

# AEHF

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## Payloads

### Briefing

AEHF (*A*dvanced *E*xtrremely *H*igh *F*requency) is a constellation of American military communications satellites, designed to provide highly-secure, anti-jam, low-probability-of-intercept/low-probability-of-detection services to theater commanders. The system, originally envisioned to consist of five satellites, is the follow-on to MILSTAR II. AEHF satellites are designed to be much more powerful than their predecessors, the MILSTAR IIs. They will provide 10-12 times the capacity and six times higher data rate transfer. Four AEHF satellites have been launched thus far, including the AEHF 1 on August 14, 2010; AEHF 2 on May 4, 2012; AEHF 3 on September 18, 2013; AEHF 4 on October 17, 2018 and AEHF 5 on August 8, 2019. Plans call for launching one more satellite by 2020.

On August 23, 1999, the US Air Force awarded Boeing and the team of Lockheed Martin/Northrop Grumman Space Technology each an 18-month, \$22.25 million system definition contract for AEHF. In December 1999, the US Department of Defense's (DoD) Joint Requirements Oversight Council (JROC) recommended a four-month study be undertaken to evaluate the feasibility of allowing both teams competing to build AEHF to work together on the program.

On April 6, 2000, the Pentagon's top procurement official, Jacques Gansler, agreed to let the competing companies join forces on the program.

In September 2001, the AEHF National Team, made up of Lockheed Martin Missiles & Space, Northrop Grumman Space Technology, and Boeing Satellite Systems, completed a preliminary design review for AEHF with the Military Satellite Communications Joint Program Office of the Air Force's Space and Missile Systems Center. Additional design reviews were scheduled during the month, followed by critical design reviews.

On November 16, 2001, the Air Force awarded the team of Lockheed Martin and Northrop

Grumman Space Technology a \$2.6 billion firm, fixed-price contract to manufacture two AEHF satellites, rather than the five that were originally proposed. On January 12, 2006, the US Air Force Space and Missile Systems Center issued Lockheed Martin a \$491.2 million contract to fund the procurement of a third AEHF satellite.

### Recent Developments

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The AEHF 5 satellite was successfully launched by an Atlas V/551 rocket from Cape Canaveral Air Force Station in Florida August 8, 2019.



## Executive

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 Air Force Space and Missile Systems  
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 USA  
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*(program manager)*

## Manufacturers

Lockheed Martin Missiles &  
 Space Co.  
 1111 Lockheed Martin Way  
 Sunnyvale, CA 94089  
 USA  
 tel: +1 (408) 743-1010  
 fax: +1 (408) 756-2187  
*(prime contractor, bus, systems,  
 and overall system integration)*

Northrop Grumman Corp.  
 Technology  
 One Space Park  
 Redondo Beach, CA 90278  
 USA  
 tel: +1 ((310) 812-4321  
 fax: +1 (310) 813-3331  
*(primary subcontractor, communications  
 payload and processing systems)*

## Specifications

Mass:	6,075 kg
Length:	9.75 m (across payload axis)
Orbit:	geostationary
Design lifetime:	14 yr
Antennas:	2 SHF downlink phased arrays, 2 crosslinks, 2 uplink/downlink nulling antennas, 1 uplink EHF phased array, 6 uplink/downlink gimballed dish antenna, 1 each uplink/downlink earth coverage horns
Payload:	onboard signal processing, crossbanded EHF/SHF communications
Coverage:	worldwide, from 65° N to 65° S
Data rates:	10-12 times the data rate of MILSTAR II

## Subsystems

### Frame

The satellites are based on a militarized version of the A2100 bus, produced by Lockheed Mar-  
tin Missiles & Space Co. of Sunnyvale, CA.

**Launch Systems**

All of the AEHF satellites, thus far, have been launched by Atlas V rockets, operated by *United Launch Alliance* (ULA) of Centennial, CO. The remaining six satellites are also expected to be launched aboard Atlas Vs.

