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LAUNCH MISSION SUMMARY

COMSTAR D-4

ATLAS/CENTAUR-42

National Aeronautics and
Space Administration

John F. Kennedy Space Center

NASA

COMSTAR PROGRAM

COMSTAR D-4, the fourth spacecraft in this series, is being launched to replace COMSTAR D-1 now operating in orbit at 128^{o} west longitude. COMSTAR D-1 will be programmed to move from its present West Coast position to another over St. Louis where it will parallel COMSTAR D-2. The three satellites now in orbit are positioned so that no more than one at a time will be operating in the shadow of the earth, or temporarily removed from service due to a transit across the face of the sun.

Although they are capable of relaying other forms of data, COMSTARs are primarily used for long-distance telephone service. The increasing need for long-distance lines within the United States prompted the development of high-capacity domestic commercial communications satellites, rather than major increases in land-line communications. COMSAT General, a wholly-owned subsidiary of COMSAT Corporation, owns the COMSTAR satellites, and leases their entire in-orbit capacity to American Telephone & Telegraph (AT&T). AT&T in turn has an agreement with GTE Satellite Corporation (GSAT), a subsidiary of General Telephone and Electronics, to share the satellites in providing communications between each company's network of terrestrial stations. AT&T has ground stations in New York, Chicago, San Francisco, and Atlanta. GSAT has stations serving Tampa, Los Angeles, and the island of Hawaii. The COMSTARs are also capable of serving Alaska and Puerto Rico, through ground stations in those locations owned by other communications carriers.

AT&T uses the COMSTAR system primarily for Wide Area Telephone Service (WATS) and U.S. Government private line communications. They are controlled by two Telemetry, Tracking & Command stations operated by COMSAT General, one in Southbury, Connecticut, and one in Santa Paula, California. Both stations are connected with COMSAT General's System Control Center in Washington, D.C. Each station has two COMSTAR antennas, a 12.8 meter (42 foot) diameter tracking antenna, and a 10.4 meter (34 foot) non-tracking antenna. A third antenna very similar to the larger one provides similar services for MARISAT, a maritime satellite communications system also owned and operated by COMSAT General. The two tracking antennas can provide backup support to each other when necessary.

The COMSTAR program is a means of providing more long-distance telephone lines in the USA without the usual accompanying increase in telephone poles and miles of wire overhead, or the alternative method of microwave towers strung across the countryside. Domestic long-distance telephone service by satellite is now as much a part of American communications as the established satellite systems for television transmission, data transfers, and telegraphic services.

COMSTAR SPACECRAFT

A COMSTAR weighs 1,516 kilograms (3,342 pounds) on the ground. It has a mass of about 811 kilograms (1,440 pounds) on station in orbit, after burning up the apogee motor propellants and some Position & Orientation (P&O) hydrazine propellant. The overall height, including antennas, is 6.1 meters (20 feet), and the width of the cylindrical main body is 2.4 meters (8 feet). In operation a COMSTAR turns on its axis at about 56 rpm, exposing the 17,000 solar cells which cover the main cylinder to sunlight for about a third of each rotation. This spinning also provides a gyroscope effect, which holds the spacecraft steady in space. The complete communications system is de-spun at the same rate, to remain constantly aimed at the earth.

Enough solar cells operate at any given moment to supply a COMSTAR with up to 570 watts of continuous power. Two nickle-cadmium batteries supply power when the satellite is operating in the earth's shadow.

A COMSTAR has 24 transponders, each capable of relaying 1,500 one-way telephone transmissions, a somewhat higher capacity than that anticipated in the original design. This equals 18,000 standard two-way telephone circuits. The two offset parabolic antenna reflectors, which are 127 X 178 centimeters (50 X 70 inches) in size, separate incoming signals by frequency and direct each beam to its particular horn within a multi-horn feed array. The two reflectors both receive and transmit. Each has a polarization grid, one polarizing incoming and outgoing signals horizontally while the other polarizes vertically. This permits frequency overlap without interference, a technique called frequency reuse by polarization isolation. Each of the 24 channels has a bandwidth of 36 MHz, but due to reuse the total bandwidth is within the 500 MHz allocated to a communications satellite. Each antenna and its receiver can handle 12 channels, in banks of six. There are two redundant receivers available, and each can replace either of the two operational receivers, should one fail. All communications signals are received in the 6 GHz range, and converted to the 4 GHz range for amplification and retransmission.

