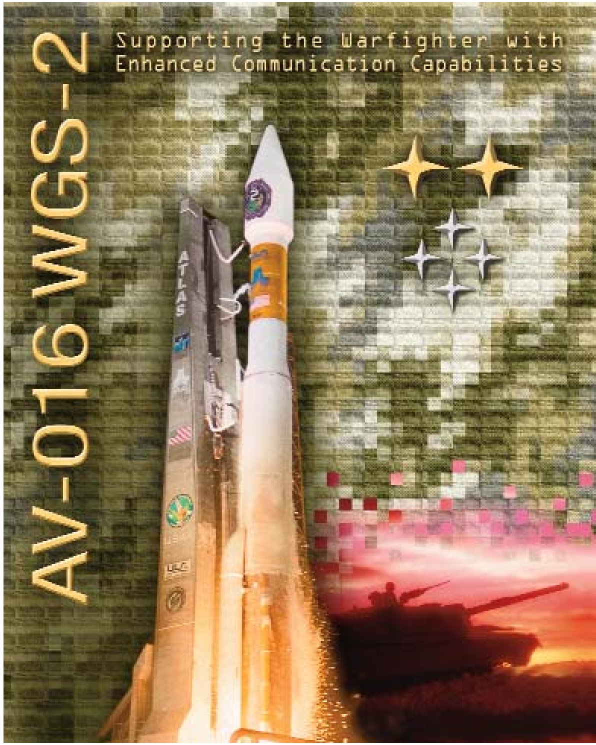
Atlas V Launches WGS-2

Mission Overview

Atlas V 421

Cape Canaveral Air Force Station, FL

Space Launch Complex-41



AV-016/WGS-2

United Launch Alliance is proud to be a part of the WGS-2 mission with the U.S. Air Force Space Command's Space and Missile Systems Center (USAF/SMC). The WGS-2 mission marks the fifteenth Atlas V launch and the third launch of an Atlas V 421 configuration.

The WGS-2 mission is the second installment of the Wideband Global SATCOM (WGS) system. The WGS satellites are an important element of a new high-capacity satellite communications system; providing enhanced communications capabilities to our troops in the field for the next decade and beyond. WGS enables more robust and flexible execution of Command and Control, Communications Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR), as well as battle management and combat support information functions. WGS-2 augments the existing service available through the UHF F/O and WGS SV-1 satellites by providing additional information broadcast capabilities.

My thanks to the entire Atlas team for its dedication in bringing WGS-2 to launch, and to the USAF/SMC for selecting Atlas for this important mission.

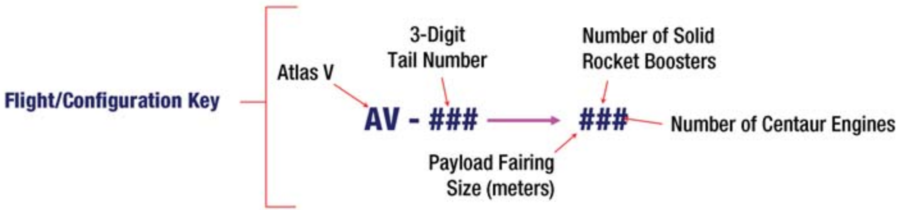
Go Atlas, Go Centaur!

Mark Wilkins

Vice President, Atlas Product Line

Atlas V Launch History

Flight	Config.	Mission	Mission Date
AV-001	401	Eutelsat Hotbird 6	21 Aug 2002
AV-002	401	HellasSat	13 May 2003
AV-003	521	Rainbow 1	17 Jul 2003
AV-005	521	AMC-16	17 Dec 2004
AV-004	431	Inmarsat 4-F1	11 Mar 2005
AV-007	401	Mars Reconnaissance Orbiter	12 Aug 2005
AV-010	551	Pluto New Horizons	19 Jan 2006
AV-008	411	Astra 1KR	20 Apr 2006
AV-013	401	STP-1	08 Mar 2007
AV-009	401	NROL-30	15 Jun 2007
AV-011	421	WGS SV-1	10 Oct 2007
AV-015	401	NROL-24	10 Dec 2007
AV-006	411	NROL-28	13 Mar 2008
AV-014	421	ICO G1	14 Apr 2008



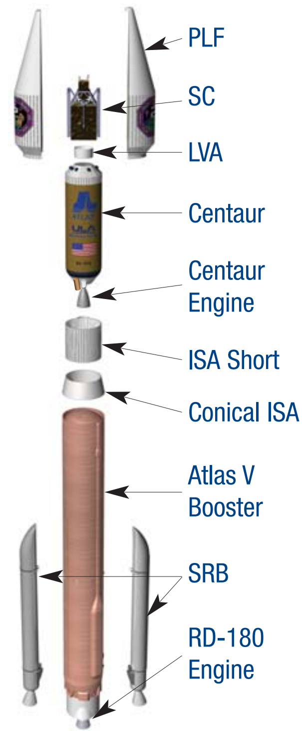
AV-016 Configuration Overview

The Atlas V 421 consists of a single Atlas V booster stage, the Centaur upper stage, and two solid rocket boosters (SRB). The Atlas V booster and Centaur are connected by conical and short interstage adapters. The SRBs are connected to the booster by a thrust pin and structural thrusters.

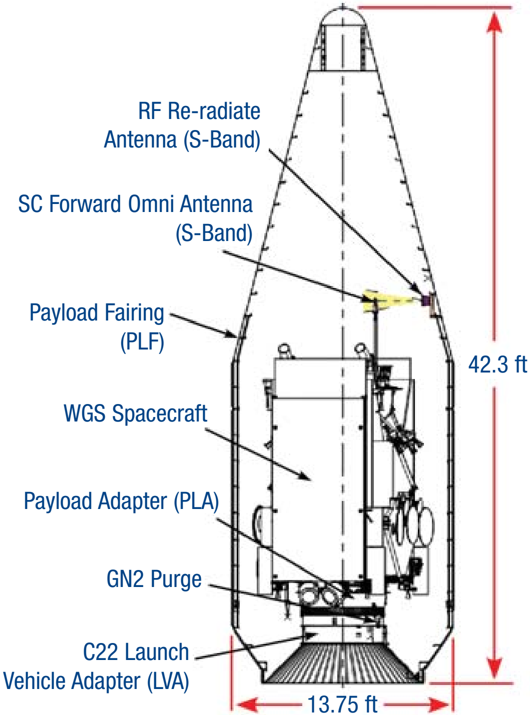
The SRBs are 61.28 in. in diameter, 67 ft long, and are constructed of a graphite-epoxy composite. Their throttle profile is designed into the propellant grain. The SRBs burn for 90 seconds and are then jettisoned.

