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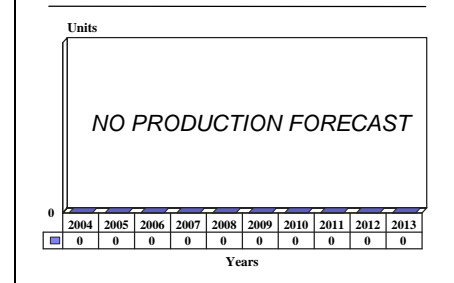
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UHF Follow-On - Archived 3/2005

Outlook

- Last UHF Follow-On satellite successfully launched
- No further UHF Follow-On satellites are planned
- The first of the UHF Follow-On satellite's successors, the Mobile User Objective System (MUOS), is expected to enter orbit in 2008

10 Year Unit Production Forecast
2004 - 2013



Orientation

Description. UHF Follow-On (UFO) satellites provide Ultra-High Frequency (UHF) and Extremely High Frequency (EHF) communications for worldwide U.S. Department of Defense (DoD) tactical and strategic applications.

Sponsor

U.S. Navy

Naval Space and Warfare Systems Command
(SPAWAR)

Dahlgren, Virginia (VA)

USA

(Overall responsibility for U.S. Navy space systems and satellite communications, including UFO program management)

Status. All 11 satellites were produced and launched. Only 10 of them reached operational orbit.

Total Produced. Eleven were produced through 2003.

Application. The UFO satellites provide voice and datalinks between ships, from shore to ship, and from ship to aircraft.

Price Range. Units 1 through 3 cost, on average, US\$138 million each. Units 4 through 10, equipped with an EHF payload, cost an average of US\$198 million each. Preliminary estimates of the 11th satellite, as mentioned in *Inside the Navy*, January 12, 1998, suggest a unit cost of between US\$200 million and US\$220 million, depending on features.

Contractors

Boeing Satellite Systems, <http://www.boeing.com/defense-space/space/bss/>, P.O. Box 92919, Los Angeles, CA 90049-2152 United States, Tel: 1 (310) 662-9000, Prime



US Navy's UHF Follow-On Satellite

Source: The Boeing Company

Technical Data

	<u>Metric</u>	<u>U.S.</u>
Dimensions		
Length (solar panel to solar panel)	18.5 m	60.6 ft
Weight (mass in orbit)	1,043 kg	2,300 lb
Channels	17 UHF, 25 kHz bandwidth 21 UHF, 5 kHz bandwidth 1 SHF, 7-8 GHz, 25 kHz bandwidth 11 EHF	
Power	2,500 watts	
Stabilization	3-axis	
Design Life	14 years	

Design Features. The UFO is a nuclear-hardened spacecraft based on the three-axis stabilized Hughes HS-601 satellite bus. The satellite measures 18.5 meters from tip to tip of the solar panels, which together will produce 2,500 watts at the end of the mission.

During their 14-year design life, the satellites will provide communications over 43 channels, as specified

above. All channels feature UHF uplinks and downlinks, except the fleet broadcast channel, whose uplink is in the super-high-frequency range (7 to 8 GHz). The UFO satellites come equipped with MD-942/DR dual-channel processors built by TRW.

Variants/Upgrades

Beginning with the fourth UFO satellite, an extremely high-frequency (EHF) communications payload was added to the satellites. The 11 channels are distributed between an Earth coverage beam and a steerable 5-

degree spot beam, and are compatible with MILSTAR ground terminals.

UFO satellites 8 through 10 will use extra-high-capacity Ka-band communications payloads for the interim

Global Broadcast Service (GBS), replacing the super-high-frequency (SHF) payload. The Ka-band package includes four 130-watt, 24-megabits-per-second military Ka-band transponders; two steerable downlink spot beam antennas; and one steerable and one fixed uplink antenna. Each satellite will then have a capacity of 96 megabits per second.

UFO satellite F11 will also carry a GBS package, plus an enhanced EHF message capability transmitted over medium-data-rate (MDR) lines. The ability to locate sources of radio-frequency interference is expected to be a priority as well. Since the receivers on the first 10 UFO satellites have become obsolete, a new digital receiver is being developed for the F11 satellite.