The P&O system includes redundant radial, spinup, and axial hydrazine thrusters that supply impulse for spacecraft spinup and station-keeping acitivities. Each COMSTAR has two experimental beacons, operating at 19.0 and 28.6 GHz, which beam directly to the earth without using the large reflectors. These are to help determine minimum power and other performance margins needed for possible future satellite communications systems operating above 10 GHz. The satellite has an expected lifetime of seven years.

COMSTAR spacecraft are built by Hughes Aircraft, under contract to COMSAT General.

ATLAS/CENTAUR VEHICLES

The two-stage ATLAS/CENTAUR combination, built by General Dynamics/Convair (GDC), has launched a wide variety of scientific and technological spacecraft. These have included Surveyors to the moon; Mariners to Venus, Mercury, and Mars; Pioneers to Jupiter and Saturn; and INTELSAT, FLTSATCOM, and COMSTAR communications satellites into geosynchronous earth orbit.

The 21.3 meter (70 foot) first stage is an uprated version of the flight-proven ATLAS vehicle. The Rockwell International/Rocketdyne MA-5 engine system burns RP-1, a highly refined kerosene, and liquid oxygen. The MA-5 utilizes two main engines, a 1,646,000 Newtons (370,000 pounds) of thrust booster with two thrust chambers, and a smaller sustainer with a single chamber that produces 266,900 Newtons (60,000 pounds) of thrust. Two smaller vernier engines which help control the vehicle in flight are also burning at liftoff, for a total thrust of 1,917,000 Newtons (431,000 pounds). Vehicle weight varies according to payload. For this mission, total vehicle weight at liftoff is about 148,120 kilograms (326,550 pounds).

After about 2 1/2 minutes of flight, Booster Engine Cut Off (BECO) occurs and the engine and supporting structures are jettisoned. An ATLAS thus drops a large portion of its structural weight without having to ignite an engine in flight, as a separate stage must. The sustainer and vernier engines continue to burn until propellant depletion, at a little over four minutes.

The only radio frequency system on the ATLAS is a range safety command system, consisting of two receivers, a power control unit, and a destruct unit. The ATLAS can be destroyed in flight if necessary, but otherwise receives all control directions from the CENTAUR stage.

The CENTAUR stage is located above the ATLAS, on a barrel-shaped interstage adapter. The ATLAS and CENTAUR separate two seconds after the ATLAS burn out. Eight small retrorockets near the bottom of the ATLAS fuel tank then back this stage away from the CENTAUR.

The CENTAUR stage is 14 meters (46 feet) in length. Exclusive of payload, it weighs about 17,700 kilograms (38,000 pounds) when loaded with propellants. The main propulsion system consists of two Pratt & Whitney engines burning liquid oxygen and liquid hydrogen, producing 133,400 Newtons (30,000 pounds) of thrust in the vacuum of space in which they are designed to operate. These engines can be stopped and restarted, allowing the CENTAUR to coast to the best point from which to achieve its final trajectory before igniting for the final burn. While coasting, the stage is controlled by 12 small thrust engines, powered by hydrogen peroxide. These hold the stage steady and provide a small constant thrust to keep the propellants settled in the bottoms of their tanks, a necessity for a second or third burn.

A cylindrical nose fairing with a conical top is located above the CENTAUR and protects the spacecraft. The extended version of the standard ATLAS/CENTAUR nose fairing is used for the COMSTAR mission resulting in a total vehicle height of 40.8 meters (134 feet). Both stages are three meters (10 feet) in diameter.

The CENTAUR astrionics system provides integrated flight control for both itself and the ATLAS. The heart of this system is an airborne Digital Computer Unit (DCU), built by Teledyne. The DCU is an advanced, high-speed computer with a 16,384 word random access memory. It issues commands which control the sequence of operations for both stages. It also issues steering commands to the engines, operating on guidance information furnished by the Inertial Measurement Group (IMG). The IMG, built by Honeywell, determines how accurately the vehicle stages are following the planned flight path, allowing the DCU to correct for any deviations by issuing new steering commands.

The DCU and other electronic packages are mounted in a circle around a conical equipment module, located above the upper CENTAUR tank. In addition to providing guidance and determining the sequence of events, these packages perform the navigation, autopilot, attitude control, and telemetry and data management functions for both stages. The CENTAUR also has a ground-controlled destruct system similar to that on the ATLAS, in case the stage must be destroyed in flight.