**Guidance & Control**

*BAE Systems Information and Electronic Warfare Systems* of Manassas, VA is under subcontract to Lockheed Martin Missiles & Space to build the radiation-protected command and control computers. The company is also providing logic and memory components and other onboard computers under subcontract to Northrop Grumman Space Technology.

**Data Handling/Transmission**

*Harris Government Communications Systems Div.* of Melbourne, FL is under contract to develop ship-, submarine-, and shore-based terminals. *Rockwell International's Collins Government Systems Div.* of Cedar Rapids, IA developed modification kits for its Single Channel Anti-jam Manportable (Scamp) terminals to make them compatible with AEHF.

**Payload**

*Northrop Grumman Space Technology* of Redondo Beach, CA is responsible for the communications payload, including the digital processors, nulling antennas, crosslink RF antenna equipment, and the uplink phased array. It also serves as the payload integrator. The company worked under a \$1.3 billion subcontract to Lockheed Martin Missiles & Space. *Sypris Solutions, Inc.'s Group Technologies Corp.* of Tampa, FL manufactured circuit card assemblies under subcontract to Raytheon Systems. Under contract to Northrop Grumman Space Technology, *EMS Technologies, Inc.* of Atlanta, GA is responsible for the Beam Forming Network (BFN) which allow the AEHF's nulling antennas to provide anti-jam protection.

**Other Subsystems & Services**

*L-3 Communications Systems-East* of Camden, NJ is the prime contractor for construction of an extremely high frequency communications security and transmission security system. *L-3 Communications' Conic Div.* of San Diego, CA is developed test equipment for the security system. *Boeing Satellite Development Center* of El Segundo, CA and *Mykotronx, Inc.* of Torrance, CA was also part of the L-3 team.

**Contract Briefs**

Date	Contract Number	Source	Value	Details
<i>AEHF National Team</i>				
09/10/01	—	SMC	\$10,000,000	Modification to a FFP contract for additional preliminary design effort and extends the System Definition phase of the AEHF satellite communications system program through September 2001. The work will be performed in Sunnyvale, CA (33%); Redondo Beach, CA (60%) and El Segundo, CA (7%). Work scheduled for completion by 9/30/01. PE involvement: 0303119F.
10/03/01	F04701-99-C-0027	SMC	\$135,500,000	FFP contract for an additional Preliminary Design effort and extends the system definition phase of the AEHF satellite communications system program. The work will be performed in Sunnyvale, CA (40%); Redondo Beach, CA (40%); and El Se-

