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Military and Civilian Satellites in Support of Allied Forces in the Persian Gulf War

Marcia S. Smith
Specialist in Aerospace Policy
Science Policy Research Division

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MILITARY AND CIVILIAN SATELLITES IN SUPPORT OF ALLIED FORCES IN THE PERSIAN GULF WAR

SUMMARY

The Persian Gulf War is the first large scale U.S. military action for which a large array of satellite systems is available for supporting military operations. From communications to navigation to intelligence gathering, space assets have proved invaluable.

The Department of Defense (DOD) has conducted its own space program since the Space Age began, but its activities are less well known that those of the civilian National Aeronautics and Space Administration (NASA). Since FY 1982, however, DOD's space budget has been larger than NASA's. In FY 1991, for example, the estimated DOD space budget is $18 billion compared to $13.9 billion for NASA. Most of this funding is for the development, procurement, launch, and operation of satellites for communications, navigation, weather forecasting, intelligence gathering, and early warning of missile launches (a comparatively small amount is for space weapons). There is now some debate in Congress over DOD's request to build advanced systems for some of these functions (such as the MILSTAR communications satellite program), but this paper addresses only existing space assets. DOD's space operations are the responsibility of U.S. Space Command (USSPACECOM) in Colorado Springs, Colorado; each Service has a component command.

In addition to these specialized military space systems, civilian/commercial satellites can be useful for military operations. The U.S. National Oceanic and Atmospheric Administration (NOAA, in the Department of Commerce) has civilian satellites for weather forecasting and remote sensing of the Earth's surface. NASA's Tracking and Data Relay Satellite System (TDRSS) may be used to relay data from military satellites to ground stations. Other countries also launch satellites for many of these same purposes. Commercial communications and remote sensing satellites are also available, some operated by international organizations (INTELSAT and INMARSAT, for example). USSPACECOM has been studying ways to make best use of U.S. and allied systems in times of crisis and the degree to which systems could or should be designed to be interoperable (some already are).

The Soviet Union launches a wide array of satellites, but since it did not participate in the military effort in the Persian Gulf, the only discussion of Soviet space systems in this report concerns commercially available remote sensing imagery.

All the information contained in this report is from open sources.

MILITARY AND CIVILIAN SATELLITES IN SUPPORT OF ALLIED FORCES IN THE PERSIAN GULF WAR

INTRODUCTION

Military and civilian satellites are being used to support allied forces involved in the Persian Gulf. The U.S. Department of Defense (DOD) and the intelligence community have satellites for communications, navigation, weather forecasting, intelligence gathering, and early warning of missile launches. In addition, the U.S. Department of Commerce (through the National Oceanic and Atmospheric Administration--NOAA) has civilian satellites for weather forecasting and remote sensing of the Earth's surface. The National Aeronautics and Space Administration's (NASA's) Tracking and Data Relay Satellite System (TDRSS) may be used for relaying data from military satellites to ground stations.

Other countries launch satellites for many of these same purposes, although it is not readily apparent how much they are being used for Desert Storm. Commercial communications and remote sensing satellites are also available, some operated by international organizations (INTELSAT and INMARSAT, for example).

The Soviet Union launches a wide array of satellites, but since it did not participate in the military confrontations in the Persian Gulf, the only discussion of Soviet space systems in this report concerns commercially available remote sensing imagery.

All the information contained in this report is from open sources.[1]

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[1] In addition to the numerous articles that have been written about military satellites in general and their role in the Persian Gulf War in particular, three books that provide considerable information on these systems are: (1) Richelson, Jeffrey T. America's Secret Eyes in Space: The U.S. Keyhole Spy Satellite Program. New York, Ballinger, 1990; (2) Burrows, William E. Deep Black: Space Espionage and National Security. New York, Random House, 1986; and (3) Whelan, C. Richard. Guide to Military Space Programs. Arlington, Va., Pasha Publications, 1984. See also: U.S. General Accounting Office. Military Space Programs: An Unclassified Overview of Defense Satellite Programs and Launch Activities. Washington, GAO, June 1990. GAO/NSIAD-90-154FS.

COMMUNICATIONS SATELLITES

Military Systems

DOD has several different military satellite communications systems. Most are in geosynchronous orbits.[2] These satellites not only are crucial for communication between the National Command Authority in the United States and Central Command in the Persian Gulf, and within Central Command, but also relay information from other military satellites (such as early warning and weather satellites) directly to analytical centers in the United States. They are used also to transmit the analyzed information to Persian Gulf commanders.

The **Defense Satellite Communications System (DSCS)** was developed and operated by the Air Force and is now operated jointly by Air Force and Army Space Commands. DSCS satellites operate at Super High Frequencies (SHF). The **Fleet Satellite Communication (FLTSATCOM)** and **LEASAT** systems, under the control of Navy Space Command, operate at Ultra High Frequencies (UHF); FLTSATCOM also has an SHF uplink. LEASAT stands for Leased Satellite, and, as the name implies, they are leased (from Hughes Aircraft) rather than owned by the Government (the satellites are also known as Syncom). Two DSCS II, four DSCS III, two FLTSATCOM, and four LEASAT satellites reportedly are operating now.