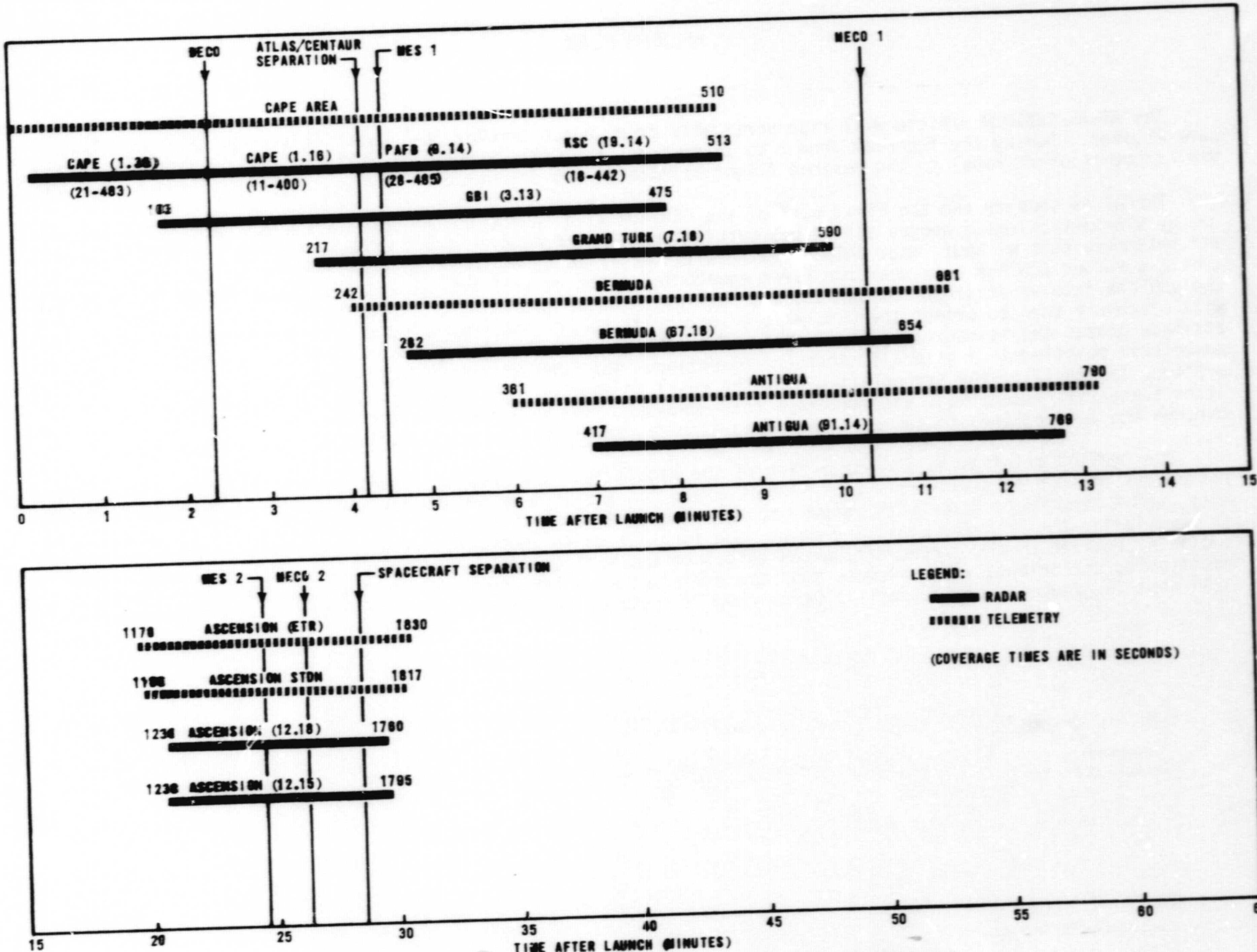
The CENTAUR utilizes the most powerful propellant combination available, has a light-weight structure, and the longest burn time of any stage now in service. This gives it more total energy for its size than any stage yet built.

FLIGHT PLAN

The ATLAS/CENTAUR vehicle will rise vertically from Launch Complex 36-A until 15 seconds of flight time have elapsed. During the interval from 2 to 15 seconds, the CENTAUR DCU will roll the vehicle from the launch pad azimuth (105 degrees) to the desired flight azimuth of 101 degrees.

