On March 19, 2003, U.S. President George W. Bush and U.K. Prime Minister Tony Blair sent coalition armies, air forces and navies to liberate Iraq. Guided by GPS space satellites thousands of miles overhead, cruise missiles opened the war with a "decapitation attack" from warships in the Red Sea and Persian Gulf, while stealth fighters dropped precision bombs, also guided by GPS satellites.

Space is an integral component of United States military planning. A sure sign of its essential nature can be found in the dozens of satellites from the United States and its international coalition partners that supported military campaigns in the Republic of Iraq in 2003, the Islamic State of Afghanistan in 2001, and the Federal Republic of Yugoslavia in 1999.

Satellites don't attack directly, but rather they offer what the Pentagon calls "force enhancement" — surveillance, reconnaissance, communications, navigation, missile warning.

The spy satellites. The U.S. National Reconnaissance Office (NRO) operates satellites for the U.S. intelligence community. American reconnaissance spacecraft, including the NRO's major equipment, are launched to Earth orbit by the U.S. Air Force and are known by a variety of code names. They are spysats and they include these general types:

- **optical** satellites that use a large mirror to gather visible light for photography -- like a Hubble Space Telescope pointing down at Earth rather than looking out into deep space,

- **infrared** and ultraviolet satellites that record invisible infrared and ultraviolet light from below,

- **radar** imaging satellites that uses microwave signals to peer through cloud cover and scan Earth's surface,
- **combo** radar, optical, infrared and ultraviolet satellites that see wide areas of Earth's surface with more detail than the separate types,

- **signals** intercept and detection satellites that tune in on radio, telephone and data transmissions,

- **ocean** observation satellites used to locate and determine the intent of ships at sea.

One of NRO's mottos is "We Own the Night," indicating the agency's ability to collect data anytime of day in any weather anywhere.

**Message intercepts.** Another member of the intelligence community, the U.S. National Security Agency (NSA), intercepts message traffic all over the world. The agency's task is complicated by the awesome increase in communications channels in use in the 21st century. It has been estimated that some five million e-mails are transmitted each minute and 35 million voice communications are completed each hour.

**Drawing maps.** The U.S. National Geospatial Intelligence Agency (NGA) uses imagery from NRO satellites to chart the globe. Spysat images are used by NGA and other members of the intelligence community to understand enemy activity, plan attack strategies, support covert ground reconnaissance, find enemy sites producing nuclear, chemical and biological weapons, monitor the flanks of deployed troops, watch for shoreline threats to sea lanes, look out for terrorists attack, and locate the sources of intercepted signals.

**Disseminating spysat data.** How does satellite information get to commanders in the field? NRO personnel from the Army, Navy, Air Force, NSA and the Central Intelligence Agency (CIA) package the data and send it on via American command and control satellites to strike planners on ships at sea, and at naval and air bases and army forts in the Near East, South Asia, Europe, the United States and elsewhere.

Here are some of the super-secret American military satellite systems in use:

- **Lacrosse.** The NRO operates a clutch of radar-imaging spysats known as Lacrosse. They also have been referred to as Onyx, Vega, Indigo and other code names. Each of these huge sky-high night watchers weighs 15 tons and is as big as a school bus. They orbit 400 miles above Earth's surface.

Lacrosse is built around a synthetic aperture radar (SAR), which can see through clouds and send down photographic-quality images. Each satellite has a huge wire-
mesh radar antenna and 150-ft. solar panels to generate the kilowatts of electricity required by its powerful radar transmitter.

Each Lacrosse passes over its assigned observation target on the ground twice a day, peering down through bad weather to show military commanders elsewhere on the ground where to strike and what damage was caused by strikes. Lacrosse satellites can show objects as small as a foot across at night and in bad weather. Big objects on the ground, like tanks or surface-to-air (SAM) missiles, can be seen even if hidden in a woods.

Keyhole. NRO also has digital-imaging satellites known as Keyhole. For example, a KH-11 is a school bus-sized satellite in a polar orbit from where it can deliver very high resolution pictures in visible light and infrared. It can see at night in good weather.

KH-11 sensors operate in visible and near infrared light, as well as thermal infrared to detect heat sources. The sensors have low-light image intensifiers to see at night. Advanced KH-11 infrared heat sensors detect camouflage and buried structures, and can be used to determine whether factories are operating or not. KH-11 satellites transmit images in real time to ground stations via Milstar communications relay satellites.

Keyhole satellites are in egg-shaped elliptical orbits ranging from a low of 175 miles to a high of 625 miles above Earth. Each passes over its assigned observation target on the ground twice a day.

- KH-1, also known as Corona, was the United States' first photo-reconnaissance satellite. The system operated from 1960-1972.
- KH-7 was a film-return satellite operated from 1963-67. The older KH-7 offered about 18-20-in. resolution.
- KH-8, also known as Gambit, also snapped photographs with conventional cameras, then dropped their exposed rolls to Earth. They flew 50 missions from 1966-1984. The satellites in that system each carried a single film pod and could fly down as low as 80 miles over the Soviet Union. That allowed them to show things as small as 3-4-in.
- KH-9, also known as Project Octagon, was a film return system of about 20 satellites from 1971-1986. They also snapped photographs with conventional cameras, then dropped their exposed rolls to Earth. KH-9 satellites referred to as Big Birds carried four film return canisters. A
typical KH-9 carried two 60-in.-diameter camera lenses for stereo pictures with 6-in. resolution. It has been reported that five of the satellites also had mapping cameras with 12-in. lenses see 9-24-in. objects on the ground. KH-9 photos have been used in maps programmed into the Tomahawk cruise missile navigation system.

