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AeroAstro Satellites

Outlook

- No production forecast over next 10 years. Barring any further developments, this report will be archived next year
- JMAPS program cancelled in 2012
- With no money coming in for JMAPS, Comtech decided to close its AeroAstro unit

Orientation

Description. AeroAstro satellites were small space platforms for carrying science or communications payloads.

Sponsor. The first ALEXIS satellite was sponsored by the U.S. Department of Energy's Office of Arms Control and developed by the Energy Department's Los Alamos National Laboratory, Los Alamos, New Mexico.

The HETE program was sponsored by NASA through the Massachusetts Institute of Technology.

TERRIERS was a collaboration between the Center for Space Physics at Boston University, AeroAstro, MIT's Haystack Observatory, the University of Illinois at Urbana-Champaign, the Naval Research Laboratory, Philips Laboratory, and Cleveland Heights High School.

The SPASE satellite was sponsored via a 1998 contract awarded by NASA to AeroAstro.

STPSat-1 was developed for the Air Force Space Command, Space and Missile Systems Center (SMC). Funding was sponsored by the Air Force Space Test Program Office at Kirtland Air Force Base (AFB) in Albuquerque, New Mexico.

Status. The AeroAstro line of satellites has been discontinued.

Total Produced. Five

Application. AeroAstro small satellites were low-cost space systems designed for scientific research, technology development and flight qualification, Earth remote sensing, and communications.

Price Range. The ALEXIS satellite cost $3 million. The AeroAstro bus and ground station together cost about $3.5 million. HETE cost $4.2 million. STPSat-1 was expected to cost $12 million for design, construction, and one year of in-orbit support.

Contractors

Prime

AeroAstro Inc	http://www.aeroastro.com, 20145 Ashbrook Pl, Ashburn, VA 20147-3372 United States, Tel: + 1 (703) 723-9800, Fax: + 1 (703) 723-9850, Prime

AeroAstro Satellites

Subcontractor

IAI Systems Missiles & Space - MLM Division	http://www.iai.co.il, PO Box 45, Beer-Yaakov, 70350 Israel, Tel: + 972 8 9272425, Fax: + 972 8 9273080, Email: mlm_marketing@iai.co.il (ALEXIS Photovoltaic Cell for Solar Panel)
Los Alamos National Laboratory	http://www.lanl.gov, Bikini Atoll Rd, SM 30, PO Box 1663, Los Alamos, NM 87545 United States, Tel: + 1 (505) 667-7000 (Alexis Payload Design, Development & Integration)
NEC Corp	http://www.nec.co.jp, 7-1, Shiba 5-chome, Minato-Ku, Tokyo, 108-8001 Japan, Tel: + 81 03 3454 1111, Email: webmaster@nec.co.jp (ALEXIS S-Band Cross Dipole Antenna; S-Band Antennae)

Technical Data

Design Features. AeroAstro satellites feature four solar panels connected to a central bus. Each panel is tipped by an S/C antenna and each contains a restraint mechanism that allows the panel to open after launch. Two magnetometers are located on two panels opposite each other. The central bus holds a single electronics box, a power distribution box, a transmitter, a receiver demodulator, four battery boxes, and six torque coils. Payloads are contained within a cylinder on top of the central bus.

Recognizing the need for a small spacecraft core module, AeroAstro had developed the "Bitsy" kernel, a core component from which custom satellites can easily be developed. The integrated electronics unit measures only 25 x 25 x 10 centimeters, not including the attached solar panel.

The Bitsy kernel meets three requirements: it is reliable, using standard interfaces and components; it is inexpensive; and it is easy to use. Bitsy kernels are designed to be ready for flight a few months after order, and should significantly reduce the access-to-space costs of small payloads. Variants of the Bitsy, the Bitsy-LX and Bitsy-DX, are available for more advanced payloads.