The ATLAS booster and the first burn of the CENTAUR will inject the vehicle into a 100-nautical-mile perigee by 978-nautical-mile apogee elliptical parking orbit. The parking orbit will be designed to obtain metric and telemetry data without range ships or aircraft. After an approximate 15-minute coast period in the parking orbit, a second CENTAUR burn near the first equatorial crossing will provide a small plane change and inject the vehicle into an inclined Hohmann transfer ellipse. After second Main Engine Cutoff (MECO 2), the CENTAUR will execute a turn to orient the COMSTAR D-4 spacecraft to its required attitude for the transfer orbit. This attitude places the spacecraft spin axis normal to the plane of the transfer orbit, with the antenna end of the spacecraft pointing in a generally southern direction. The COMSTAR D-4 will spin up, in roll, shortly after separation, to stabilize the spacecraft during the coast to apogee. The CENTAUR will turn approximately 90 degrees after spacecraft separation, and perform a retromaneuver. The retromaneuver includes a propellant tank blowdown through the main engines to increase the separation distance from the spacecraft.

The COMSTAR missions require injection of the satellites into geosynchronous equatorial orbit. The nominal parameters of such an orbit are a 23.935-hour period, an altitude of 19,365 nautical miles, near zero eccentricity, and a zero inclination with respect to the equatorial plane. An apogee motor on the COMSTAR D-4 is used to circularize the transfer orbit and reduce the inclination to near zero. Final positioning in geosynchronous orbit is provided by the spacecraft, which drifts to its assigned place and then fires its hydrazine-powered positioning and orientation system to stop the drift motion. The operating position for COMSTAR D-4 will be at 127^{o} west longitude, over the Pacific Ocean roughly south of San Francisco.



ANTICIPATED RADAR AND TELEMETRY COVERAGE, COMSTAR D-4

COMSTAR D-4 SELECTED TRAJECTORY INFORMATION

Events	Time (seconds)	Time (min:sec)	Surface Range (nautical miles)	Altitude (nautical miles)
Liftoff	T=0	0:00.0	0.0	0.0
BECO	T+139	2:19	43	30
SECO	T+257	4:17	222	79
ATLAS/CENTAUR Separation	T+259	4:19	226	80
MES 1	T+266	4:26	239	82
MECO 1	T+624	10:24	1233	102
MES 2	T+1491	24:51	4631	300
MECO 2	T+1579	26:19	4991	337
Spacecraft Separation	T+1714	28:34	5589	435
Transfer Orbit to Apogee	T+20,560	342:40	9000	19,324

These numbers may vary, depending on exact launch date and launch time.

LAUNCH WINDOWS

The launch period for COMSTAR D-4 is scheduled to start on February 19, 1981, and will continue through March 12, 1981. The launch windows for COMSTAR D-4 are as follows:

	First Window		Second Window		
Date	EST Open - Close	GMT* Open - Close	EST Open - Close	GMT* Open - Close	Window Duration (minutes)
Feb 19	1815 - 1915	2315 - 0015	-- --	-- --	60
20	1814 - 1915	2314 - 0015	-- --	-- --	61
21	1813 - 1914	2313 - 0014	-- --	-- --	61
22	1813 - 1910	2313 - 0010	-- --	-- --	57
23	1812 - 1905	2312 - 0005	-- --	-- --	53
24	1811 - 1901	2311 - 0001	-- --	-- --	50
25	1811 - 1857	2311 - 2357	-- --	-- --	46
26	1810 - 1853	2310 - 2353	-- --	-- --	43
27	1809 - 1849	2309 - 2349	-- --	-- --	40
28	1808 - 1845	2308 - 2345	-- --	-- --	37
Mar 1	1808 - 1840	2308 - 2340	-- --	-- --	32
2	1807 - 1836	2307 - 2336	-- --	-- --	29
3	1806 - 1832	2306 - 2332	2039 - 2049	0139 - 0149	26 - 10
4	1805 - 1827	2305 - 2327	2034 - 2048	0134 - 0148	22 - 14

Launch Windows (Cont'd)

Date	First Window EST Open - Close	First Window GMT* Open - Close	Second Window EST Open - Close	Second Window GMT* Open - Close	Window Duration (minutes)
Mar 5	1805 - 1823	2305 - 2323	2030 - 2047	0130 - 0147	18 - 17
6	1804 - 1819	2304 - 2319	2028 - 2047	0128 - 0147	15 - 19
7	1803 - 1814	2303 - 2314	2027 - 2046	0127 - 0146	11 - 19
8	1802 - 1809	2302 - 2309	2026 - 2045	0126 - 0145	7 - 19
9	1801 - 1805	2301 - 2305	2025 - 2044	0125 - 0144	4 - 19
10	2024 - 2043	0124 - 0143	-- --	-- --	19
11	2023 - 2042	0123 - 0142	-- --	-- --	19
12	2023 - 2041	0123 - 0141	-- --	-- --	18

*Note: All GMT launch times that occur after midnight are actually one day later in GMT than the date shown opposite that entry in the left column.