Program Review

Background. The UHF satellite communications system, of which the UFO satellites are a part, became operational in the late 1960s with the deployment of TACSAT tactical and LES 6 experimental communications satellites. These spacecraft were responsible for some of the first simultaneous satellite communications between U.S. aircraft, submarines, ships, and ground units. Further development of the UHF satellite communications system culminated in the GAPFILLER communications satellite, leased from COMSAT and launched in 1976. The full operational configuration was achieved in the early 1980s with the development of the Fleet Satellite Communications (FLTSATCOM) and Leased Satellite Communications (LEASATCOM) satellites.

The UHF satellite communications system currently consists of a mix of FLTSATCOM, LEASATCOM, and UFO satellites in geosynchronous orbit, along with hundreds of Earth terminals on ships, aircraft, and land.

UHF Follow-On Satellite. A milestone in U.S. DoD efforts to modernize its UHF satellite communications system was the July 29, 1988, selection of Hughes Aircraft Co (now Boeing Satellite Systems) to supply up to 10 UHF Follow-On satellites. The Space and Naval Warfare Systems Command awarded Hughes a US\$120.3 million firm fixed-price contract for the satellites. Estimates of the total cost of the program, including satellites, launch services, and support, ran as high as US\$1.8 billion.

UFO satellites have a minimum mission life expectancy of 10 years and a design life of 14 years. On the basis of experience with the FLTSATCOM and LEASATCOM satellites, which have lasted considerably longer than expected, the UFOs may continue to operate for more than 14 years.

Hughes awarded General Dynamics a US\$240 million launch vehicle development and integration contract in 1988 that led to all UFO satellites being launched on General Dynamics' Atlas II commercial launch vehicle. (General Dynamics is now part of Lockheed Martin.)

Of the 10 satellites planned for production, four were to be placed in geostationary orbit, four were earmarked as in-orbit backups, and two were designated spares. The

UFO contract contains a repayment clause that would require Hughes to provide a refund to the U.S. Navy in the event of a satellite failure.

EHF Package. Whether or not to provide the UFO with an EHF system was a hotly contested issue between the U.S. Air Force and the U.S. Navy. The U.S. Air Force developed the jam-resistant, EHF-equipped MILSTAR (Military Strategic and Tactical Relay) satellite and argued that another EHF package on UFO satellites would be redundant. The U.S. Navy's response was that UHF frequencies are not immune to jamming and that the EHF frequency would enhance the new satellite system's ability to survive.

In the fall of 1989, Congress approved the U.S. Navy's plan to equip some UFO satellites with an EHF package. The EHF package was slated to be installed on satellite numbers 4 to 10. Moreover, the requirements outlined for satellite F11 in 1998 call for enhancement of the EHF feature.

First UFO Lost, Second UFO OK. The much delayed launch of the first UFO satellite on March 25, 1993, ended in failure when the Atlas booster left the satellite in a useless orbit. An investigation by General Dynamics into the incident revealed that a loose screw in the MA-5 booster engine precision reference regulator interrupted the flow of liquid oxygen. This reduced the power of the engine, causing the rocket to deliver the satellite short of its normal orbit.

The following September, an Atlas I successfully carried the second UFO satellite to its proper orbit. The new satellite is stationed over the Indian Ocean. A total of seven UFO satellites were launched through July 1997.

UFO Satellites to Feature GBS Capabilities. On March 8, 1996, the U.S. Navy announced its award of a US\$9.9 million sole-source contract to Hughes to modify UFO satellites F8, F9, and F10, with GBS capabilities. Loud protests followed from Hughes' competitor PanAmSat, as well as from Loral/Lockheed Martin/TRW. They felt the sole-source award to Hughes was unfair, and that they ought to have been allowed to compete the contract; furthermore, the award gave

Hughes an unfair advantage in competing for future GBS programs.

PanAmSat claimed to offer a system of satellites that could be built not only with more capability than Hughes' UFO modification, but also less expensively and in less time. Whatever the technical merits of PanAmSat's or Loral's systems, these systems could not be broken out in terms of exact costs due to the Lockheed/Loral merger (ongoing at the time), which prohibited such financial determinations. The proposals could therefore not be properly evaluated within the U.S. DoD's timeframe.

In addition to the March 1996 award, contract modifications involving GBS incorporation into UFO satellites had gone to Hughes in the amounts of US\$19.6 million (March 1996), US\$17.9 million (May 1996), and US\$13.6 million (August 1996). UFO satellites F8 and F9 were launched in 1998, and F10 was launched in November 1999.

Eleventh UFO Satellite. In November 1997, space representatives from the U.S. Army, Navy, and Air Force met to discuss the technical and operational requirements of an additional UFO satellite, F11. They

agreed that the focus should be placed on expanding EHF capacity. Other specifications, including details of F11's development, were to be discussed in subsequent meetings in early 1998.