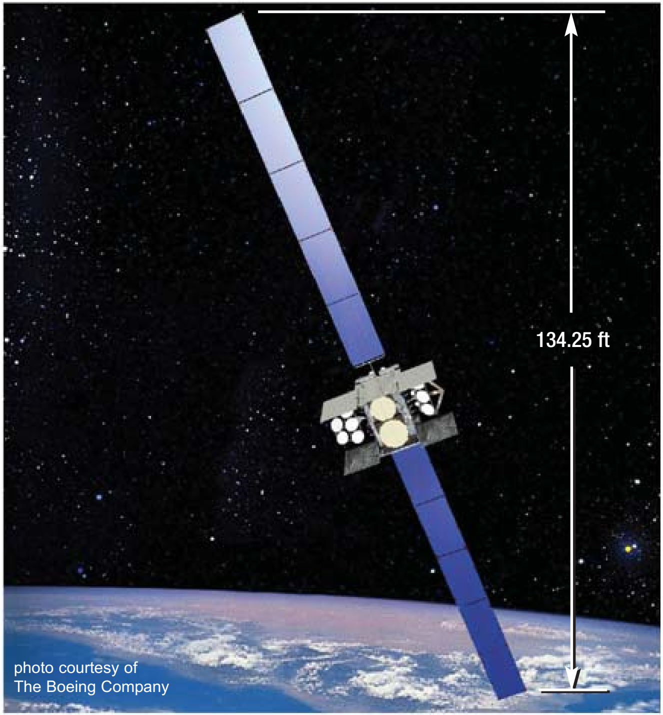
The Atlas V booster is 12.5 ft in diameter and 106.5 ft long. The booster's tanks are structurally rigid, and constructed of isogrid aluminum barrels, spun-formed aluminum domes, and intertank skirts. Atlas booster propulsion is provided by the RD-180 engine system (a single engine with two thrust chambers). The RD-180 burns RP-1 (Rocket Propellant-1, which is 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 booster and Centaur phases of flight. The boost phase of flight ends 6 seconds after BECO, when the separation charge attached to the forward interstage adapter (ISA) is fired and eight retrorockets push the spent Atlas booster stage away from the Centaur upper stage.

The Centaur upper stage is 10 ft in diameter and 41.5 ft long. The propellant tanks are constructed of pressure-stabilized corrosion-resistant stainless steel. Centaur is a cryogenic liquid hydrogen/liquid oxygen-fueled vehicle. It uses a single RL10A-4-2 engine that produces 22,300 lb of thrust. The cryogenic tanks are insulated with a combination of helium-purged insulation blankets, radiation shields, and closed-cell polyvinyl chloride (PVC) insulation. The Centaur forward adapter (CFA) provides the structural mountings for vehicle electronics and the structural and electronic interfaces with the spacecraft (SC). The WGS SV-2 mission uses the 4-m (14-ft) diameter extended payload fairing (EPF). The payload fairing (PLF) is a bisector (two-piece shell) fairing consisting of aluminum skin/stringer construction with vertical split-line longerons. The vehicle's height with the EPF is 192 ft.



WGS-2 Spacecraft





WGS-2 Overview

The WGS-2 spacecraft (SC) is an approximately 13,200-lb communications satellite. The SC is mated to the Centaur upper stage by the space vehicle contractor (SVC)-provided spacecraft launch vehicle adapter (SCLVA), separation system, and electrical harness, and a ULA-provided, mission-unique C22 launch vehicle adapter (LVA).

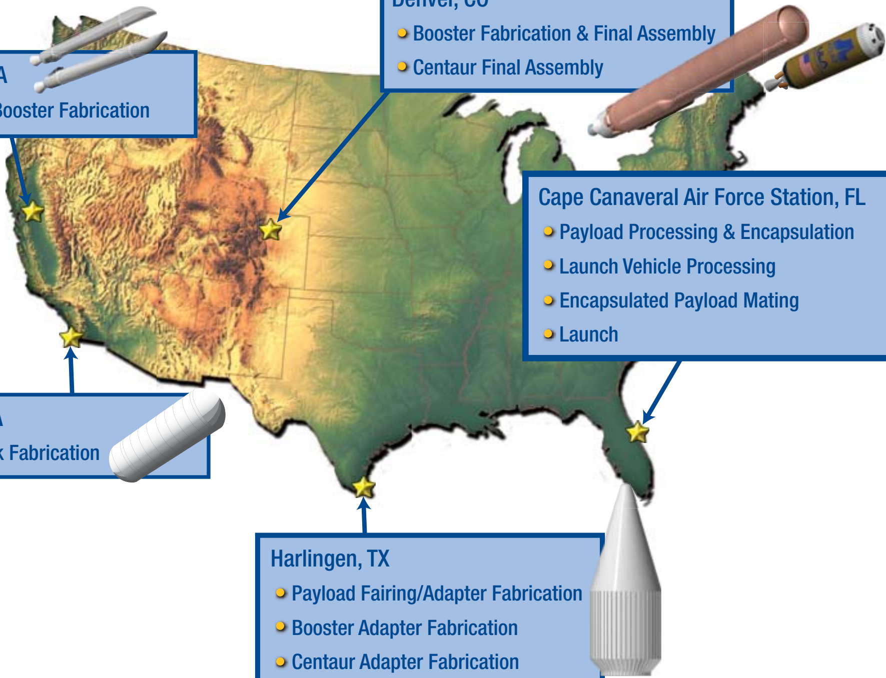
WGS supports communications links in the 500 MHz range of the X-band and 1 GHz range of the Ka-band spectra. WGS can filter and route up to 4.875 GHz of instantaneous bandwidth. Depending on the mix of ground terminals, data rates, and modulation schemes employed, a WGS satellite can support data transmission rates between 2.4 and 3.6 Gbps.

WGS has 19 independent coverage areas that can be positioned throughout its field of view. This includes eight steerable/shapeable X-band beams formed by separate transmit/receive phased arrays; 10 Ka-band beams served by independently steerable diplexed antennas (three with selectable RF polarization); and transmit/receive X-band Earth-coverage beams. WGS can tailor coverage areas and connect X-band and Ka-band users anywhere within its field of view.

