National Aeronautics and Space Administration

Press Kit

June 2009

GOES-O

www.nasa.gov

GOES-O

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GOES-O Media Contacts

NASA Headquarters
Stephen Cole
Policy/Program Management
202-358-0918 office
stephen.e.cole@nasa.gov

NASA Goddard Space Flight Center
Cynthia M. O'Carroll
Public Affairs
301-286-4647 office
410-507-0958 cell
cynthia.m.ocarroll@nasa.gov

NASA Kennedy Space Center
George H. Diller
Launch Operations
321-861-7643 office
george.h.diller@nasa.gov

NOAA National Environmental Satellite
John Leslie
Data and Information Service
301-713-2087 office
202-527-3504 cell
john.leslie@noaa.gov

Patrick Air Force Base
Eric Brian
Chief, Media Relations
45th Space Wing Public Affairs
321-494-5949/33 office
321-508-2072 cell
321-494-7302 fax
eric.brian@patrick.af.mil
www.patrick.af.mil

The Boeing Company/Space & Intelligence Systems
Angie Chen
Communications
310-364-6708 office
310-227-6568 cell
angie.e.chen@boeing.com

Boeing Space Exploration - Florida Operations
Susan Wells
Communications Manager
321-264-8580 office
321-446-4970 cell
susan.h.wells@boeing.com

United Launch Alliance
Michael J. Rein
ULA Senior Communications Manager
321-730-5646 office
321-693-6250 cell
michael.j.rein@ulalaunch.com

Media Services Information

The Geostationary Operational Environmental Satellite (GOES-O) is scheduled to launch June 26, 2009 at 6:14 p.m. EDT (60-minute window) from the Eastern Range SLC 37, Cape Canaveral Air Force Station, Fla.

News Center/Status Reports

NASA Public Affairs will staff the Kennedy Space Center (KSC) News Center beginning on L-3 days, continuing until approximately five hours after a successful launch. The NASA News Center at KSC may be reached at 321/867-2468. Recorded status reports also will be available beginning three days before launch by dialing **321-867-2525** or **301-286-NEWS**.

Prelaunch Press Briefing

The L-1 Pre-launch Press briefing is scheduled for June 25 at 1 p.m. EDT at the NASA News Center at KSC. Information presented will include the details about the Delta IV countdown, launch readiness of GOES-O, background on the satellite and its mission, and the launch weather forecast. The briefing will be carried live on NASA TV. Audio of the conference will be carried on the NASA "V" circuits, which may be accessed by dialing 321/867-1220...1240...1260...7135.

Media Credentialing

- **U.S. Media attending BOTH the NASA Prelaunch Press Briefing and launch day viewing:** Please contact the NASA KSC Press Site's Laurel Lichtenberger (321-867-4036 or laurel.a.lichtenberger@nasa.gov), for accreditation for both events.

- **U.S. Media attending ONLY launch day viewing:** Media will be accredited on the day of launch by the U.S. Air Force's 45th Space Wing Public Affairs Office. Please bring two forms of picture I.D. for accreditation. Media should arrive at the KSC Badging Office parking lot at the entrance of Cape Canaveral Air Force Station no later than 4:45 p.m. EDT on launch day. Please call Mr. Eric Brian at 321-494-5933 for questions.

NASA Television Transmission

NASA Television will broadcast live launch coverage of GOES-O that begins at 4:00 p.m. EDT, concluding 30 minutes after liftoff.

NASA Television is on AMC-6, Transponder 17C, located at 72 degrees West longitude, frequency 4040.0 MHz video, 6.8 MHz audio (MPEG-2 digital signal). For NASA TV information and schedules on the Internet, visit:

http://www.nasa.gov/ntv

Internet Information

Detailed information about the GOES-O mission and science objectives can be found at the following NASA and NOAA websites:

http://www.nasa.gov/goes-o
http://goespoes.gsfc.nasa.gov
http://www.noaa.gov
http://nws.noaa.gov

NASA Hurricane Resource website:

http://www.nasa.gov/hurricane

June 16, 2009

Cynthia M O'Carroll
Goddard Space Flight Center
301-286-4647
cynthia.m.ocarroll@nasa.gov

John Leslie
NOAA National Environmental Satellite, Data and Information Service
301-713-2087
john.leslie@noaa.gov

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NASA AND NOAA'S GOES-O SATELLITE READY FOR LAUNCH

GREENBELT, Md. -- NASA is preparing for the launch of the Geostationary Operational Environmental Satellite-O (GOES-O) from Space Launch Complex 37 at the Cape Canaveral Air Force Station, Fla. The GOES-O launch is targeted for June 26 during a launch window from 6:14 to 7:14 p.m. EDT.

"Launching GOES-O will contribute the data needed for accurate NOAA forecasts for severe weather, including hurricanes that threaten at least 35 million Americans living in areas vulnerable to land-falling hurricanes," stated Steve Kirkner, GOES program manager at NASA's Goddard Space Flight Center, Greenbelt, Md.

GOES-O is the second spacecraft to be launched in the GOES N Series of geostationary environmental weather satellites. The GOES satellites continuously provide observations of 60 percent of the Earth including the continental United States, providing weather monitoring and forecast operations as well as a continuous and reliable stream of environmental information and severe weather warnings.

GOES-O joins a system of weather satellites that provide timely environmental information to meteorologists and the public. The GOES system provides data used to graphically display the intensity, path and size of storms. Early warning of impending severe weather enhances the public's ability to take shelter and protect property.

GOES-O will be launched on board a United Launch Alliance Delta IV (4, 2) launch vehicle under an FAA commercial license contracted out through Boeing Launch Services. The satellite will be turned over to NASA after a successful checkout is completed by Boeing Space and Intelligence Systems, El Segundo, Calif.

The current GOES operational system consists of GOES-12, operating as GOES East, and GOES-11, operating as GOES-West. GOES-13 is in an on-orbit storage mode nominally located at 105 west longitude. Once in orbit GOES-O will be designated GOES-14, checked out and then stored on-orbit and ready for activation should one of the operational GOES satellites degrade or exhaust their fuel.

NOAA manages the GOES program, establishes requirements, provides all funding and distributes environmental satellite data for the United States. NASA Goddard procures and manages the design, development and launch of the satellites for NOAA on a cost reimbursable basis. Boeing Space and Intelligence Systems built GOES-O.

For more information about the GOES-O mission and program on the Web, visit:

http://www.nasa.gov/goes-o
http://goespoes.gsfc.nasa.gov
http://www.noaa.gov
http://nws.noaa.gov

For information about NASA and agency programs on the Web, visit:

http://www.nasa.gov/home

GOES-O Quick Facts

The GOES-O satellite was built by Boeing Space & Intelligence Systems and will be launched by United Launch Alliance. GOES-O is the second satellite in the GOES-N Series and it carries two major instruments: an Imager and a Sounder. In addition, GOES-O carries the Space Environment Monitor suite which includes the Solar X-ray Imager, several charged particle detection instruments, and x-ray and extreme ultraviolet sensors. GOES-O continues 406 MHz emergency beacon support with a Search and Rescue Transponder.