				gundo, CA (20%). Work scheduled for completion by 12/31/01. PE involvement: 0604479F.
11/16/01	F04701-02-C-0002	SMC	\$12,250,000	Increment as part of a \$2,698,000,000 NTE FFP and CPAF contract to provide for the System Development and Demonstration phase of the AEHF satellite communications system program. The work will be performed in Sunnyvale, CA (45%) and Redondo Beach, CA (55%). Work scheduled for completion by 12/31/11. PE involvement: 0603430F.
<i><u>BAE Systems, BAE Systems Information and Electronic Warfare Systems</u></i>				
09/00/02	—	Lockheed Martin	\$9,500,000	Contract to build radiation-protected command and control computers. Delivery due in 2005.
<i><u>Boeing</u></i>				
08/24/04	F19628-02-C-0048	ESC	\$20,193,000	Cost-plus award-fee contract modification. At the time the FAB-T contract F19628-02-C-0048 was signed, the Advanced Extremely High Frequency (AEHF) specifications referenced in the contract were not complete and/or mature. Since that time, the (AEHF) system design and specifications have been maturing through working groups involving the government, Boeing and the AEHF system contract team. Most of these specifications have been updated since the contract award by the AEHF working groups. Therefore the changes included in these specifications must be included in the FAB-T terminal in order to be in line with the rest of the system. FAB-T is the Command Post Terminal for the (AEHF) Satellite System and thus serves as a key component of AEHF operations. At this time, \$2,143,000 of the funds have been obligated. Work scheduled for completion by December 2007.
12/08/04	F19628-02-C-0048	ESC	\$42,487,000	Cost-plus award-fee contract modification for Family of Advanced Beyond Line-of-Sight Terminals (FAB-T), ECP 0011: Incorporated of additional Advanced Extremely High Frequency (AEHF) COMSEC/TRANSEC System (ACTS) chip and keying material delays into the FAB-T baseline; and update of FAB-T and AEHF baseline specifications. This contract modification incorporates both the most recent ACTS-related delays and synchronization with the maturing AEHF specifications. These modifications will be incorporated into 16 AEHF Engineering Development Models of terminals for the B-2, B-52, E-4, E-6, and RC-135 aircraft and for ground-fixed and ground-transportable command post terminals. At this time, \$10,000,000 of the funds has been obligated. Work scheduled for completion by September 2008.
<i><u>Boeing, Satellite Development Center</u></i>				
05/22/97	F04701-97-C-0026	SMC	\$64,598,762	CPFF contract to provide for the Advanced Extremely High Frequency (AEHF) Engineering Model Program. Work scheduled for completion by 5/31/00. PE involvement: 0603430F.
08/23/99	F04701-99-C-0028	SMC	\$22,249,925	FFP contract to provide for system definition of the Advanced Extremely High Frequency (AEHF) communications satellite program. Work sched-

uled for completion by 3/31/01. PE involvement: 0604479F.

EMS Technologies

01/02/02	—	NGST*	\$22,000,000	Three-year contract to manufacture the Beam Forming Network (BFN) for the first two satellites of the Advanced Extremely High Frequency (AEHF) program.
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Harris, Government Communications Systems Div.

06/00/01	—	SPAWAR	\$1,300,000	Seven-month contract to develop ship-, submarine-, and shore-based terminals for AEHF system.
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L-3 Communications, L-3 Communications Systems-East

01/00/00	—	NSA	\$28,700,000	Contract to build an extremely high frequency communications security and transmission security system for the AEHF satellite system.
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LinQuest

11/23/04	F04701-98-C-0046	SMC	\$6,499,025	Cost-plus award-fee contract modification. This modification extends for one fiscal year the specialized systems engineering support that the contractor provides to the Milsatcom Joint Program Price, particularly to the System Program Director and the advanced EHF (AEHF) program. Support includes analysis of requirements, wave form development, Interface Control Documents, advanced concepts development, training, system design support, and systems integration. The contractor also will maintain and upgrade the AEHF End-to-End Simulation Environment. Total funds have been obligated. Work scheduled for completion by September 2005.
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Lockheed Martin, Lockheed Martin Missiles & Space