Four Army Wideband Satellite Operations Centers (WSOC) provide command and Control of WGS. Each Global SATCOM Configuration and Control Element (GSCCE) has the capability to control up to three satellites at a time, using X-band or Ka-band telemetry and command links. Spacecraft platform control is accomplished by the 3rd Space Operations Squadron (3 SOPS) at Schriever Air Force Base (AFB) in Colorado Springs, CO; using WGS mission-unique software and databases.

Support technologies for WGS include the xenon-ion propulsion system (XIPS), which is 10 times more efficient than conventional bipropellant systems; highly efficient triple-junction gallium arsenide solar cells; and deployable radiators with flexible heat pipes. Four 25-cm XIPS thrusters remove orbit eccentricity during transfer orbit operations. The thrusters are also used to perform orbit maintenance and any required station-change maneuvers during the mission’s life. The triple-junction gallium arsenide solar cells provide on-orbit electrical power for the spacecraft. The deployable radiators’ flexible heat pipes provide increased radiator area; resulting in a cooler, more stable thermal environment for the spacecraft.

Atlas V Processing Overview



Sacramento, CA
- Solid Rocket Booster Fabrication

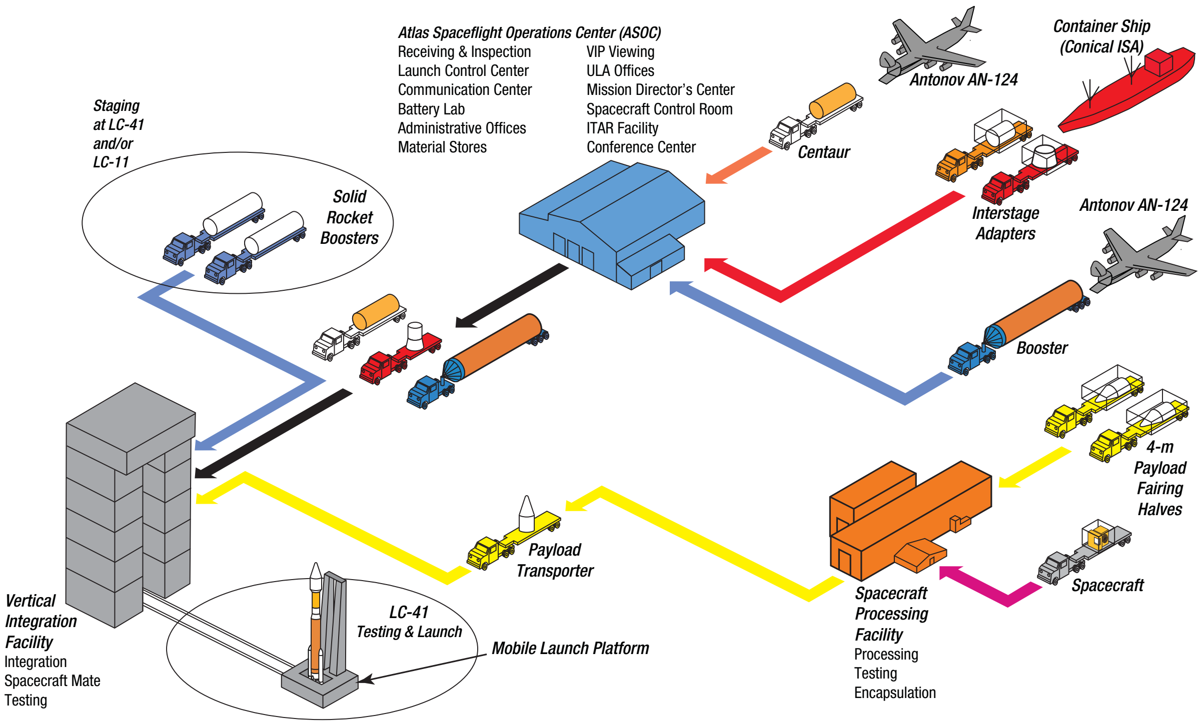
Denver, CO
- Booster Fabrication & Final Assembly
- Centaur Final Assembly

Cape Canaveral Air Force Station, FL
- Payload Processing & Encapsulation
- Launch Vehicle Processing
- Encapsulated Payload Mating
- Launch

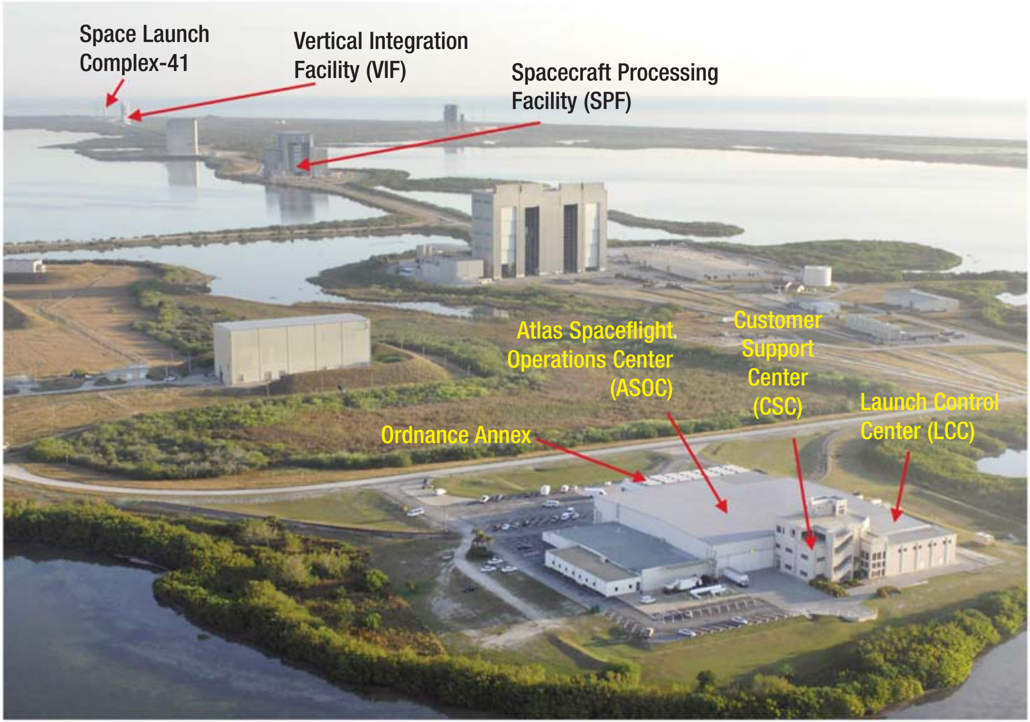
San Diego, CA
- Centaur Tank Fabrication