In November 1999, it became publicly known that an 11th UFO satellite would be produced when Hughes Space and Communications Company (now Boeing Satellite Systems) was awarded a US\$27.3 million contract for the production of the F11 satellite. The F11 will include UHF, EHF, SHF, and GBS capabilities. The contract also contains options that, if exercised, will bring the contract's cumulative value to approximately US\$213.2 million.

The 11th UFO carries a newly developed digital receiver, replacing the obsolete analog receiver such as those installed on all the previously launched UFO satellites. Funding for the development of the new digital receiver was covered in PE#0303109N, Project P2472 - Mobile User Segment. Allocations for this project ran from 2000 to 2003. The 11th UFO was launched in December 2003. The F11 will be used as an interim satellite until the next-generation satellite constellation, the Mobile User Objective System (MUOS), becomes fully operable.

Funding

The UHF Follow-On satellite program was covered under the U.S. Navy program WPN, N-BA2 Other Missiles, Fleet Satellite Communications Follow-On 2433, Subhead 52EU. The program now covers the development of the Mobile User Objective System (MUOS), the UHF Follow-On satellite successor. Funding for the UHF Follow-On satellite command and control functions now falls under the U.S. Air Force's Satellite Control Network program element (#0305110F).

Recent Contracts

<u>Contractor</u>	<u>Award (US\$ millions)</u>	<u>Date/Description</u>
Hughes Space & Communications Co	27.3	Nov 1999 – A fixed-price option modification to previously awarded contract N00039-88-0300 for the U.S. Navy's 11th UFO satellite (F11). This modification contains 12 options which, if exercised, will bring the contract value to US\$213.2 million. Work is scheduled to be completed by September 2003.

Timetable

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
Jul	1988	UFO satellite production contract awarded to Hughes
FY	1993	Loss of first UFO satellite (F1); F2 launched on Atlas
Jun	1994	F3 launched on Atlas
FY	1995	UFO F4 launched (Atlas), UFO F5 launched (Atlas II), UFO F6 launched (Atlas IIAS)
FY	1996	GBS modification contract awarded to Hughes; F7 launched on Atlas II
Nov	1997	Tri-service meeting outlines the capabilities projected for UFO F11

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
FY	1998	UFO F8 launched, UFO F9 launched
FY	1999	UFO F10 launched
Nov	1999	UFO F11 contract awarded to Hughes Space & Communications Co
Aug	2000	DoD decides to buy two new spacecraft similar to the UFO satellites
FY	2003	UFO F11 launched

Worldwide Distribution

UHF Follow-On satellites are exclusive to the **U.S. Department of Defense**.

Forecast Rationale

The U.S. Navy's constellation of 10 UHF Follow-On (UFO) satellites serves as a global communications network and includes thousands of stationary and mobile users on land, at sea, or airborne. Eleven satellites were produced, but the first one launched did not reach its operational orbit. The final UHF Follow-On satellite was launched on December 17, 2003, aboard a Lockheed Martin Atlas IIIB launch vehicle.

Now that the final satellite is in orbit, funding for the command and control of the UHF Follow-On system falls under the U.S. Air Force's Satellite Control Network program element (#0305110F). The UHF Follow-On system's program, the Fleet Satellite

Communications Follow-On, is now dedicated to the UHF Follow-On satellite's successor, the Mobile User Objective System (MUOS). MUOS is a narrowband satellite communications system that will have 10 times the capability of the UFO satellite system. The advanced system development and demonstration phase is slated to begin in 2004. A final contractor is to be named in 2004 or 2005, with initial satellite launch planned for 2008. MUOS system deliveries will begin in late 2007 or early 2008 and will likely extend through 2014, allowing for an average of one satellite per year to replace the existing UFO system. No further funding, except for command and control functions, is expected for the UHF Follow-On system.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR PRODUCTION

<u>Designation</u>	<u>Application</u>	<u>Thru 03</u>	<u>High Confidence Level</u>				<u>Good Confidence Level</u>				<u>Speculative</u>			<u>Total 04-13</u>
			<u>04</u>	<u>05</u>	<u>06</u>	<u>07</u>	<u>08</u>	<u>09</u>	<u>10</u>	<u>11</u>	<u>12</u>	<u>13</u>		
UHF FOLLOW-ON	Prior Prod'n:	11	0	0	0	0	0	0	0	0	0	0	0	0