Bitsy core components are designed to be used for a variety of applications, including:

- Data and messaging store and forward
- Hosting of remote sensing instruments, including staring and spinning sensors
- Tracking of assets, wildlife, and Earth and ocean surface motion
- Custom orbits, including high-energy trajectories for geophysics, solar physics, and astrophysics sensing
- Precise orbit maintenance for Sun-synchronous Earth sensing and satellite constellation maintenance
- Space environment testing and qualification of components and materials
- Launch on demand for event-driven missions, including tactical communications and imaging, and environmental events including forest fires, volcano eruptions, and severe weather

ALEXIS. The ALEXIS (Array of Low-Energy X-ray Imaging Sensors) satellite, developed by the Los Alamos National Laboratory, was designed to detect soft (low-energy) X-rays in three narrow bands: 62 eV, 72 eV, and 93 eV (a typical medical X-ray has an energy of 80,000 eV). The payload consisted of six wide-field X-ray telescopes, each with a 30° field of view. The telescopes could survey half the sky each time the satellite rotates. A second experiment, called Blackbeard, measured the effect of the Earth's ionosphere on broadband radio signals.

Data from ALEXIS' X-ray telescopes was made available to researchers through NASA's astrophysical data program. The telescope's combination of wide field of view and precise energy resolution offered a unique view of the cosmos that complemented information being returned by other orbiting observatories.

The detectors on the X-ray telescopes had to precisely time the arrival of each X-ray photon so that researchers could determine where the spinning satellite was pointing when the photon arrived. The ALEXIS team had to de-spin the data to reconstruct an unblurred picture of the sky. Unfortunately, ALEXIS suffered some damage during launch, and the computer programs used to reconstruct the X-ray image had to be rewritten from scratch.

HETE. The High Energy Transient Explorer (HETE) was a program aimed at studying gamma-ray bursts (GRBs) with UV, X-ray, and gamma-ray instruments. The low-Earth-orbiting HETE spacecraft was to provide accurate positions for about 30 GRBs in real time each year. HETE was lost during a Pegasus mission in November 1996.

MIT developed HETE-2 based on the first satellite. It was launched in October 2000 on Orbital's Pegasus XL. The spacecraft included nearly all of the original HETE design features along with a new soft X-ray camera, which takes the place of UV cameras.

TERRIERS. The Tomographic Experiment Using Radiative Recombinative Ionospheric Extreme Ultraviolet and Radio Sources (TERRIERS) was to conduct a global upper-atmospheric study. Using a combination of ground-based and space instruments, the satellite would have surveyed the upper atmosphere using a technique called tomography, the measuring of ultraviolet light emissions, to construct an image of Earth's ionosphere.

STPSat-1. This technology demonstration satellite featured a highly accurate three-axis stabilized platform with 200+ watts of orbit average power and better than 0.1° pointing accuracy in a 150-kilogram total spacecraft package. Instruments included:

- *SHIMMER* – Spatial Heterodyne Imager for Atmospheric Radicals
- *WSSP* – Wafer Scale Signal Processing
- *CITRIS* – Computerized Ionospheric Tomography Receiver in Space
- *MEPSI* – the MEMS-based PICOSAT Inspector

STP-SIV. AeroAstro teamed with Ball Aerospace to design and build the Space Test Program Standard Interface Vehicle (STP-SIV) for the DoD Space Test Program Office. AeroAstro was the lead contractor for building, integrating, and testing the spacecraft bus. The 180-kilogram, three-axis stabilized spacecraft was designed to be compatible with a variety of U.S. launch vehicles and operate in low-Earth orbit for a year.

SPASE. NASA chose the Bitsy-SX core component for its Small Payload Access to Space Experiment (SPASE). The satellite was a microgravity technology demonstrator in NASA's Future-X program. Although SPASE is fully assembled and integrated with the payload, its launch has been canceled.

Team Encounter. Encounter 2001 LLC selected the Bitsy kernel for its commercial interplanetary spacecraft, which was planned to contain photos, messages, and symbolic representations (in the form of human hair) from millions of people. The vehicle was supposed to be launched in 2006, but was canceled in 2004.

	Metric	U.S.
Dimensions (ALEXIS)		
Payload cylinder	91 x 61 cm	36 x 24 in
Weights		
Maximum payload mass	158 kg	315 lb
ALEXIS payload mass	115 kg	254 lb
ALEXIS bus mass	45 kg	99 lb
Performance		
Power supply	45 watts continuous	
ALEXIS power supply	60 watts continuous	
Stabilization	3-axis	
Telemetry	750 kbit/s downlink	
	9,600 bit/s uplink	
Digital control	1 Gbit data buffer	
	3 parallel 80C86 µP	
	Interface to VME bus and dual-ported RAM	
	Interface to VME bus	
Dimensions (HETE)		
Payload cylinder	89 x 66 cm	35 x 25 in