Harlingen, TX
- Payload Fairing/Adapter Fabrication
- Booster Adapter Fabrication
- Centaur Adapter Fabrication

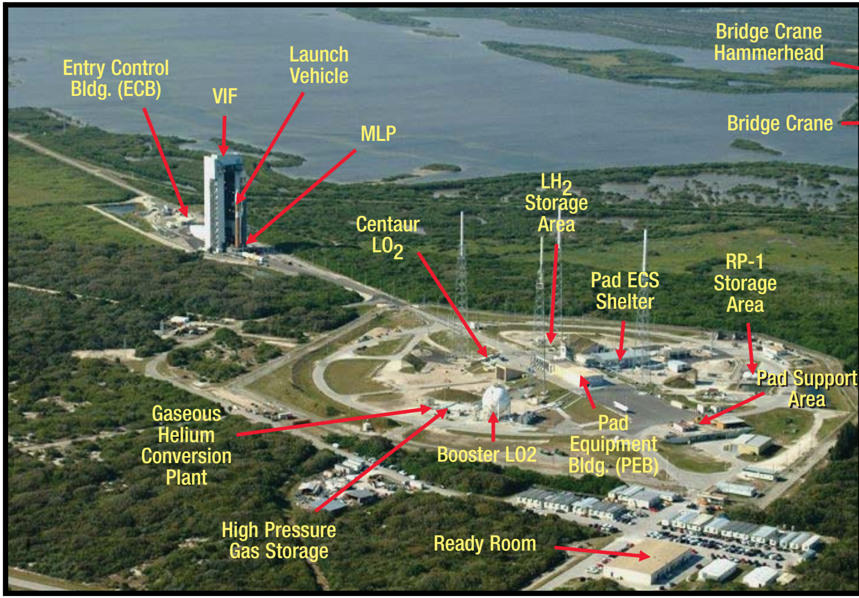
Launch Site Processing Overview

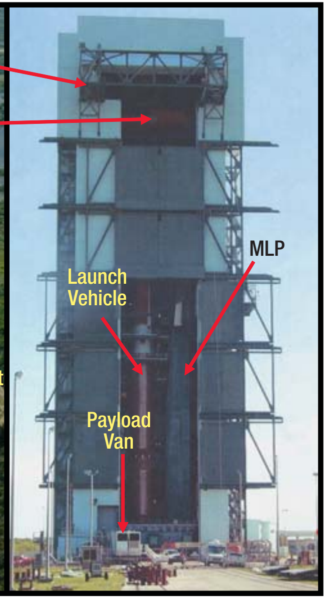


Launch Site Overview



SLC-41 Overview

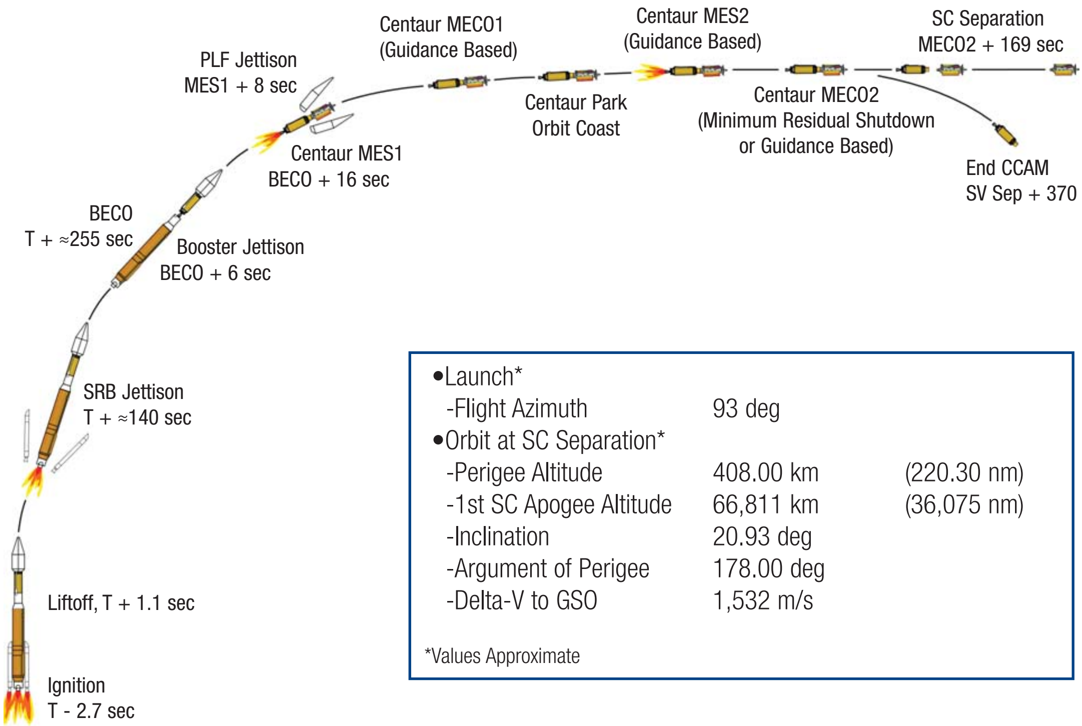




Southwest View of Space Launch Complex-41 (SLC-41)

South View of the Vertical Integration Facility (VIF)

Mission Profile



•Launch*		
-Flight Azimuth	93 deg	
•Orbit at SC Separation*		
-Perigee Altitude	408.00 km	(220.30 nm)
-1st SC Apogee Altitude	66,811 km	(36,075 nm)
-Inclination	20.93 deg	
-Argument of Perigee	178.00 deg	
-Delta-V to GSO	1,532 m/s	

*Values Approximate

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Mission Overview

ATLAS

The WGS-2 mission will be flown from Space Launch Complex 41-(SLC-41) at Cape Canaveral Air Force Station, FL on an Atlas V 421 vehicle (tail number AV-016) with two solid rocket boosters (SRB) and a single engine Centaur. The payload will be encapsulated in a 4-meter diameter extended payload fairing (EPF) and integrated to the Centaur upper stage using a modified C22 payload adapter (PLA) and a space vehicle contractor (SVC)-provided spacecraft launch vehicle adapter (SCLVA), separation system, and electrical harness.