Main Spacecraft Design Elements

Space dimensions:	Length 26 ft. (8.2 m) Width 7 ft 4 in x 11 ft (2.25 m x 3.37 m)
Weight at Launch:	7,088 lb (3,215 kg)
Weight in orbit:	4,806 lb (2,180 kg) beginning of life
Propulsion:	Liquid Apogee Motor 110 lbf (490 N) 12 Bipropellant Thrusters 12 lbf (9 N)
Power – Solar:	Beginning of life, 2.3 kW; End of life, 2 kW
Solar panels:	1 wing, w/1panel of dual-junction gallium arsenide solar cells
Batteries:	24-cell Nickel-Hydrogen 123 A-hr
Communications:	S-Band, 5 uplinks S/L-Band, 9 downlinks UHF, 1 downlink, 2 uplinks T&C, 2 downlinks, 1 uplink
Antennas:	2 S/L-band, cup-shaped dipole 1 L-band, cup-shaped dipole 1 UHF, cup-shaped dipole 1 omni antenna 1 L-band horn 1 S-band horn
Attitude Control:	three-axis body stabilized Boeing 601 heritage design
Control System:	stellar inertial based control system that employs a set of three star trackers and a Hemispherical Inertial Reference Unit (HIRU) to monitor and compute the spacecraft's attitude
Spacecraft control:	four reaction wheels are used to control the spacecraft in the normal mode
Momentum control:	twelve 2-lb. thrusters are used to manage momentum and to maintain the orbital location
Launch vehicle:	United Launch Alliance Delta IV Medium + (4,2) 4 meter fairing with 2 solids

Science Instruments: Imager, Sounder, Solar X-ray Imager (SXI), and the Space Environment Monitor System (SEM). The SEM consists of two magnetometers; an Energetic Particle Sensor (EPS) composed of a High-Energy Proton and Alpha Detector (HEPAD), a Magnetosphere Electron Detector (MAGED), an Energetic Proton Electron and Alpha Detector (EPEAD), and a Magnetosphere Proton Detector (MAGPD); Energetic X-Ray Sensor (XRS) and Extreme Ultraviolet (EUV) sensors.

Mission Lifetime: 10 years (after 2 years of on-orbit storage and 8 years operational)

Launch Site: Eastern Range SLC 37, Cape Canaveral Air Force Station

Launch Date/Window: June 26, 2009 at 6:14 p.m. – 7:14 p.m. EDT (60 minute window)

Spacecraft separation: 4 hours and 21.4 minutes after launch

First Satellite Signal Acquisition: 4 hours and 21.4 minutes after launch at the Air Force Tracking Station, Diego Garcia located in the Indian Ocean.

Engineering Handover from Boeing to NASA: Launch + 24 days
NASA completes on-orbit checkout: Launch + approximately 200 days – spacecraft acceptance by NASA and handover to NOAA for operations

Spacecraft Provider: Boeing Space & Intelligence Systems

Launch Operations: United Launch Alliance

Spacecraft Operations: NOAA Satellite Operations Facility, Suitland, Md.

Mission Management: NASA Goddard Space Flight Center, Greenbelt, Md. and National Oceanic and Atmospheric Administration.

GOES-O Mission Cost: Total mission costs are approximately $499M for the spacecraft, the instrument payload and launch services.

Q What is the Geostationary Operational Environmental Satellite program and what is NASA's role?

A The Geostationary Operational Environmental Satellite (GOES) system continuously observes and measures meteorological phenomena in real time, providing the meteorological community and the atmospheric scientist greatly improved observational and measurement data of the Western Hemisphere. In addition to short-term weather forecasting and space environmental monitoring, these enhanced operational services also improve support for atmospheric science research, numerical weather prediction models, and environmental sensor design and development. Forecasting the approach of severe storms, the GOES system of weather satellites provides timely environmental information to meteorologists and the general public alike—graphically displaying the intensity, path and size of storms. Early warning of impending storms enhances the public's ability to retreat to safety and protect their property. The GOES satellites continuously provide observations of 60% of the Earth including the continental United States.

NASA's Goddard Space Flight Center in Greenbelt, Md., procures and manages the development and launch of the satellites for the National Oceanic and Atmospheric Administration (NOAA) on a cost reimbursable basis.

Q What are the key objectives of the GOES system of satellites?

A The key objectives are to:

- Maintain a continuous, reliable, operational, environmental and storm warning system to protect life and property
- Monitor the Earth's surface and space environmental conditions
- Provide atmospheric and oceanic observations and data dissemination capabilities
- Provide services and products for a wide range of federal agencies, state and local governments and private users.

Q Where are the GOES satellites stationed in orbit?

A GOES-O is the second spacecraft to be launched in the GOES N series of geostationary environmental satellites. The GOES system serves the central and eastern Pacific Ocean; North, Central, and South America; and the central and western Atlantic Ocean. Pacific coverage includes Hawaii and the Gulf of Alaska.

Two satellites accomplish this, GOES West located at 135 degrees west longitude and GOES East at 75 degrees west longitude. The current GOES operational system consists of GOES-12, operating as GOES East and GOES-11, operating as GOES-West. GOES-13 is in an on-orbit storage mode nominally located at 105 West longitude. GOES-O will be checked out, stored on-orbit and available for activation should one of the operational GOES satellites degrade or exhaust their fuel.

Q How does the GOES program differ from the Polar Operational Environmental Satellite (POES) program?

A The GOES and POES satellites are complementary to each other. The GOES satellites provide hourly observations, but over limited areas centered about their equatorial locations. The two GOES satellites provide data from the continental U.S. and Hawaii, and well out into the Atlantic and Pacific Oceans. This is useful for monitoring severe weather and short-term weather prediction. The two operational POES spacecraft provide full global data four times daily, which is useful for short-, medium-, and long-range forecast models, climate modeling, and various other secondary missions.

Q Why are we launching GOES-O and storing it in orbit?

A It is less expensive to store a satellite on-orbit than it is to put it in ground storage. The true costs of on-orbit storage are only the costs of using any of the satellite expendables such as fuel or battery power and the degradation of thermal surfaces. Since the expendables are sized to well exceed the 10-year mission-required life, there is no discernable cost involved with on-orbit storage. To store on the ground the costs are approximately $3 million per year for the satellite plus the costs of the instrument teams, project personnel and other related costs. GOES-O was stored on the ground from May 2005 until December 2008, when the project began processing it for launch.

Q Has a satellite of this type ever been stored on-orbit before?

A Yes. The GOES-10, 11, 12, & 13 were all stored on-orbit. In 1997 NOAA required a store in orbit capability for the GOES-N Series. GOES-O will become GOES-14 after achieving the proper orbit and, following approximately 6 months of checkout by NASA, can be stored in orbit until it is needed.

Q What will it take to bring GOES-O out of on-orbit storage? What if GOES-O doesn't work when it comes out of storage?

A Bringing GOES-O out of storage is a low risk maneuver. It takes approximately one day to return to normal mode and approximately one week to return to full operations. If the maneuver does not work, NASA and NOAA have contingency procedures available.

Q Will NASA perform a storage test and then try bringing the spacecraft out of storage?

A Yes. This will be done during the initial checkout period performed by NASA before handover to NOAA.

Q Where will GOES-O be stored?

A GOES-O will be stored in geosynchronous orbit where it circles the Earth once each day near 105 degrees west longitude.

Q Who will control GOES-O while in storage?

A The NOAA/NESDIS Satellite Operations Control Center in Suitland, Md.

Q What is NASA's role in bringing GOES-O out of storage?

A NOAA will perform the out-of-storage operations and move the spacecraft to its operational location. NASA will assist if required.

Q When GOES-O is in storage, can it be activated temporarily, such as during severe weather events? Would it be used this way?

A The GOES-O satellite could be activated temporarily, but there are no plans to do so. It would require additional recurring manpower at NOAA and additional ground system infrastructure such as another dedicated antenna.

Q Will turning GOES-O off and then on again harm the spacecraft?

A No. All analyses and tests indicate this is low risk.

Q By storing GOES-O on-orbit, will it need more fuel and/or shorten the satellite's life?

A No. The system is sized for two years in storage with margin. Fuel usage during storage is comparable to usage during normal operations, but fuel is not expected to be a significant life-limiting factor.

Q What happened to GOES-Q?