AeroAstro Satellites

	Metric	U.S.
Weight		
Spacecraft mass	127 kg	281 lb
Performance		
Desired orbit (0 degree inclination)	600 km	373 mi
Operating life	6 months (could last longer than 2 years)	
Attitude	Sun pointing, momentum bias	
Data processing	Multiprocessor, 80 VAX MIPS	
Data buffering	96 mbytes of EDAC mass memory	
Downlink	250 kbits/sec data rate	

Artist's Rendition of the STPSat-1

Source: AeroAstro

Variants/Upgrades

ALEXIS. Array of Low-Energy X-ray Imaging Sensors. Launched in 1993; no longer operational.

HETE. High Energy Transient Explorer satellite to observe high-energy astronomical events in the gamma-ray, X-ray, and ultraviolet spectra. Lost in failed launch attempt in 1996. MIT produced and launched the follow-on HETE-2 in 2000.

TERRIERS. The Tomographic Experiment Using Radiative Recombinative Ionospheric Extreme Ultraviolet and Radio Sources. Specialized satellite for conducting a global upper-atmospheric study. Failed shortly after its launch in 1999.

Escort. This spacecraft was a micro-satellite that provided on-orbit satellite servicing and refueling.

Team Encounter. A commercial solar sail mission planned for launch in 2006. Canceled in 2004.

STPSat-1. The Department of Defense Space Test Program Satellite Mission 1. Launched in 2007 for the Air Force Space Command, Space and Missile Systems Center (SMC) on an Atlas V EELV.

STP-SIV. Part of the Department of Defense Space Test Program. The STP-SIV was to reduce mission cost and lead time with a common spacecraft bus, a standard payload interface, and a streamlined acquisition process.

SMARTBus. Modular spacecraft design featuring a plug-and-play architecture for the payload bus interface and the bus's subsystems. Plans call for two missions that are in development to use the SMARTBus platform: SCOUT, a DARPA microsatellite program; and FEBSS (Flexible and Extensible Bus for Small Satellites), an Air Force Research Laboratory program. The launch dates have not been determined.

Program Review

Background. The designs of AeroAstro satellites were based on the company's commitment to building efficient and inexpensive multipurpose systems. AeroAstro offers complete space systems, including satellite and low-cost ground stations, permitting satellite operation and control from the user's office, lab, or site. Software, launch support, ground site support, and flight operations services are included in systems, which start at under $1 million. A miniaturized Bitsy-based satellite can be developed for $100,000.

AeroAstro Spacecraft on First Pegasus

AeroAstro developed and fabricated the ALEXIS satellite and ground station for the U.S. Energy Department. Originally scheduled for 1991, the satellite's launch was pushed to 1993 due to repeated delays in the Orbital Sciences Pegasus winged air-launched space booster program. The mission was the winged rocket's first for the Air Force.

Once the satellite was in orbit, it was determined that one of its six solar panels had been damaged during launch (a cable to a magnetometer may have been severed, disabling the magnetometer). Without the instrument, ALEXIS could not use its onboard magnetic torque coils to orient itself toward the Sun. Engineers controlled the spacecraft attitude with uplinked, timed command strings that were stored and executed by the satellite according to the uploaded schedule. After several days, the satellite's batteries were nearly drained, and ALEXIS entered a rest mode that shut down nearly all of its onboard systems. Gathering just enough solar power to wake itself, the satellite listened for the ground station, which finally made contact.

Within a few weeks, engineers gained control of the spacecraft and shut off unnecessary systems to reduce power draw. Using the torque coils, the team manually oriented ALEXIS toward the Sun, providing the satellite with plenty of electric power to conduct its science mission. The low-power draw of the basic spacecraft bus (about 6.5 watts) made it possible for engineers to recover the spacecraft quickly, despite the damage.

HETE and HETE-2. AeroAstro fabricated the spacecraft, performed payload integration and testing, and provided the main ground stations for the High Energy Transient Experiment (HETE) satellite for MIT as the first NASA UNEX pathfinder, launched in 1996. HETE was a collaborative program with France and Japan that was managed by MIT. The mission provided information about the precise location of gamma-ray bursts and spectral analysis of these and other high-energy transient phenomena.