- KH-10 would have been used in a once-proposed military space station, the Manned Orbiting Lab. The Lab never flew.
- KH-11 is digital-imaging non-film satellite with 4-6-in. resolution. The first was launched in 1976.
- KH-12, or Advanced KH-11, weighs 30,000 lbs. and can see 100 miles to the left and right of its ground track. The resolution of the optical images are said to be as fine as 4-6 in. during daytime. At night, other infrared and radar satellites can see things as small as 2-3 ft.

As war started in March 2003, six NRO high-resolution imaging satellites maintained hourly watch over Iraq. They were three Advanced KH-11 satellites with infrared and optical cameras and three Lacrosse radar satellites able to search at night and in bad weather for production of nuclear, chemical and biological weapons of mass destruction and missiles.

DSP. NRO has other spysats crossing over target areas, such as the Defense Support Program (DSP) satellites operated by the Air Force Space Command as part of North America's early warning system. DSP satellites watch from 22,000-mile-high stationary (geosynchronous) orbits for missile and space launches and nuclear detonations.

Their infrared sensors detect heat from missile and booster rocket exhaust plumes. They even can detect launch of small missiles to warn of an attack by short-range missiles against any target anywhere in the world.

SBIRS. A new system of spy satellites known as Space-Based Infrared System (SBIRS) will replace DSP in coming years. SBIRS will have multiple constellations of infrared satellites, some in high orbits and some in low orbits — known as SBIRS High and SBIRS Low.

SBIRS High will be a flotilla of satellites in stationary (geosynchronous) orbits and in
highly elliptical orbits. SBIRS Low will have satellites flying in low Earth orbit (LEO). Together, the high and low satellites will be integrated into a system offering greater missile warning capability than the older DSP satellites.

**SDS.** Satellite Data System (SDS) relay satellite The Satellite Data System (SDS) satellites are highly elliptical orbiting relays. They are used for real-time data relay from reconnaissance gathering satellites which are out of range from US tracking stations. The satellites use elliptical Molniya orbits which have high perigees in the Northern hemisphere and relatively low perigees in the Southern hemisphere. The orbit permits long relay durations, especially at Northern latitudes which are not visible to geosynchronous satellites. Most Molniya orbits have an inclination of 63.4 degrees and a period of 12 hours.

**DSCS.** A wide array of communications satellites around the world are used to relay military messages and data. One type of American military spacecraft is the Defense Satellite Communications Systems (DSCS) satellite.

DSCS satellites are highly important to the American military establishment. Everyone from the President of the United States to special operation troops in the field relies on them for secure communications. Each DSCS also has a single channel for broadcasting emergency action messages to nuclear forces.

- The first small 100-lb. DSCS satellite was launched in 1966.
- The second generation of DSCS started in 1971.

Flying 22,300 miles above Earth, the satellites are the backbone of the military network. They use super high frequencies for secure, jam-proof voice and data communications among defense officials, battlefield commanders, ground troops, aircraft, ships, the White House and the State Department. They also carry space operations communications and early warning data.

DSCS 3-B6, launched August 29, 2003, was supposed to have been launched by space shuttle back in 1986. DSCS 3-B6 and 3-A3 were to have shared the ride to orbit, but the explosion of Challenger changed the plan.

The pair were modified to enhance their capabilities and 3-A3 flew to orbit on the Delta 4 rocket launched March 10, 2003. That made 3-B6 the 65th and last DSCS satellite to launch.
DSCS 3-B6 will replace 3-B7 over the western Atlantic Ocean. The 3-B7 satellite, which was launched back in July 1995 by an Atlas 2A rocket, will be moved to another location.

**Milstar.** The constellation of Milstar satellites make up the most advanced military communications satellite system to date. From stationary orbit 22,000 miles above Earth, they provide secure, jam resistant, worldwide communications, linking command authorities with ships, submarines, aircraft and ground stations.

Each giant Milstar is a smart switchboard in the sky, directing encrypted voice, data, teletype and fax messages traffic anywhere on the Earth. Each can link up with other Milstars to forward messages. A Milstar is the size of a city bus with electricity-generating solar arrays as wide as the wingspan of a 747 jumbo jet.

In addition to a pair of DSCS satellites, a third military communications satellite was launched in 2003. It was the sixth and final Milstar satellite ferried to orbit in April by a Titan 4 rocket.

Milstars are the most secure of the various communications satellites. They resist jamming and are hardened against nuclear attack. Milstars can operate in any combat environment with a low probability of detection or interception. In fact, they are used to relay the most sensitive information between the President and the armed forces.

On the other hand, DSCS offers a much larger communication capacity.