A The GOES-Q option was not exercised after the program moved to the Delta IV launch vehicle. Use of the Delta IV allows the satellites to be placed in a higher initial orbit, allowing more of the spacecraft fuel to be used to extend on-orbit life. After the switch to the Delta IV, GOES-Q was no longer needed to satisfy the NOAA two GOES continuity of service requirement.

Q What is the combined lifetime of the GOES N Series?

A The three GOES N series missions on Delta IVs provide a combined on-orbit life of 30 years. Each satellite has a contract requirement for two years on-orbit storage and eight years of operations. Prior to switching from the Delta III to the Delta IV, the contract requirement for GOES N-Q constellation was 28 years. After the switch to the Delta IV, more combined lifetime was achieved with one less satellite.

Q What is the cost to the government to build and launch the GOES N series of satellites? How much did GOES-O cost?

A The total cost to the government to acquire, build and launch the three satellites and provide new ground system components in the GOES N series is estimated at approximately $1.5 billion. This figure includes the cost of the three satellites; an extra set of imagers and sounders; and component spares for the Solar X-ray Imager (SXI) instrument. The cost for GOES-N was approximately $481 million. The cost for GOES-O is approximately $499 million.

Q What launch vehicle will be used for GOES-O?

A GOES-O will be launched on a Boeing Delta IV (4, 2) launch vehicle. This Delta IV (4, 2) configuration uses a 4-meter fairing and 2 solid strap-on graphite epoxy motors. This is the same launch vehicle configuration as used for the GOES-N launch.

Q Why not put GOES-O into operation right away?

A GOES-O is designed and required to be capable of being stored in-orbit and will become operational when needed by NOAA.

Q What is the plan if GOES-O should fail on launch?

A If GOES-O fails on launch, then GOES-P will be launched as soon as practical. The contract requires that a satellite that fails on launch must be replaced within three years.

Q What is the Solar X-ray Imager (SXI)?

Like GOES-N, GOES-O is equipped with a Solar X-ray Imager (SXI). This instrument is capable of taking full-disk images of the sun every minute. NOAA and the U.S. Air Force will use the data for solar forecasting and monitoring of special events such as solar flares or radiation storms, the precursors of geomagnetic storms.

The ability to monitor and forecast such events is valuable to astronauts, high-altitude and polar route air flights, operators and users of military and civilian radio and satellite communications systems, navigation systems and power networks, and scientists. The SXI is used to detect and locate flares for forecasts of solar energetic particle events related to flares; monitor changes in the corona that indicate coronal mass ejections, detect active regions beyond east limb; analyze active region complexity for flare forecasts; and locate coronal holes for geomagnetic storm forecasts.

Q How does the launch of GOES-O differ from a NASA launch?

A United Launch Alliance will conduct the commercial launch under a Federal Aviation Administration (FAA) launch license. ULA will oversee launch service duties that include oversight of the launch vehicle processing activities, integration of the GOES-O spacecraft with the United Launch Alliance Delta IV and the launch countdown activities.

Q Have there been any launch delays associated with GOES-O? Are there costs associated with the launch delays?

A The GOES-O contractual engineering handover date to NASA was April 2008 and there were launch delays associated with meeting this requirement. This is a firm-fixed price contract with the Boeing Space & Intelligence Systems and the cost of the spacecraft launch delays rests with the contractor. There are also costs for the rest of the project elements, which NOAA had to cover.

Q What is the planned launch date for the GOES-P?

A April 2010.

Earth System Science and the Geostationary Operational Environmental Satellite Program Objectives

Beginning in the 1960s, NASA pioneered the study of the atmosphere from the unique perspective of space with the launch of its Television Infrared Observation Satellite. Thanks to new satellite and computer technologies, it is now possible to study the Earth as a global system.

Earth System Science integrates many disciplines of scientific research that focus on understanding the planet as a whole, its integral parts and how its parts interact. Through research, scientists are getting better at understanding and improving their forecasting of climate and weather phenomena such as the onset of the 1997-98 El Nino.

The GOES N Series of spacecraft continuously observe and measure meteorological phenomena in real time, providing the meteorological community and the atmospheric scientist greatly improved observational and measurement data of the Western Hemisphere. In addition to short-term weather forecasting and space environmental monitoring, these enhanced operational services also improve support for atmospheric science research, numerical weather prediction models, and environmental sensor design and development. Forecasting the approach of severe storms, the GOES system of weather satellites provides timely environmental information to meteorologists and their audiences alike—graphically displaying the intensity, path and size of storms. Early warning of impending storms enhances the public's ability to retreat to safety and protect their property.

The GOES program objectives support NASA's objectives by providing for distribution of meteorological data to various organizations, improving the capability for forecasting, providing real-time warnings of solar disturbances and by extending our knowledge of the atmosphere and its processes to improve short- and long-term weather forecasts. Data from the NOAA spacecraft are helping NASA scientists design instruments for follow-on Earth science missions. Also, with the data from the GOES satellites, NASA scientists are continuing to develop applications that will directly enhance the quality of human life and help to protect the environment.

The GOES program disseminates information about the Earth system, expands scientific knowledge by characterizing the Earth system and enables productive use of Earth science products in the public and private sectors.

GOES-O Mission

GOES-O is the second spacecraft to be launched in the GOES N Series of geostationary environmental weather satellites. Developed by NASA for the National Oceanic and Atmospheric Administration (NOAA), the GOES satellites continuously provide observations of 60 percent of the Earth including the continental U.S., providing weather monitoring and forecast operations, as well as a continuous and reliable stream of environmental information and severe weather warnings.

The GOES environmental satellites are key in helping meteorologists observe and predict local weather events, including thunderstorms, tornadoes, fog, flash floods, and severe weather. In addition, GOES satellites are able to monitor dust storms, volcanic eruptions and forest fires. Plus, the satellites support the search and rescue satellite aided system (SARSAT). The program directly enhances the quality of human life and furthers the protection of the Earth's environment. GOES-O data will add to the global climate change databases of knowledge, embracing many civil and government environmental forecasting organizations that work to benefit people everywhere and help save lives.

Each GOES satellite carries two major instruments: an Imager and a Sounder. Together they provide 2 valuable features. One feature is a is a flexible scanner that offers small-scale area imaging allowing meteorologists to take pictures of local weather trouble spots. This allows them to improve short-term forecasts over local areas. The second feature, simultaneous and independent imaging and sounding, is designed to allow weather forecasters to use multiple measurements of weather phenomena to increase the accuracy of their forecasts.

These instruments acquire high-resolution visible and infrared data, as well as temperature and moisture profiles of the atmosphere. They continuously transmit data to ground terminals where it is processed for rebroadcast to primary weather service offices in the U.S. and around the world, including the global research community.

GOES-O is scheduled to launch in the summer of 2009 on board a Boeing Delta IV (4,2) Expendable Launch Vehicle from the Space Launch Complex (SLC 37) at Cape Canaveral Air Force Station, Fla.

The NASA-NOAA Partnership

In 1983, NASA signed an agreement with the NOAA to design and build a new generation of environmental satellites. These satellites would carry instruments designed to operate as never before, taking near continuous observations of Earth. NASA and NOAA have worked jointly to perfect, develop and complete the GOES program, begun in 1975 with the launch of the GOES-1 satellite. The two agencies have been actively engaged in a cooperative program ever since, and will continue the GOES series with the launch of the GOES-O satellite.

NOAA manages the overall GOES Program and establishes requirements, provides funding, distributes environmental data for the U.S., and determines the need for satellite replacement.

NASA teams with NOAA to acquire and manage the study, design and development of each of the GOES spacecraft. NASA's Goddard Space Flight Center (GSFC) in Greenbelt, Md., is responsible for the construction, integration and verification testing of the spacecraft, instruments and unique ground equipment. Working as a team, NOAA and NASA design, develop, install and integrate the ground system needed to acquire, process, and disseminate the data from the sensors on the GOES satellites.