08/23/99	F04701-99-C-0027	SMC	\$22,250,000	FFP contract to provide for system definition of the Advanced Extremely High Frequency (AEHF) communications satellite program. Work scheduled for completion by 3/31/01. PE involvement: 0604479F.
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05/22/02	F04701-02-C-0002	SMC	\$498,000,000	FFP contract for the Advanced Extremely High Frequency (AEHF) System Development and Demonstration (SD&D) phase. The work will be performed in Redondo Beach, CA (46%); Sunnyvale, CA (28%) and other locations (26%). Work scheduled for completion by 5/31/12. PE involvement: 0603430F.
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08/08/03	F04701-02-C-0002	SMC	\$78,500,000	Cost-plus award-fee, cost-plus fixed-fee, firm fixed price contract modification to provide for an in-scope change to Incorporate KI-54 Interface Control Document (ICD) Revision F-Phase 2 impacts. In Phase 2, the contractor will focus on identifying and mitigate the Advanced Extremely High Frequency (AEHF) system level impacts associated with the Host Accessory Logic Application Specific Integrated Circuit (HAL ASIC) redesign so that the 4-month HAL ASIC Program Development Review (PDR) slip will not result in a launch delay. A two-phase approach was initiated to evaluate the KI-54 ICD Revision F changes, Phase I focused on the
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				effort to redesign the HAL ASIC. Phase 2 focused on identifying and mitigating the AEHF system level impacts associated with the HAL ASIC redesign, as defined in Phase 1, such that the 4-month HAL ASIC PDR slip will not result in a launch delay. Work scheduled for completion by September 2008.
12/22/03	F04701-02-C-0002 SMC	\$15,000,000		Cost-plus award-fee contract modification incorporating Option 5 of the investigation of an analysis study that defines Mission Planning Element (MPE) versus Terminal Functionality into the AEHF baseline. This technical change will provide two different connection modes to allow MPE to communicate with Army and Air Force terminals and adapt to different terminal and network changes. Work scheduled for completion by September 2008.
03/07/05	F04701-02-C-0002 SMC	\$78,226,000		Cost-plus award-fee, cost-plus fixed-fee, firm fixed-price contract modification to provide for the advance procurement of long-lead parts for AEHF Satellite Vehicles #3 (SV3) in FY05. This advance procurement ensures that parts requiring significant lead-time to manufacture will be in place to assemble SV3 on schedule. The locations of performances are Lockheed Martin Space Systems Co., Sunnyvale, CA (30%), and Northrop Grumman Space Technology, Los Angeles, CA (70%). Work scheduled for completion by September 2008.
01/12/06	F04701-02-C-0002 SMC	\$491,207,797		CPAF, CPFF, FFP contract to modify the Advanced Extremely High Frequency (AEHF) contract to add satellite vehicle #3 (SV3) as envisioned and permitted by a clause in the contract. Work scheduled for completion by 5/31/11. Program involvement: 0603430F.
04/14/06	F04701-02-C-0002 SMC	\$454,882,060		CPFF, CPAF contract for the implementation of the Advanced Extremely High Frequency (AEHF) Satellite Communication System Program re-plan. Work scheduled for completion by 5/31/10. PE involvement: 0603430F.
10/04/06	F04701-02-C-0002 MSCS	\$263,922		Increment as part of a \$7,639,325 CPAF contract to incorporate software and hardware changed to the Advanced Extremely High Frequency satellite system. Work scheduled for completion by 1/31/09. PE involvement: 0603430F.
12/28/06	F04701-02-C-0002 MSCS	\$1,014,821		Increment as part of a \$7,841,530 CPAF contract for the use of commercial payload processing facility to test, integrate, and fuel the Advanced Extremely High Frequency satellite in preparation for launch. Work scheduled for completion by 12/31/07. PE involvement: 0603430F.
12/29/06	F04701-02-C-0002 MSCS	\$1,003,797		Increment as part of a \$7,841,530 CPAF contract for the use of commercial payload processing facility to test, integrate, and fuel the Advanced Extremely High Frequency satellite in preparation for launch. Work scheduled for completion by 12/31/07. PE involvement: 0603430F.
02/28/07	FA8816-06-C-0004 SMC	\$108,000,000		FFP contract for the purchase of launch services using an Atlas V launch vehicle under the Evolved Expendable Launch Vehicle (EELV) program.

Work scheduled for completion by 2/28/09.  
PE involvement: 0604853F.

09/17/12	F04701-02-C-0002	SMC	\$42,962,261	Modification contract for Advanced Extremely High Frequency (AEHF) Crypto Availability KI-54D for Space Vehicle 6. The work will be performed in Camden, NJ and El Segundo, CA. Work is scheduled to be completed by 10/16/15. Program involvement: AEHF.
07/23/13	F04701-02-C-0002	SMC	\$8,791,516	CPIF contract for Interim Contractor Sustainment FY12-15 Additional Scope for the Advanced Extremely High Frequency (AEHF) System Development and Demonstration Program. Work is scheduled to be completed by 11/30/14. PE involvement: 0603430F. Program involvement: AEHF.