HETE and its piggyback partner, SAC-B, were launched on a Pegasus XL rocket in November 1996. However, the two spacecraft were not ejected from the rocket's third-stage dual payload attachment fitting, bringing a premature end to both missions. HETE-2, a follow-on mission, was launched in October 2000. MIT built HETE-2 based on the original HETE design.

TERRIERS. AeroAstro designed and co-fabricated the spacecraft and ground stations for the TERRIERS satellite (Boston University under the USRA STEDI program); it launched in 1999. The 121-kilogram TERRIERS was launched into a Sun-synchronous orbit in 1999 aboard a Pegasus XL from Vandenberg AFB, California. The satellite ran out of power after it was unable to orient itself and point its solar arrays toward the Sun.

Team Encounter Spacecraft. AeroAstro developed the system and spacecraft design for the Team Encounter spacecraft, a commercial solar sail mission that planned to launch in 2006. However, the principal investor in the Team Encounter enterprise pulled out in late 2004, and the company has not been revived; nor have plans for the solar sail spacecraft.

Escort. Escort was a small satellite designed to diagnose on-orbit failures and service or refuel spacecraft on orbit. AeroAstro developed many of the key technologies needed for the Escort system. The versatile little satellite can be launched piggyback or separately, and can begin operations immediately or wait in on-orbit storage mode for years until needed. Escort was funded by AeroAstro and by partners in the satellite insurance industry.

Not Much Chance for SPASE

SPASE. The Small Payload Access to Space Experiment was sponsored by NASA's Marshall Space Flight Center. The SPASE technology demonstrator satellite was built on the Bitsy-SX kernel and carried the Microgravity Crystal Growth Demonstration (MCGD) instrument, which is really just a camera monitoring an attempt to grow rock candy in space. The satellite was planned to launch from a Space Shuttle Hitchhiker module on mission STS-107 in 2001, but was de-manifested as cash crunches limited Shuttle launch availability to only the most crucial missions. In the

AeroAstro Satellites

wake of the Shuttle Columbia disaster, the SPASE launch was canceled.

Technology Development. In late 1999, AeroAstro won a $150,000 contract from the United States Air Force for research into military tactical use of nanosatellites. The study made use of the Bitsy core module. AeroAstro also received the Mississippi Space Commerce Initiative contract in October 1999, an award that includes funding for micro and nanosatellite research.

In August 2000, AeroAstro received a $1.6 million contract from NASA to build miniaturized X-band transponders for NASA's New Millennium Space Technology 5 (ST5) Nanosatellite Constellation Trailblazer mission. Each transponder, the size of an inkjet cartridge, was to be 12 times lighter and nine times smaller than previous communications systems. The transponder would require only one-fourth the voltage of and half as much power as existing models.

Bitsy. Through funding from the Small Business Innovation Research (SBIR) program, AeroAstro co-developed, with the U.S. Air Force, a 1-kilogram nanospacecraft core module designated "Bitsy," which later formed the foundation for the SPASE spacecraft and for the KitCore and NanoCore series of core electronics bundles for small satellite buses. Manufacturability and modularity were key drivers of the Bitsy development effort.

AeroAstro developed a radio frequency (RF) probe under an SBIR program contract. The satellite-based probe was designed to analyze near-field RF signals emanating from a target satellite in space. This instrument was capable of sifting through the spectrum, searching for, and identifying signal characteristics for trends, threats, etc.

KitCore and NanoCore. These two electronics bundles were highly miniaturized spacecraft cores based on the Bitsy design, supporting all electronics bus functions (communications, command and data handling subsystem, ACDS, power, etc.). They were highly rugged and modular for a variety of missions.

KitCore was available as a parts kit for optional customer assembly, and offered an optional training package. NanoCore had a higher level of processing capability, and formed the core of AeroAstro's SPORT and NanoObservatory spacecraft buses.

Space Frame. Space Frame, yet another SBIR-funded endeavor, took the Bitsy concept a step further. Its architecture was built around a set of mechanical building blocks called Space Frame Blocks (SFB). Space Frame technology involved mechanical and electrical plug-and-play interfaces that permit simple, reliable integration with other SFB modules. This technology was an important step toward on-orbit configuration, servicing, and upgrading of satellites. The standardized mechanical and electrical interfaces allowed one block to be easily removed and replaced with another.