NASA's GSFC is responsible for the procurement of the GOES satellites for NOAA including final testing in Florida and the initial on-orbit checkout. NOAA is responsible for satellite operation, data distribution and management of the

program. Boeing Launch Systems will conduct the commercial launch of GOES-O with a Federal Aviation Administration (FAA) launch license. Boeing is responsible for the Delta IV launch vehicle processing, the integration of the GOES-O spacecraft with the Boeing Delta IV and the launch countdown activities.

Design and Operations

The GOES N Series will provide scientists with continuous, dependable, timely and high-quality observations of the Earth and its environment. The instruments on board the satellites measure the Earth's emitted and reflected radiation from which atmospheric temperatures, winds, moisture and cloud cover can be derived.

The GOES satellites operate in geosynchronous orbit 22,236 miles above the Earth and, because their orbital velocity matches the rotation of the Earth, they appear to remain stationary in the sky. The GOES satellites have a three-axis body stabilized spacecraft design which enables the satellite to "stare" at the Earth and provide images of clouds, relay data about the Earth's surface temperature and water vapor fields, and to continuously sound the atmosphere for vertical thermal and water vapor profiles.

The system provides long-range weather forecasting, ensuring that non-visible data, for any region of the Earth, is no more than six hours old. It serves the central and eastern Pacific Ocean; North, Central, and South America; and the central and western Atlantic Ocean. Pacific coverage includes Hawaii and the Gulf of Alaska. Two satellites accomplish this, GOES west located at 135 degrees west longitude and GOES East at 75 degrees west longitude. NOAA's Command and Data acquisition station located in Wallops, Va., supports the interface to both satellites. The NOAA Satellite Operations Control Center in Suitland, Md. provides spacecraft scheduling, health and safety monitoring and engineering analyses. Processed data are received at the National Weather Service's National Centers for Environmental Prediction in Camp Springs, Md., and NWS forecast offices across the U.S.

The GOES N Series has several capabilities not on previous GOES satellites. These capabilities include the Weather Facsimile service changing from an analog to a digital Low Rate Information Transmission format; expanded measurements for the space environment monitoring instruments; a new dedicated channel for the Emergency Managers Weather Information Network service; and most importantly, a more stable platform for supporting improved Imager, Sounder, and SXI instruments.

GOES-O will carry the government furnished ITT Space Systems Division built Imager and Sounder instruments to provide regular measurements of the Earth's atmosphere, cloud cover, ocean temperatures and land surfaces. An advanced attitude control system using star trackers and an optical bench onto which the Imager and Sounder are mounted will provide enhanced instrument-pointing ability. These enhancements improve image navigation and registration to better locate severe storms and other events important to NOAA. NASA's GSFC and the NOAA's National Environmental Satellite, Data and Information Service (NESDIS) have set a higher standard of accuracy for the GOES N Series, including data pixel location to approximately two kilometers from geosynchronous orbit of 22,300 miles above the Earth's surface.

GOES-O will also carry a government furnished Solar X-ray Imager (SXI) built by Lockheed Martin Advanced Technology Center in Palo Alto, Calif. Carried for the first time by GOES-M launched in 2001, the SXI will monitor solar weather conditions, including the dynamic environment of energetic particles, solar wind streams and coronal mass ejections emanating from the sun. This data will allow forecasters to issue alerts of "space weather" conditions that may interfere with ground and space systems.

Another instrument package onboard GOES-O will be the Space Environment Monitor (SEM). SEM consists of three instrument groups including an Energetic Particle Sensor package, two magnetometer sensors, and a Solar X-Ray Sensor with an Extreme Ultraviolet Sensor. The units will perform *in situ* measurements of the magnetic and particle environments as well as remote measurement of the integrated X-ray emission and the extreme ultraviolet spectra of the sun.

The Energetic Particle Sensor and the Solar X-Ray Sensor with an Extreme Ultraviolet Sensor were built by Assurance Technology Corporation, Carlisle, Mass., and the two magnetometers were built by Science Applications International Corporation, Columbia, Md.

The GOES system currently consists of GOES-12, operating as GOES East in the eastern part of the constellation at 75 degrees west longitude, and GOES-11, operating as GOES West at 135 degrees west longitude. GOES-13 is in an on-orbit storage mode nominally located at 105 West longitude.

In addition to relaying information about the Earth's climate and atmosphere, the GOES satellites provide instantaneous relay of distress signals from people, aircraft, or marine vessels to the search and rescue ground stations of the Search and Rescue Satellite Aided Tracking (SARSAT) System. A dedicated search and rescue transponder on board GOES is designed to detect emergency distress signals originating from Earth-based sources. These unique identification signals are normally combined with signals received by NOAA's Polar Operational Environmental Satellite system and relayed to a search and rescue ground terminal. The combined data are used to perform effective search and rescue operations.

GOES System in Weather Forecasting

The GOES system is a basic element of U.S. weather monitoring and forecast operations and is a key component of NOAA's National Weather Service modernization program. Spacecraft and ground-based systems work together to accomplish the GOES mission of providing weather imagery and quantitative sounding data that form a continuous and reliable stream of environmental information for weather forecasting and related services.

The GOES satellites provide weather imagery and atmospheric sounding information for improved weather services, particularly for the timely forecasting of life-and property-threatening severe storms. The GOES N Series will aid activities ranging from severe storm warnings to resource management and advances in science. GOES-O data will add to the global community of knowledge, embracing many civil and government environmental forecasting organizations that work to benefit people everywhere and help save lives.

Commercial weather groups, universities, the Department of Defense, NASA and the global research community also use GOES data products. Other users of these products can also be found in air and ground traffic control, ship navigation and agricultural sectors.

The GOES satellites are given a letter designation while under construction on the ground and are renamed with a numerical designation after successful launch and orbit-raising. The satellites are built in alphabetical order, but are not necessarily launched in this same order.

GOES-O will be renamed GOES-14 upon reaching orbit where it will be stored until needed.

GOES N Series Enhancements Over Previous GOES

- An improved Image Navigation and Registration (INR) system will use star trackers to provide precision image navigation and registration information for use with the Imaging and Sounding data products. This will improve knowledge by at least 50 percent of exactly where severe weather events are located (3 km accuracy now becomes 1.5 km). A stable optical bench has been provided to isolate the thermal deformations of the spacecraft from the Imager and Sounder instruments.

- The power subsystem has been improved so that operations during eclipse periods can be sustained. Outages due to solar intrusion Keep Out Zones (KOZ) will also be minimized because thermal shields have been added to the secondary mirror structure elements for the Imager and Sounder instruments. Over 600 more images and sounding sequences should be accomplished per year. Spacecraft design reduces solar loading on the radiant cooler and patch (no solar sail) so lower detector temperatures should reduce noise.

- The Satellite design lifetime has been improved from 7 to 10 years, and the expected propellant lifetime has been increased to 14 years.

- The Space Environmental Monitoring instruments have been increased and there are expanded measurement capabilities for charged particles.

- A data product improvement has been developed for digital Low Rate Information Transmission (LRIT) for distribution of data Products that were previously distributed in an analog WEFAX format. The LRIT system permits the transmission of data products consistent with the World Meteorological Organization (WMO) and allows the distribution of more National Weather Service (NWS) information at a higher data rate.

- The Data Collection System (DCS) has been enhanced with the addition of 300 and 1200 bps Data Collection Platforms (DCPs) and a higher power satellite transponder so that more DCPs can use the link at the same time.