Northrop Grumman, Space Technology

05/22/97	F04701-97-C-0025	SMC	\$59,199,244	CPFF contract to provide for the Advanced Extremely High Frequency (AEHF) Engineering Model Program. Work scheduled for completion by 5/31/00. PE involvement: 0603430F.
08/04/04	F04701-02-C-0002	SMC	\$28,062,500	Increment as part of a \$32,550,000 CPAF contract to procure space critical components to be used in factory by the contractor during assembly and test of Advanced Extremely High Frequency satellite. Work scheduled for completion by 1/31/09. PE involvement: 0603430F.

Rockwell International, Collins Government Systems Div.

03/00/01	—	US Army	\$34,700,000	Contract to upgrade Single Channel Anti-jam Manportable (Scamp) terminals to be compatible with the AEHF system. Terminal modifications kits scheduled for completion in 2005.
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Sypris Solutions, Group Technologies

02/00/00	—	Raytheon	\$3,500,000	Contract to manufacture circuit card and assemblies.
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\* Northrop Grumman Space Technology

## Funding

<i>RDT&amp;E (\$ Millions)</i>	FY11	FY12	FY13	FY14	FY15	FY16	FY17	2018	2019	2020*
US Air Force										
<b>PE 0603430F</b> AEHF										
MILSATCOM	361.0	385.0	211.6	—						
<b>PE 0605431F</b> AEHF										
MILSATCOM	—	—	—	261.6	294.5	228.1	221.6	145.6	383.1	117.3
<i>Procurement (\$ Millions)</i>	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20*
US Air Force										
Space Programs										
AEHF	29.7	551.5	476.6	328.3	298.5	327.4	645.6	57.0	29.8	—

\* Request

## Costs

Estimated cost of building and launching the six AEHF satellites is \$15 billion. The cost for the first two satellites was about

\$6.5 billion. The third satellite was \$950 million. The fourth satellite was priced at approximately \$2 billion. The fifth and

sixth satellites will cost a total of about \$1.62 billion.

## Teal Group Evaluation

AEHF has been a complex program from its inception. Originally, it called for a system of five satellites, including one ground spare. The price was estimated at \$2.5 billion, and the goal was to have the first satellite ready for launch by 2004. The AEHF 1 satellite was to have been less capable than the four that would come after it. But the Air Force was willing to live with that, given its concern about the possibility of a coverage gap in 2004-2005 in its secure communications infrastructure due to the loss of the MILSTAR II-F1 satellite in 1999.

It was precisely because of its sense of urgency to launch a secure communications satellite by 2004 that the Air Force opted to go sole-source with the development of AEHF, rather than to

open up the program to a competitive bid process. The idea was to save time by letting Lockheed Martin, Northrop Grumman Space Technology, and Boeing team and build the system together. But it soon became clear that the team would not be able to deliver the first satellite by 2004.

During the past decade, AEHF has suffered sizeable Congressional cutbacks in its budget. International partners such as the governments of Canada, Great Britain, and the Netherlands have also failed to come through with their expected financial contributions to the program, primarily out of concern that the downsized system (from five satellites to three) may provide insufficient worldwide coverage. In addition, the Air Force has in-

creased the performance requirements (specifically with regard to encryption) of the system. All three of these factors have caused delays and made the program more expensive. The first satellite was finally launched in 2010. And the value of the AEHF program has risen to about \$15 billion, which represents a costs growth of more than 300%. The figure includes approximately \$2 billion for the procurement of a fourth satellite, which the Air Force thought it would have to do without. Congress, however, added the AEHF 4, as well as the AEHF 5 and 6 satellites, because it foresaw a bigger gap than anticipated between the design lifetime of the AEHF system and the advent of the next-generation TSats.

## Launch Forecast

<i>(payload units)</i>	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
AEHF	1	—	1	—	1	—	—	1	—	—