The WGS-2 payload consists of a single communications satellite. The two-burn, minimum-residual-shutdown mission will fly an easterly trajectory from SLC-41 with an approximately 93° flight azimuth. The separation event will release the WGS-2 spacecraft into a supersynchronous transfer orbit with a 220.3-nmi perigee, an apogee radius no greater than 39,687 nmi, and an approximately 20.93° inclination.

Launch begins with RD-180 engine ignition approximately 2.7 seconds before liftoff (T-2.7 seconds). SRB ignition takes place at T+0.8 seconds; after telemetry indication of healthy RD-180 startup.

Liftoff occurs at T+1.1 seconds. Shortly after the vehicle clears the pad, it performs its pitch/yaw/roll program. Maximum dynamic pressure occurs 66 seconds into flight.

Mission Overview (concl'd)

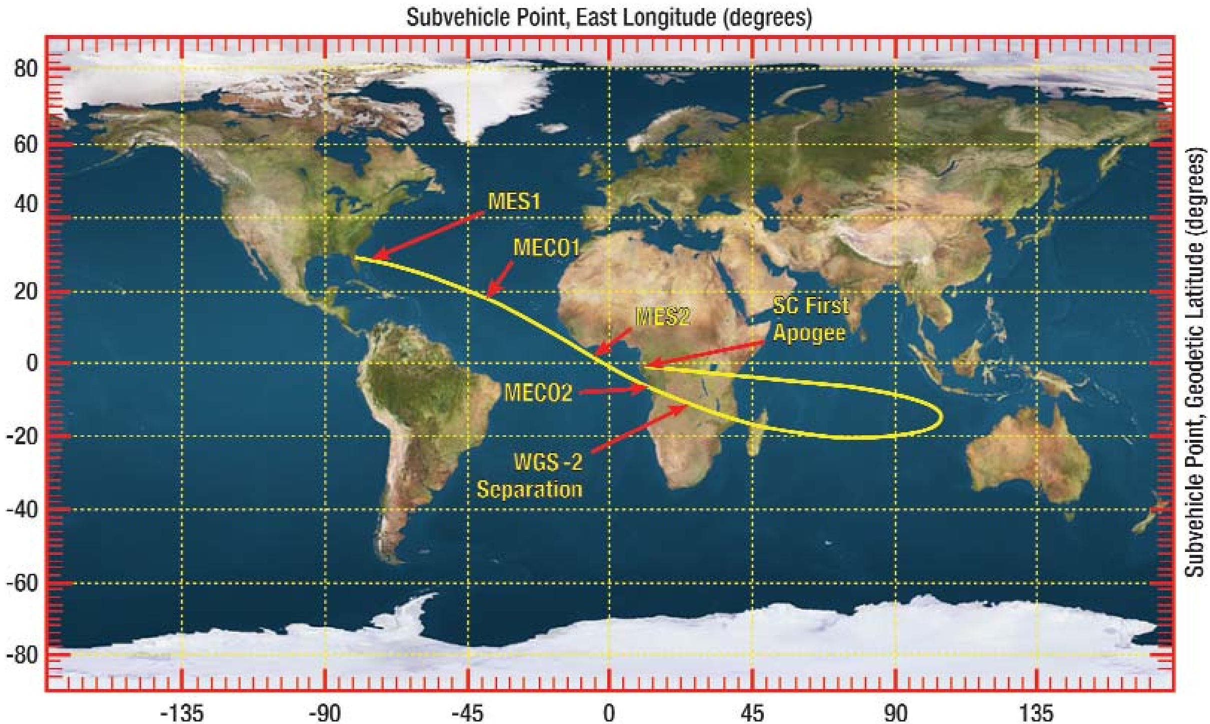
The SRBs burn out at T+90 seconds, and are jettisoned at T+140 seconds. Booster engine cutoff (BECO) occurs at approximately 255 seconds. Telemetry data are gathered by TEL-4, Jonathan Dickinson Missile Tracking Annex (JDMTA), Antigua, Diego Garcia, and Guam Tracking Stations. The Tracking and Data Relay Satellite System (TDRSS) will also participate in gathering telemetry during the WGS-2 mission.

Centaur separation is 6 seconds after BECO. Centaur main engine start (MES1) occurs 10 seconds after the separation event. Payload fairing jettison takes place at 8 seconds after MES1. At approximately 15 minutes into the mission, main engine cutoff 1 (MECO1) occurs and Centaur has achieved its parking orbit.

After a 9-minute coast phase, Centaur reorients itself for MES2. MES2 begins approximately 24 minutes into the mission and lasts about 4.5 minutes. After MECO2, Centaur re-orients its attitude for the separation event.