**Wideband Gapfiller Satellites.** The future American military satellites designed to replace DSCS and Milstar are known as Wideband Gapfiller Satellites. They will have greater bandwidth and communications capacity than DSCS. The first Wideband Gapfiller Satellite will be ferried to orbit from Cape Canaveral by a Delta 4 rocket in 2005.

**Other Mil Comm Sats.** Other American military communication (milcom) satellites are the so-called UHF Follow-On and FLTSATCOM satellites. Military communications satellites from other nations include Great Britain's Skynet satellite, France's Telesat Syracuse satellite and the NATO-4 satellite. All of these coordinate
land, sea and air forces.

DMSP. The Defense Meteorological Satellite Program (DMSP) has been collecting weather data for American military operations for four decades.

Weather conditions across the globe vary widely, of course, which highlights the importance of DMSP satellites, as well as other civilian weather satellites, used to read conditions in target areas. Weather not only affects the timing of air strikes, but also the timing of damage assessments by overflying spacecraft.

At least two DMSP satellites in polar orbits 500 miles above Earth continuously send down visible light photos and infrared images of cloud cover. They also report atmospheric moisture and temperature. Military weather forecasters use such data to predict regional and global weather patterns, including severe thunderstorms, hurricanes and typhoons. DMSP pictures show areas as small as 1,000 feet in diameter.

DMSP satellites also measure charged particles and electromagnetic fields in the ionosphere, which have an impact on the effectiveness of ballistic-missile early warning radar systems and long-range communications. That same data is used to predict global auroral activity, which affects electronics on Earth and in space. Problems in the space environment can affect military satellites.

Meanwhile, at least a dozen other American, European, Russian and Chinese civilian and military weather satellites also deliver images. For instance, the U.S. National Oceanic and Atmospheric Administration operates NOAA and GOES civilian weather satellites. Also in space are European Meteosat, Russian Meteor, and Chinese Feng Yun weather satellites.
Navstar GPS. How do military commanders know where things are? Today, they use signals from Navstar Global Positioning System (GPS) satellites orbiting Earth.

Navstar GPS is a constellation of more than two dozen orbiting satellites controlled by the U.S. Air Force 50th Space Wing at Schriever Air Force Base, Colorado. It sends navigation data to military and civilian users all over the world.

GPS satellites continuously transmit navigation signals as they circle Earth every 12 hours. Receivers for those signals have been built into cars, ships and airplanes. There also are handheld receivers.

People on the ground, in the air, and on the high seas can receive the signals 24 hours a day and use them to know the time and calculate their location and velocity. The signals are so accurate that time can be figured to within a millionth of a second, speed within a fraction of a mile per hour, and location to within less than 100 feet.

Cruise missiles, and smart bombs dropped by B-1, B-2, B-52 and other bombers, home in on their targets with GPS receivers. Transport planes, U2 spy planes, and aircraft carriers navigate the globe following GPS signals. Troops, tanks and trucks locate themselves with GPS receivers.

NAVSTAR is short for Navigation System using Timing And Ranging.

XSS-11. How could military commanders fix things that break in space? The U.S. Air Force's Experimental Satellite System-11, or XSS-11 for short, is a vision of the future, pointing toward a time when satellites flying on orbit will be refueled, resupplied, repaired, repositioned or removed from space.

XSS-11 was launched April 11, 2005, on a Minotaur I rocket from Vandenberg Air Force Base, California. Minotaur is a refurbished Minuteman missile.

In numerous tests since then, the 300-lb., dishwasher sized microsatellite successfully rendezvoused with the upper stage of its depleted launch rocket, which is nearby in space. XSS-11 approached as close as 1,500 feet from the discarded rocket.

The XSS-11 project is managed by the U.S. Air Force Research Laboratory, Space
Vehicles Directorate Integrated Space Experiments Division, Kirtland Air Force Base, Albuquerque, New Mexico, and operated by the Air Force Space and Missile Systems Center Detachment 12 at Kirtland AFB.

How could the military benefit from the satellite technology demonstrated by XSS-11? A satellite with the slow maneuverability of XSS-11 probably would not be used to attack other satellites. However, there are other non-weapon possibilities:

- A small maneuverable satellite could inspect larger U.S. satellites for accidental or hostile damage. Such a seek-and-diagnose satellite could be sent to space as needed, or one could be attached to a larger satellite at launch and then detach itself to scout around after arrival in orbit. That capability also might be of use during civilian space shuttle flights.

- A small maneuverable spacecraft could fly near a foreign satellite for a first-hand, close-up inspection or to intercept targeted beams of radio or laser communications.

XSS is short for Experimental Satellite System.

🔍 Spysat Orbits. Spy satellites can be found flying a variety of orbital patterns:

- high-resolution photography satellites usually travel around Earth in low-altitude polar orbits to take advantage of a good Sun angle.

- surveillance satellites often are in stationary orbits at 22,300 miles altitude.

- navigation satellites usually fly mid-altitude orbits at altitudes around 12,500 miles.

- communication satellites usually travel either in elliptical orbits, ranging from 300 to 25,000 miles altitude, or in stationary orbits at 22,300 miles altitude.