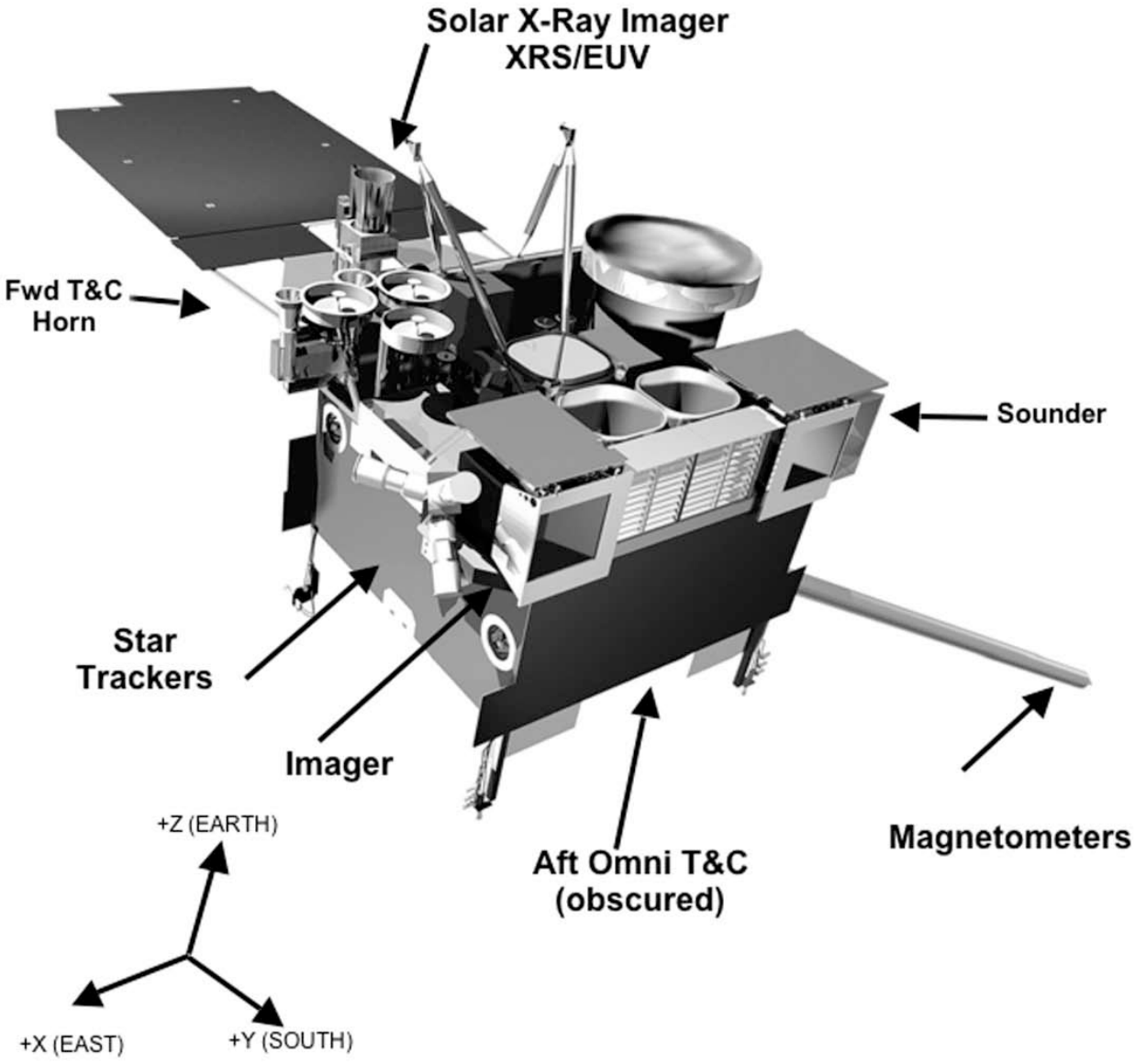
- A dedicated transponder is being provided to support the Emergency Manager's Weather Information Network (EMWIN) service.

- The communications services have been tailored to comply with modern national and international requirements.

- The command data rate has been increased to 2,000 bps, as compared to a data rate of 250 bps for the previous generation of GOES satellites. The telemetry data rate has been improved to provide data at either 4,000 or 1,000 bps, as compared to the 2,000 bps data rate on the previous generation.

- A new Solar X-Ray Imager (SXI) developed by the Lockheed Martin Advanced Technology Center. SXI improvements include:

  - A back illuminated CCD (no high voltage)
  - Increased dynamic range
  - Improved charge collection efficiency (charge spreading/blurring)
  - Image jitter correction using the High Accuracy sun Sensor
  - Automatic flare event detection and more sequence capability
  - Multiple image exposure and downlink capability each minute
  - Flexibility of programmable memory for imaging



SPACECRAFT LOCAL COORDINATE REFERENCE FRAME

The Solar X-ray Imager

The Solar X-ray Imager (SXI) -- to be launched as part of the Space Environment Monitor suite of instruments on the GOES N Series of environmental satellites -- will be used to aid National Oceanic and Atmospheric Administration (NOAA) and U.S. Air Force personnel in issuing forecasts and alerts of "space weather" conditions that may interfere with ground and space systems. Turbulent "space weather" can affect radio communication on Earth, induce currents in electric power grids and long distance pipelines, cause navigational errors in magnetic guidance systems, upset satellite circuitry and expose astronauts to increased radiation.

The Solar X-ray Imager will observe solar flares, coronal mass ejections, coronal holes, and active regions in the X-ray region of the electromagnetic spectrum from 6 to 60 A (Angstroms). These features are the dominant sources of disturbances in space weather that lead to, for example, geomagnetic storms. The Imager will also examine flare properties, newly emerging active regions, and X-ray bright points on the sun.

NOAA and the Air Force will use Solar X-ray Imager data for solar forecasting and monitoring solar storms, and to develop a better understanding of sun-related phenomena that affect the Earth's environment.

The SXI was developed, tested, and calibrated by Lockheed Martin Advanced Technology Center. SXI consists of a telescope assembly with a 6.3-inch (16-centimeter) diameter grazing incidence mirror and a detector system. Incoming X-rays graze the mirror's surface at very shallow angles and are brought to a focus on the detector system.

As long as the grazing angles are very shallow, about one degree, the X-rays do not penetrate the surface, but are reflected, just like visible light. The detector system contains a micro-channel plate that converts the X-rays to visible light that is then recorded using a CCD camera. Resulting data is electronically packaged for transfer to NOAA ground stations in Suitland, Md., and Boulder, Colo. The images are processed and distributed by the NOAA Space Weather Prediction Center (SWPC) in Boulder. The solar images are made available to the public via the Internet by the NOAA National Geophysical Data Center, also in Boulder.

SXI will provide continuous, near real-time observation of the sun's corona, acquiring a full-disk image every minute. The solar images cover a 42 arc-minute field of view with five arc-second pixels. The sun, as viewed from Earth, is approximately 32 arc-minutes in diameter.

By recording solar images every minute, NOAA observers will be able to detect and locate the occurrence of solar flares. Solar flares are explosive releases of vast amounts of magnetic energy in the solar atmosphere. Since scientists are not yet able to predict the occurrence, magnitude or location of solar flares, it is necessary to continually observe the sun to know when they are happening.

When a flare erupts, it throws out large clouds of ionized, or electrically charged, gas. A small fraction of the cloud is very energetic and can reach the Earth within a few minutes to hours of the flare being observed. These energetic particles pose a hazard to both astronauts and spacecraft.

Coronal mass ejections, which are often associated with flares, take several days to reach the Earth. Fast, powerful ejections give rise to geomagnetic storms, which can disrupt radio transmissions and induce large currents in power transmission lines and oil pipelines. They have resulted in large-scale failures of the North American power grid and greatly increased pipeline erosion. SXI also will monitor coronal holes -- persistent sources of high-speed solar wind. As the Sun rotates every 27 days, these sources spray across the Earth like a lawn sprinkler and cause recurring geomagnetic storms.