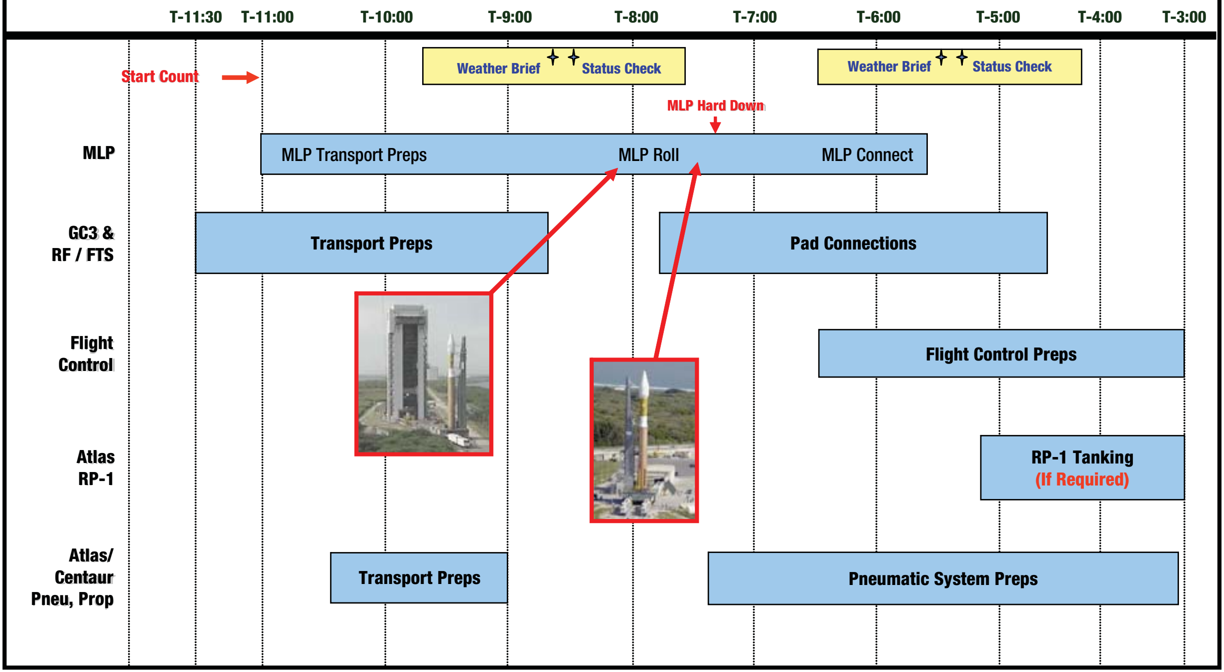
The WGS-2 spacecraft separates about 31.5 minutes after launch. The turn to Centaur Collision and Contamination Avoidance Maneuver (CCAM) attitude begins about three minutes after the separation event. Centaur's mission ends 1.5 hours after launch after blowdown of the propellant tanks and burn off of residual N_2H_4.

Mission Ground Trace

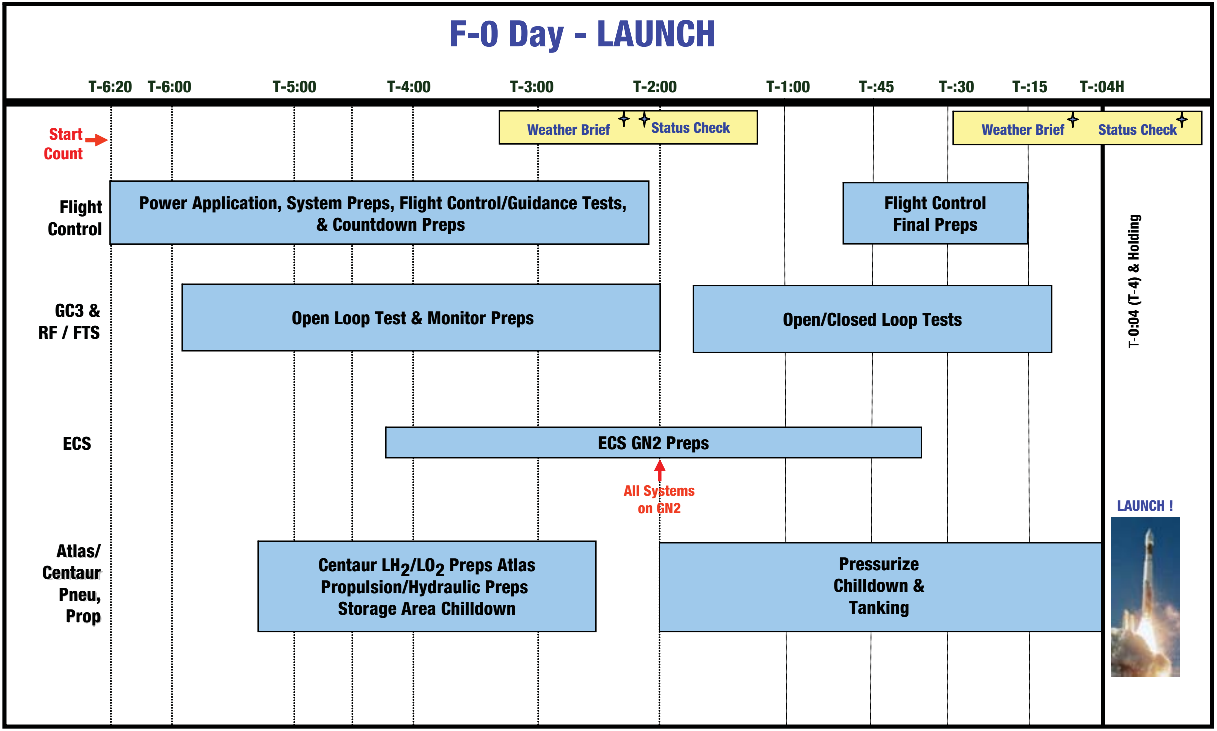


Countdown Timeline

F-1 Day - MLP TRANSPORT TO PAD



Countdown Timeline (concl'd)



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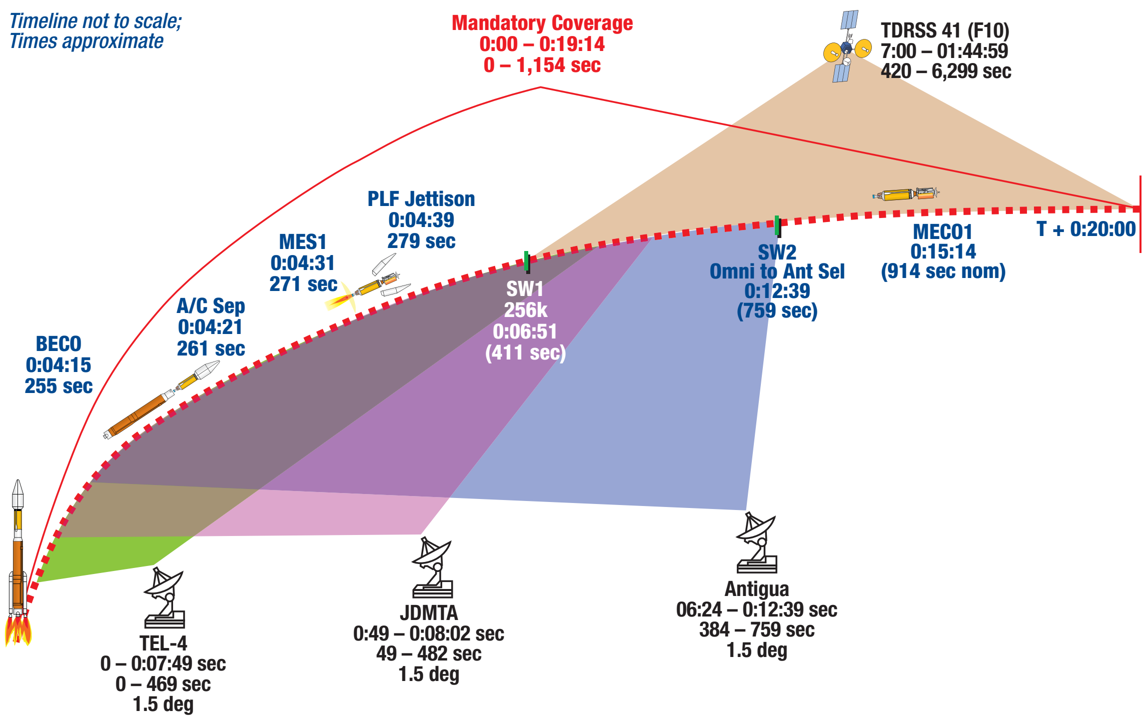
Plus Count Key Events