USPI. A flexible template, the Universal Secondary Payload Interface (USPI) was another project under way at AeroAstro. USPI reduced mission cycle time and increased flexibility and frequency of available secondary launch opportunities for small satellites designed by AeroAstro. The program was partially funded by a $300,000 contract from the U.S. National Reconnaissance Office.

Despite Powerful Partners, SPORT Not Launched

SPORT. The SPORT (Small Payload Orbital Transfer) system was developed in partnership with Malaysia's Astronautic Technology (M) Sdn Bhd (ATMSB). SPORT was a propulsion module that used a unique aerobraking and propulsion system to reduce the amount of propellant required and enabled transfer from GTO to LEO in 45 days.

Arianespace of Evry, France, signed a collaborative agreement with AeroAstro to jointly offer the SPORT system to qualified customers. The two firms also had a cooperative agreement for a SPORT system compatible with the Ariane 5 piggyback system. AeroAstro working with the U.S. National Reconnaissance Office at one point to expand U.S. piggyback capabilities.

USPI designs were intended for specific launch vehicles: Ariane 5, Delta II, EELV, and the Space Shuttle; however, both USPI and SPORT were to offer flexibility in spacecraft design regardless of the type of launch vehicle chosen for the mission.

The first SPORT demonstration model was expected to be launched on an Ariane 5 in 2004; however, Bob Meurer, Space Systems Business Director at AeroAstro at the time, informed Forecast International that the launch was postponed. No new launch date for the SPORT demonstration model has been announced.

SHERPA. AeroAstro developed the Shuttle Expendable Rocket for Payload Augmentation. The SHERPA was viewed as a "space tug" capable of performing multiple orbit and inclination changes, station-keeping, and de-orbiting.

The initial mission of SHERPA was planned to raise a payload from a 350-kilometer orbit to a 700-kilometer circular orbit, including plane changes and collision avoidance maneuvers. AeroAstro was the prime integrator for all technologies for this project, which was sponsored by the Missile Defense Agency and the Air Force Research Laboratory. Since 2003, nothing has been heard from AeroAstro concerning this project.

SENS. AeroAstro was contracted by a commercial company in Australia to develop the system architecture for a 10-satellite LEO communications system. This system, called KITCOM, later evolved into AeroAstro's Satellite Enabled Notification System (SENS). The system is essentially a decoder located at the gateways of the Globalstar network. The mission was to be both terrestrial and space-based, offering a wider range of coverage.

SENS Transmitter Allows Real-Time Transfer

AeroAstro and Globalstar developed and successfully tested an inexpensive new simplex data modem in 2002 for remote sensing and asset tracking via satellite. The SENS transmitter unit allowed real-time data to be sent at preset or random intervals through the Globalstar satellite communications network with AeroAstro's SENS technology. Sensing or tracking data could be sent from remote locations through SENS decoders at the Globalstar gateways and over the Internet to the customer. The basic modem unit – the size of a wireless pager – with antenna was expected to cost as little as $60 in large quantities on an OEM basis.

In June 2002, AeroAstro commenced marketing and distribution agreements with the first two value-added resellers – Offshore Warriors of Gulfport, Mississippi, and Aerotec of Bessemer, Alabama – for SENS and the first sales of SENS transmitter units (STUs). The two resellers develop, market, and sell application-specific STUs for the oil, gas, and electrical utility industries. SENS began service in May 2003.

New Facility, New Capabilities

Several years ago, AeroAstro moved into a new 24,000-square-foot facility in Ashburn, Virginia, that could accommodate multiple simultaneous space programs. The spacious new headquarters had three Class 10,000 clean rooms for assembly and hardware integration, as well as approximately 100 engineering workstations. The facility featured two laboratory spaces to accommodate a range of hardware programs that supported both electronics and mechanical fabrication. AeroAstro had environmental test capability in-house, including temperature and vacuum testing. There was room for all facets of spacecraft development and manufacture, plus specialized workspace and access controls for international visitors and engineers.

Observatory Platforms. AeroAstro developed a conceptual design for a line of Earth remote sensing platforms:

The *MicroObservatory system* offered 2.5-meter-resolution panchromatic imaging and 5-meter multispectral imaging. Four to five spectral bands provided a range of image generation and processing suites.

The *NanoObservatory system* operated in three to four visible and near-infrared bands, providing 10-meter spatial-resolution panchromatic and multispectral imagery. It was capable of being reconfigured to support a variety of other space mission applications.