The Solar X-ray Imager

The first Solar X-ray Imager instrument was launched on NOAA's GOES-12 weather satellite. GOES stands for Geostationary Operational Environmental Satellite. That name refers to the fact that the satellites are "parked" in a geostationary orbit, 22,300 miles above the Earth's equator. The orbital velocity of these satellites matches the Earth's rotation, so they remain in the same position in the sky.

For more information about NOAA's Space Weather Prediction Center and the SXI visit:

Space Weather Prediction Center: http://www.swpc.noaa.gov/
SXI Home Page: http://www.swpc.noaa.gov/sxi/
Space Weather Now: http://www.swpc.noaa.gov/SWN/index.html

SMS-1 (SMS-A) was launched on May 17, 1974, from the Eastern Test Range (ETR) at Cape Canaveral, Florida. It was the first geostationary meteorological satellite. Launched from a Delta 2914 launch vehicle, its objec¬tives were to evaluate a prototype operational meteorological satellite for NOAA's National Weather Service and provide regular daytime and nighttime meteorological observations in support of the national operational meteor¬ological satellite system. The principal instrument on board was the Visible/Infrared Spin Scan Radiometer (VISSR), which provided day and night imagery of cloud conditions. Additionally, the satellite was equipped with a SEM and a DCS. The satellite also had the capability to perform facsimile transmissions of processed images and weather maps to WEFAX field stations. The satellite was positioned in a geostationary orbit directly over the equator at 45° W (over the central Atlantic), which provided continuous coverage of the central and eastern U.S. and the Atlantic Ocean. It was operational until January 1976 and was deactivated and boosted out of orbit on January 21, 1981.

SMS-2 (SMS-B) was launched February 6, 1975, from a Delta 2914 launch vehicle. It was equipped with a VISRR, SEM, and DCS and had WEFAX capability. It was placed in a geostationary orbit directly over the equator at 135° W (over the east-central Pacific Ocean). The satellite was deactivated August 5, 1982. SMS-1 and SMS-2 proved the viability of geosynchronous meteorological satellites.

GOES-1 (GOES-A) was the first in the series of Geostationary Operational Environmental Satellites. It was launched from a Delta 2914 launch vehicle on October 16, 1975. Its instrument complement was identical to SMS-1 and SMS-2. GOES-1 was placed over the Indian Ocean west of SMS-2 so that the combined coverage of the three satellites would include nearly 60 percent of the Earth's surface. It operated successfully in this orbit until June 1978 when it was relocated to replace SMS-2 and GOES-3 replaced GOES-1. It was deactivated on March 7, 1995.

GOES-2 (GOES-B) was launched on June 16, 1977, from a Delta 2914 launch vehicle. Its instrument complement was identical to the SMS and GOES-1 satellites. GOES-2 was placed in orbit directly over the equator at 60° W to replace SMS-1. It was operational until 1993. The satellite was reactivated in 1995 to broadcast National Science Foundation (NSF) transmissions from the South Pole to public broadcasting facilities in the U.S. The WEFAX system on GOES-2 continued to operate, although cloud images were no longer being received from the system. The satellite was deorbited at the beginning of May 2001.

GOES-3 (GOES-C) was launched June 16, 1978, from a Delta 2914 launch vehicle. The satellite was used to replace GOES-1 and to support the Global Atmospheric Research Program (GARP) over the Indian Ocean. It had the same instruments and capabilities as the earlier GOES spacecraft.

GOES-4 (GOES-D) was launched September 9, 1980, from a Delta 3914 launch vehicle. It was the first geostationary satellite to provide continuous vertical profiles of atmospheric temperature and moisture, which its primary instrument, the VISSR Atmospheric Sounder (VAS), provided. The VAS also provided both day and nighttime imagery of cloud conditions. Instrument limitations did not permit both types of operations simultaneously. The satellite also used new despun S-band and UHF antennas to relay meteorological data from more than 10,000 surface locations into a central processing center for incorporation into numerical weather prediction models and to transmit processed images and weather maps to WEFAX field stations. It was also equipped with a SEM and DCS similar to those on previous GOES. GOES-4 was placed in orbit at 135° W to replace the failing GOES-3. GOES-4's most serious anomaly occurred on November 25, 1982, when the VAS's scan mirror stopped during retrace after exhibiting excessively high torque. Efforts to restore either the visible or infrared capability were unsuccessful. It was deactivated November 22, 1988.

GOES-5 (GOES-E) was launched May 22, 1981, from a Delta 3914 launch vehicle. Its instrument complement was identical to GOES-4. It was placed in orbit at 75° W longitude. The satellite failed on July 29, 1984, when a VAS encoder lamp filament burned out that was needed to read the angle of the scan mirror used to obtain images. It was deactivated on July 18, 1990.

GOES-6 (GOES-F) was launched April 28, 1983, from a Delta 3914 launch vehicle. It was designed to replace GOES-4 and was originally placed in orbit at 136° W. After GOES-5 failed, it was moved to a central location at 98° W. When GOES-7 was placed in service, it was returned to its original location. The VAS imager on GOES-6 failed on January 21, 1989, so direct readout images and soundings were no longer available. WEFAX data continued to be transmitted to the data user community until the spacecraft was deactivated on May 24, 1992.

GOES-G was launched May 3, 1986, from a Delta 3914 launch vehicle. The spacecraft did not reach operational orbit because of a failure in the launch vehicle.

GOES-7 (GOES-H) was launched February 26, 1987, from a Delta 3924 launch vehicle and placed in orbit at 75° W. The spacecraft was moved to 98° W in July 1989 following the January 1989 failure of GOES 6. In 1992, GOES-7 ran out of stationkeeping fuel, as expected. GOES-7 went to stand¬by in January 1996 and was parked at 95° W in June 1996. Consequently, the VAS instrument and the associated data, along with WEFAX, DCS, and search and rescue services through GOES-7, were deactivated. In mid-¬November 1999, GOES-7 was moved to 175° W to take over the communications-relay duties of PEACESAT. The high orbital inclination made it possible to relay data from near the poles, particularly to support the National Science Foundation science group at the South Pole. In addition to the same instrument complement as the earlier GOES, GOES-7 carried experimental search and rescue equipment that allowed near-instantaneous detection of emergency distress signals on the ground transmitting at 406 MHz.

GOES-8 (GOES-I) was launched April 13, 1994, from an Atlas-I/Centaur launch vehicle. It operated as GOES-East at 75° W for 8 years, from spring of 1995 to spring of 2003. It was the first in a new series of three-axis stabilized GOES that provided significant improvements over the previous GOES spin-stabilized spacecraft in weather imagery and atmospheric sounding information. The satellite was equipped with a separate Imager and Sounder, which allows simultaneous and independent imaging and sounding. Previously, a single instrument performed both functions alternately. GOES-8 features a flexible scan mechanism that offers small-scale area imaging, resulting in improved short-term forecasts over local area. It was also equipped with a SEM and DCS, had WEFAX capabilities, and performed near-instantaneous relay functions for the SARSAT system with its dedicated search and rescue transponder. The GOES-8 satellite reached the end of its useful life and was de-orbited on May 5, 2004.

GOES-9 (GOES-J) was launched May 23, 1995, from an Atlas-I/Centaur launch vehicle into a geostationary orbit at 135° W. The GOES-9 satellite provided support to the Japanese Meteorological Agency (JMA), with ground station support from the NOAA facility at Fairbanks, Alaska. GOES-9 was decommissioned on June 15, 2007.