ATLAS

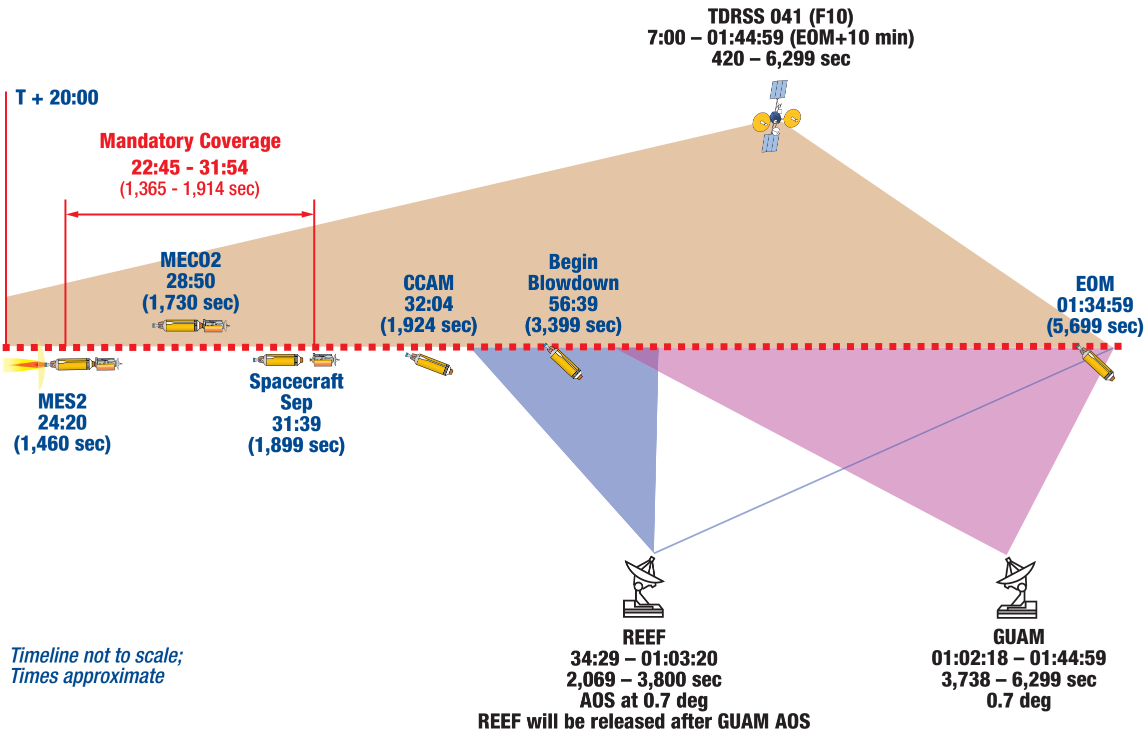
MET (sec)	MET* (hr:min:sec)	Action
0	**+00:00:00.**	**T=0 (Engine Ready)**
49	+00:00:49	JDMTA AOS (1.5 deg)
90	**+00:01:30**	**(Mark Event 1) SRB Burn Out**
139	**+00:02:19**	**(Mark Event 2) SRB Jettison**
255	**+00:04:15**	**(Mark Event 3) Atlas Booster Engine Cutoff**
261	**+00:04:21**	**(Mark Event 4) Atlas/Centaur Separation**
271	**+00:04:31**	**(Mark Event 5) Centaur First Main Engine Start (MES1)**
279	**+00:04:39**	**(Mark Event 6) Payload Fairing Jettison**
384	+00:06:24	Antigua AOS (1.5 deg)
411	+00:06:51	Switch Date Rate from 512k to 256k (MES1+140 sec)
420	+00:07:00	TDRS 041 AOS
469	+00:07:49	TEL-4 LOS (1.5 deg)
482	+00:08:02	JDMTA LOS (1.5 deg)
759	+00:12:39	Antigua LOS (1.5 deg)
760	+00:12:40	Switch from OMNI to Antenna Select (MES1+489 sec)
914	**+00:15:14**	**(Mark Event 7) Centaur First Main Engine Cutoff (MECO1)**
1460	**+00:24:20**	**(Mark Event 8) Centaur Second Main Engine Start (MES2)**
1730	**+00:28:50**	**(Mark Event 9) Centaur Second Main Engine Cutoff (MECO2)**
1899	**+00:31:39**	**(Mark Event 10) SV Separation**
1924	+00:32:04	Begin CCAM
2069	+00:34:29	DGS (REEF) AOS (0.7 deg)
3399	+00:56:39	Begin Blowdown
3738	+01:02:18	GTS (GUAM) AOS (0.7 deg)
3800	+01:03:20	DGS (REEF) LOS (0.7 deg)
4843	+01:20:48	Expected N2H4 Depletion
5685	+01:34:45	GTS (GUAM) LOS (0.7 deg)
5699	+01:34:59	End of Mission (Arm Uplink Interrupt)
6299	+01:44:59	End TDRS 041 Coverage (EOM+10 Minutes)