STPSat-1 Development. The Air Force awarded AeroAstro a $12 million contract in September 2001 to design and build STPSat-1. AeroAstro was also responsible for the integration of four government-provided experiments, space vehicle testing, launch vehicle integration support and testing, and launch and early orbit operations support. Partners in the construction of STPSat-1 included Northrop Grumman TASC and Avidyne.

A successful Preliminary Design Review of the STPSat-1 spacecraft was completed in July 2002. The PDR included reviews of the space vehicle system-level architecture, subsystem-level engineering, and mission operations.

The Critical Design Review was completed in the third quarter of 2003, and STPSat-1 was completed in 2005. The satellite was part of a one-year technology demonstration mission and the first spacecraft intended to fly on the EELV Secondary Payload Adaptor (ESPA) ring. STPSat-1 was launched in March 2007 on an Atlas V launch vehicle.

ALEXIS Calls it Quits. After 12 years in orbit, the ALEXIS satellite finally reached the end of its useful life. The solar arrays had degraded in charge-producing ability, and two of the four battery packs had failed. One of the remaining two batteries was working, but barely. On April 29, 2005, the final two satellite contacts were made, at which time the solar arrays were intentionally tipped away from the Sun, placing the system in the lowest power state for safety purposes.

The 45-kilogram spacecraft bus, built by AeroAstro for less than $3 million, far exceeded its nominal six-month mission and three-year engineering lifetime. ALEXIS achieved its mission of demonstrating its telescope and radio-receiver technology.

AeroAstro Satellites

AeroAstro Subs for Ball on STP-SIV

AeroAstro designed and built spacecraft and provided integration, launch, and mission operations support under a six-year contract with Ball Aerospace & Technologies Corp. The Ball Aerospace & Technologies Corp/AeroAstro team was awarded the DoD Space Test Program Standard Interface Vehicle (STP-SIV) contract in April 2006.

This indefinite delivery/indefinite quantity contract supported procurement of up to six small satellites to fly space experiments. The initial award called for one spacecraft with a standard payload interface, integration and testing of one or more experiments, launch integration, and technical support for at least one year of mission operations. The spacecraft was designed to fly in low-Earth orbit at a wide range of inclinations, with a minimum one-year lifetime.

The proposed STP-SIV spacecraft bus was derived largely from AeroAstro's STPSat-1 space vehicle.

In March 2010, AeroAstro was awarded a $37.9 million contract from the U.S. Navy to develop and deliver a spacecraft bus for the Joint Milli-Arcsecond Pathfinder Survey (JMAPS) program. The satellite was to be based on AeroAstro's Astro 200AS. Expected to be delivered in 2013, the JMAPS mission would have updated the star position catalog for critical national security and civil applications. However, the Navy has since canceled the program.

Timetable

Month	Year	Major Development
Apr	1993	ALEXIS launched
Nov	1996	HETE launch fails
May	1999	TERRIERS launched on Pegasus XL
Oct	2000	HETE-2 launched on Pegasus XL
Mar	2007	STPSat-1 launched on Atlas V
	2012	JMAPS expected to be delivered

Forecast Rationale

AeroAstro's parent company, Comtech Telecommunications Corp, has decided to close down the unit. The cancellation of the U.S. Navy Joint Milli-Arcsecond Pathfinder Survey (JMAPS) program was the final straw for AeroAstro after years of challenges that limited the company's opportunities for growth.

The company participated in a number of government research programs, but overall, there is no need for a large quantity of small satellites. Many of the government agencies and universities that utilize small satellites generally build them in-house. AeroAstro faced strong competition from companies such as Sierra Nevada Corp and Surrey Satellite Technology Ltd on programs that it could bid on.

Opportunities for AeroAstro to expand internationally were also limited. This dearth of international activity was due to a combination of U.S. export control regulations, the cost and time of pursuing international business, and the desire of many countries to favor their own manufacturers.

On top of these difficult factors, AeroAstro faced a decline in U.S. government spending. U.S. military programs that focused on small satellites, such as the Space Test Program and the Operationally Responsive Space office, have been terminated by the U.S. Air Force.

The final blow to AeroAstro was the U.S. Navy's decision to cancel its JMAPS program. Without money coming in from that program, Comtech was forced to shut down its AeroAstro unit.

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