GOES-10 (GOES-K) was launched April 25, 1997, from an Atlas I/Centaur launch vehicle and was placed in orbit at 105° W. It has the same instrument complement as GOES-8 and GOES-9. In the spring of 1998, GOES-10 was shut down and designated an “on-orbit spare” until the failure of GOES-8 or GOES-9. A month after launch, the GOES-10 solar array ceased rotating, but, due to the ingenuity of the GOES government-industry team, it was possible to invert the satellite, modify software, and operate the solar array in the reverse direction. Shortly thereafter, GOES-9

began experiencing problems with its momentum wheels, and GOES-10 was placed in active service as *GOES-West*, positioned at 135° W. GOES-10 is supporting South America imaging.

GOES-11 (GOES-L) was launched May 3, 2000, from an Atlas Centaur IIA launch vehicle and placed in storage mode at 105° W in August 2000. It has the same instrument complement as GOES-8, 9, and 10.

GOES-12 (GOES-M) was launched July 23, 2001, from an Atlas Centaur IIA launch vehicle. It is the first GOES to fly an SXI-type instrument. The GOES-12 satellite has been operating as GOES -East at 75° W longitude since the spring of 2003.

GOES-13 (GOES-N) was launched on May 24, 2006 on a Boeing Delta IV (4,2) launch vehicle and has been in an on-orbit storage mode nominally located at 105 West longitude. It is available for activation should one of the operational GOES satellites fail.

GOES Spacecraft Contractors

Ford Aerospace and Communications Corporation (now Space Systems/Loral) built the Synchronous Meteorological Satellite and GOES 1-3. Hughes Space and Communications (now Boeing Satellite Systems) built the GOES 4-7 series of satellites. Space Systems/Loral built the GOES 8-12 series. Boeing Space & Intelligence Systems (BS&IS) is building GOES N Series of satellites.

Program Management

NASA's GSFC is responsible for the construction, integration and verification testing of the spacecraft, instruments and unique ground equipment. NASA coordinates the launch of the spacecraft. NASA's comprehensive on-orbit verification period is expected to last 6 months after launch when NASA will hand over formal operations to NOAA.

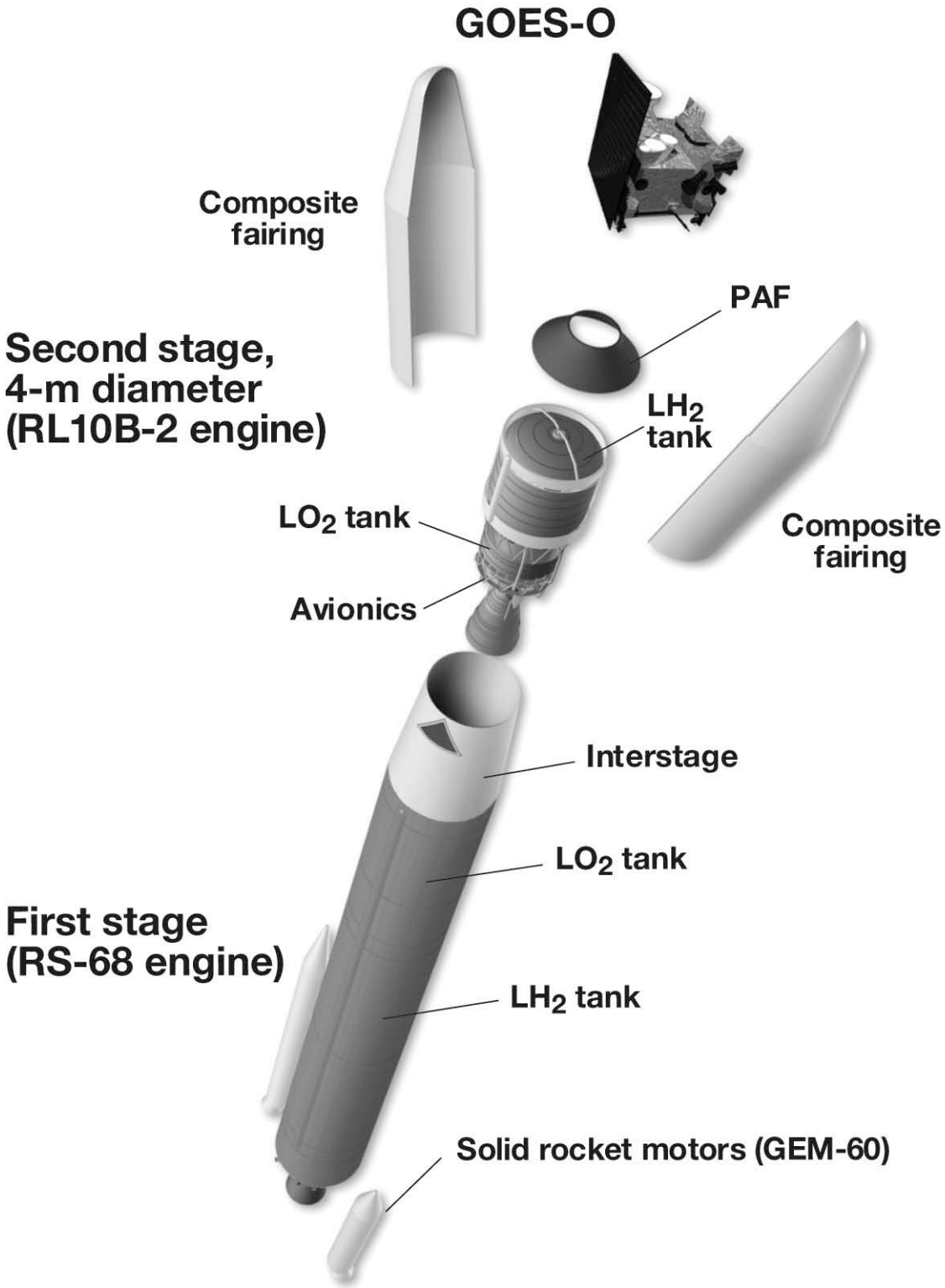
NOAA is responsible for program requirements funding and the on-orbit operation of the multi-satellite system. NOAA also determines the need for satellite replacement. NOAA designs, develops and operates the ground system needed to acquire, process and disseminate the satellite data.

NASA Program Management:

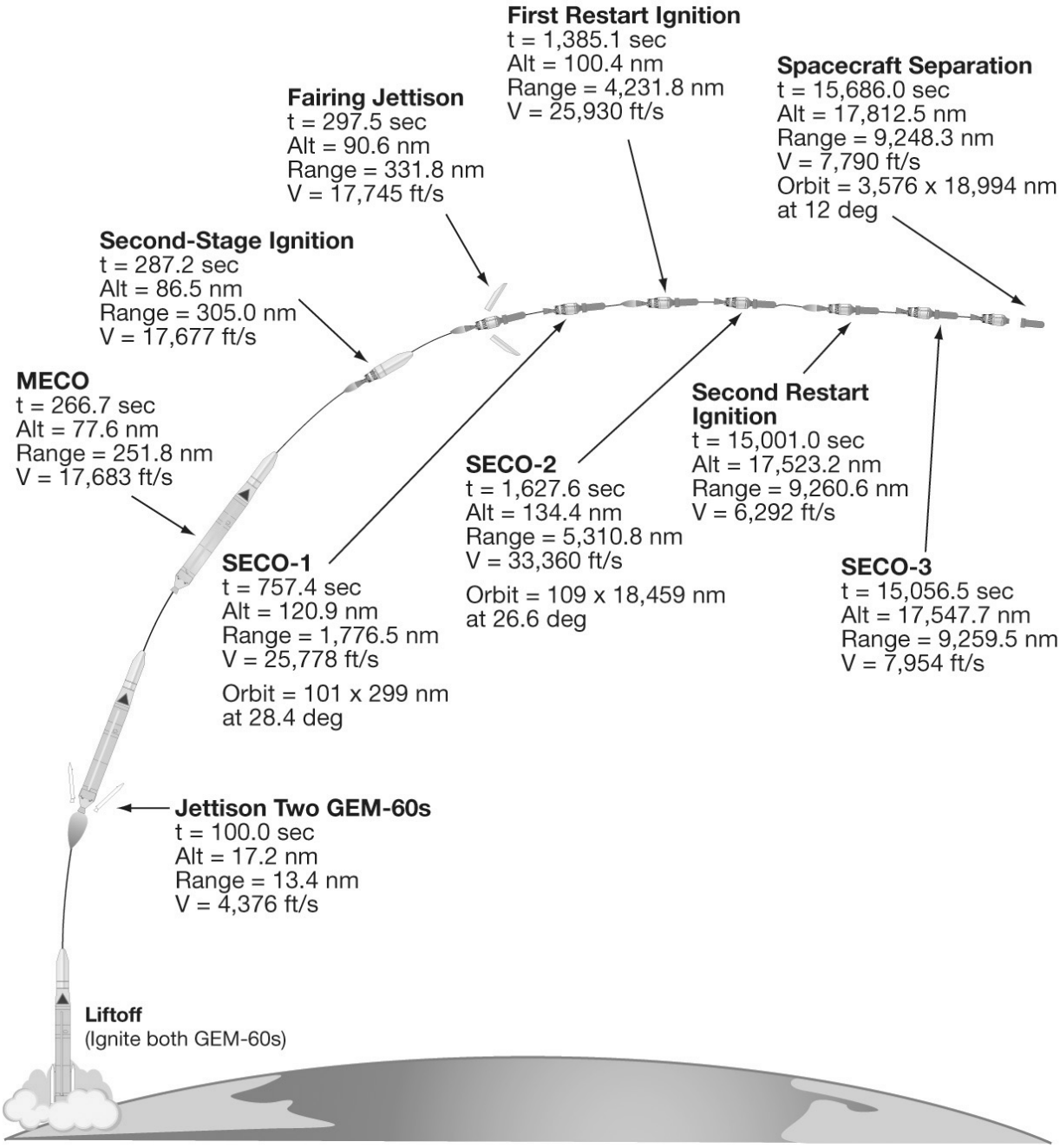
Headquarters
Nandkishore N. Topiwala, GOES Program Executive
Science Mission Directorate

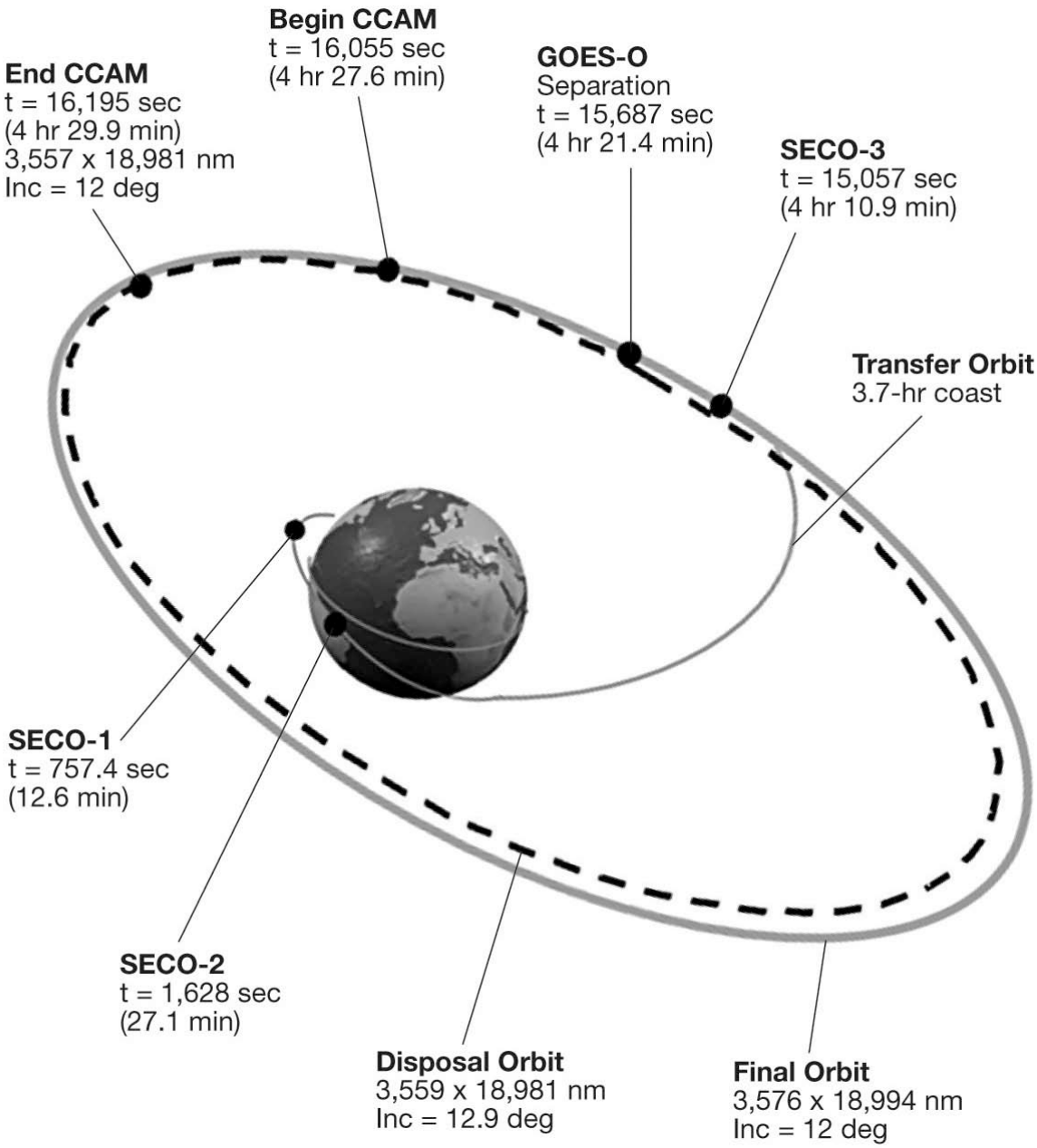
Goddard Space Flight Center
Steve Kirkner, GOES Project Manager
Andre' Dress, GOES Deputy Project Manager
Dennis Chesters, GOES Program Scientist

NOAA Management:
Gary K. Davis, Director, Office of Systems Development
Steve Kirkner, GOES Program Manager
Tom Wrublewski, GOES N Series Technical Acquisition Manager
Edward M. Miller, GOES N Series Instrument Manager


GOES-O
Composite fairing
PAF
Second stage, 4-m diameter (RL10B-2 engine)
LH_2 tank
LO_2 tank
Composite fairing
Avionics
Interstage
LO_2 tank
First stage (RS-68 engine)
LH_2 tank
Solid rocket motors (GEM-60)

GOES-O Launch Sequence




Begin CCAM
t = 16,055 sec
(4 hr 27.6 min)
End CCAM
t = 16,195 sec
(4 hr 29.9 min)
3,557 x 18,981 nm
Inc = 12 deg
GOES-O
Separation
t = 15,687 sec
(4 hr 21.4 min)
SECO-3
t = 15,057 sec
(4 hr 10.9 min)
Transfer Orbit
3.7-hr coast
SECO-1
t = 757.4 sec
(12.6 min)
SECO-2
t = 1,628 sec
(27.1 min)
Disposal Orbit
3,559 x 18,981 nm
Inc = 12.9 deg
Final Orbit
3,576 x 18,994 nm
Inc = 12 deg

GOES-O


GOES-O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