*Values Approximate

Expected Telemetry Coverage

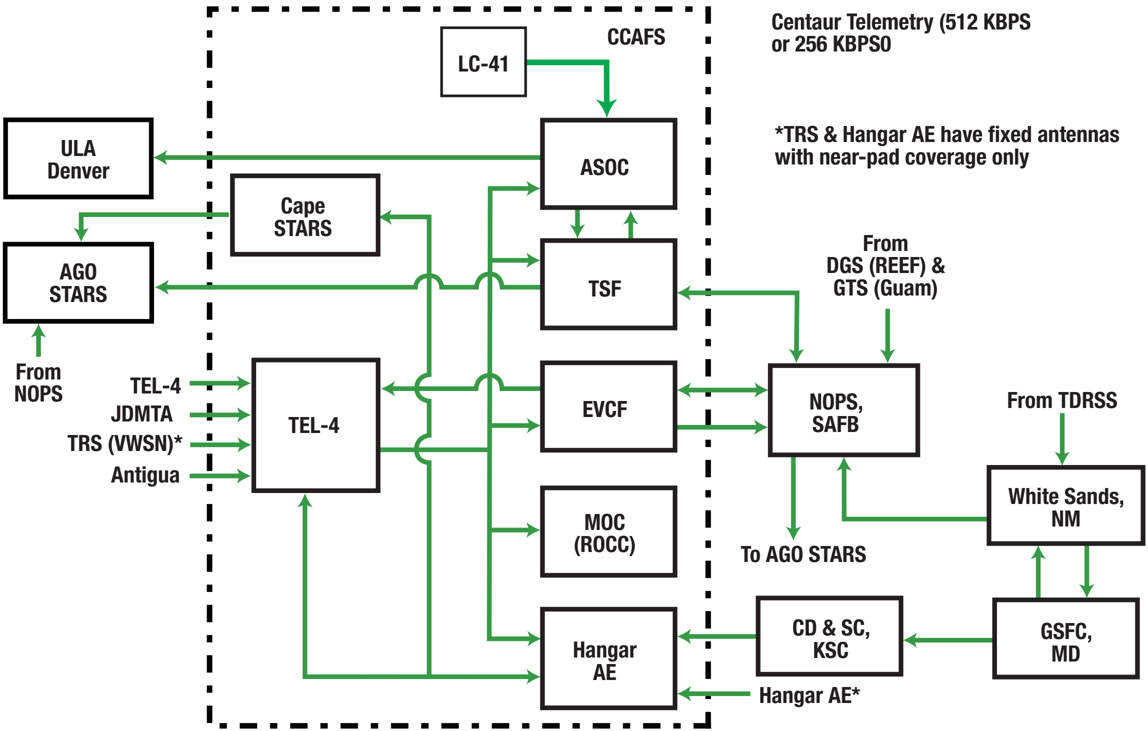


Expected Telemetry Coverage (concl'd)



Timeline not to scale;
Times approximate

I-Channel Telemetry Flow



Abbreviations & Acronyms

3 SOPS	3rd Space Operations Squadron
A/C	Atlas Centaur
AFSCN	Air Force Satellite Control Network
AGO	Aerospace Group Offices
AOS	Acquisition of Signal
ASOC	Atlas Spaceflight Operations Center
BECO	Booster Engine Cut Off
BPSK	Binary Phase Shift Key
C4ISR	Command and Control, Communications, Computers; Intelligence, Surveillance, and Reconnaissance
CCAFS	Cape Canaveral Air Force Station
CCAM	Collision and Contamination Avoidance Maneuver
CCLS	Computer Controlled Launch System
Ch	Channel
DGS	Diego Garcia Station
ECB	Entry Control Building
ECS	Environmental Control System
EDT	Eastern Daylight Time
EELV	Evolved Expendable Launch Vehicle
EOM	End of Mission
EPF	Extended Payload Fairing
ER	Eastern Range
EVCF	Eastern Vehicle Checkout Facility
F/O	Follow On
FTS	Flight Termination System
Gbps	Gigabits per second (billions of bits per second)
GC3	Ground Command Control and Communications
GMT	Greenwich Mean Time
GN2	Gaseous Nitrogen
GSCCE	Gapfiller Satellite Configuration and Control Element
GSO	Geosynchronous Orbit
GSFC	Goddard Space Flight Center
GTS	Guam Transmitter Station
INU	Inertial Navigation Unit
ISA	Interstage Adapter
Isp	Specific Impulse
JDMTA	Jonathan Dickinson Missile Tracking Annex
Jett	Jettison
Kbps	Kilo Bits Per Second
LC	Launch Complex
LH_2	Liquid Hydrogen
LO_2	Liquid Oxygen
LOS	Loss Of Signal
LVA	Launch Vehicle Adapter
Max Q	Maximum Dynamic Pressure
MBPS	Mega Bits Per Second
MECO	Main Engine Cut Off
MES	Main Engine Start

Abbreviations & Acronyms (concl'd)

MD	Maryland
MD	Mission Director (USAF)
MLP	Mobile Launch Platform
MOC	Morrell Operations Center
N_2H_4	Hydrazine
NHS	New Hampshire Tracking Station AFSCN (Call Sign - BOSS)
NM	New Mexico
nmi	Nautical Mile
NOPS	NRO Operations Squadron
NRO	National Reconnaissance Office
PEB	Pad Equipment Building
PLA	Payload Adapter
PLF	Payload Fairing
Pneu	Pneumatics
Prop	Propulsion
PTC	Passive Thermal Control
QPSK	Quadrature Phase Shift Key
REEF	Diego Garcia Tracking Station
ROCC	Range Operations Control Center
RF	Radio Frequency
RP-1	Rocket Propellant – 1 (Kerosene)
SAFB	Schriever Air Force Base
SATCOM	Satellite Communications
SC	Spacecraft
SCLVA	Spacecraft Launch Vehicle Adapter
Sep	Separation
SMC	Space and Missiles Systems Center
SRB	Solid Rocket Booster
STARS	Space Launch Operations (SLO) Telemetry Acquisition and Reporting System
SVC	Space Vehicle Contractor
SW	Switch
TDRSS	Tracking & Data Relay Satellite System
TLM	Telemetry
TRS	Telemetry Receiving Site
TSF	Technical Support Facility
UHF	Ultra High Frequency
ULA	United Launch Alliance
USAF	United States Air Force
Vac	Vacuum
VIF	Vertical/Vehicle Integration Facility
VWSN	Visual Warning Site, North
XIPS	Xenon Ion Propulsion System
WANIU	Wide Area Network Interface Unit
WGS	Wideband Global SATCOM
WSOC	Wideband Satellite Operations Centers

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Notes

ATLAS