The **Air Force Satellite Communications (AFSATCOM)** system consists of transponders on the FLTSATCOM and DSCS satellites, as well as on the **Satellite Data System (SDS).**[3] Unlike the previous satellites, SDS satellites are in "Molniya" orbits[4] that provide better coverage of polar regions. Among other things, SDS reportedly is used to relay data from photographic reconnaissance satellites (see below) to ground stations. The AFSATCOM system operates at UHF frequencies and is operated by the Air Force.

NASA developed and operates a **Tracking and Data Relay Satellite System** (TDRSS) of three geostationary satellites that relay data from satellites

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[2] Geosynchronous orbits are located at an altitude of 35,800 kilometers. A satellite placed there makes one orbit of the Earth in the same amount of time as the Earth makes one revolution about its axis (24 hours), so the satellite's period is synchronized with the Earth. If the satellite is located at 0° inclination (directly above the equator), it will maintain a fixed position relative to a point on Earth and is called geostationary. Satellites in geosynchronous orbits at other inclinations trace a figure 8 pattern relative to the Earth's surface.

[3] Whelan, Richard. Guide to Military Space Programs. Arlington, Va., Pasha Publications, 1984. p. 38-39.

[4] These are called Molniya orbits after the Soviet communications satellites that first used them. They are in high inclination (near-polar) orbits with an apogee of approximately 40,000 kilometers and a perigee of approximately 500 kilometers, providing a long linger time over the northern hemisphere.

at lower altitudes to a ground station at White Sands, NM (and from there to other locations). The system is used by both the civilian and military sectors, and presumably carries some traffic from reconnaissance satellites.

Coincidentally, DOD had launched a pair of experimental communications satellites called **Macsat** (Multiple Access Communications Satellite) in May 1990 that have proved useful for certain communications needs. Unlike the communications satellites described above, which instantly relay communications from one location to another, Macsats are "store and forward" satellites where a user sends information to the satellite where it is stored for later transmission when the satellite is in view of the recipient's ground station. The Macsats are in polar,[5] rather than geostationary, orbits. Users have four opportunities of a few minutes each to send or receive information every 24 hours. Thus, the two Macsats are useful for low priority communications such as relaying logistics supply requests and are being used by the Marines for this purpose.[6] The two single-channel UHF satellites are part of the "Lightsat" program[7] in the Defense Advanced Research Projects Agency (DARPA) to determine the utility of small satellites.

The United Kingdom and NATO have their own geostationary military communications satellites, called Skynet and NATO respectively, that operate at both UHF and SHF. NATO satellites are interoperable with U.S. systems.[8] French Government Telecom 1 satellites carry a communications package called "Syracuse" for secure military communications.

Civilian/Commercial Systems

Many countries, companies, and organizations own and operate communications satellites. These systems can be used to transmit non-secure military communications, phone calls home from the troops, and television

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[5] A satellite in a "polar orbit" circles the Earth's poles. As the Earth rotates under the satellite's orbit, the satellite can view the entire globe. This is particularly useful for reconnaissance and other remote sensing satellites. Polar orbits are not widely used for communications because the satellite is constantly moving in relation to the transmitter and receiver on the ground, restricting the amount of useful communication time. Such orbits do, however, provide better coverage of polar regions, where communicating with geostationary satellites is difficult because of the curvature of the Earth.

[6] Marcus, Daniel J. Marines Use Macsats in Mideast. Space News, Sept. 3-9. 1990. p. 4.

[7] Desert Shield Sees R&D Macsats in Limited Operations Role. Aerospace Daily, Nov. 16, 1990. p. 289.

[8] Kolcum, Edward H. Delta 2 Boosts NATO Satellite; Problem Found in New GPS Spacecraft. Aviation Week and Space Technology, Jan. 14, 1991. p. 24.

signals for the media, for example. The following discussion is meant to be illustrative of the types of satellites that are available for use in the Persian Gulf War, and is not all inclusive.

Some of the satellites are owned and operated by the International Telecommunications Satellite Organization (INTELSAT), to which 119 countries belong, including Iraq and Kuwait. According to press reports, Kuwait's access to the Intelsat system was cut on Aug. 2, the day of Iraq's invasion. Iraq has three INTELSAT ground stations, and its service also has been cut, although it is not clear whether it was a voluntary action by Iraq, a decision by INTELSAT (possibly for non-payment), or the result of the antennas being destroyed by air strikes.[9]

INMARSAT (International Maritime Telecommunications Satellite Organization), similar to INTELSAT but for mobile rather than fixed communications,[10] also is playing a significant role. INMARSAT has 63 members, including Kuwait and Iraq. INMARSAT ground stations can be smaller than those for INTELSAT and are transportable, spurring development of portable satellite telephones.[11]

Among other communications satellite systems probably being used are those operated by regional consortia such as the European Telecommunications Satellite Organization (EUTELSAT), and the Arab Satellite Communications Organization (ARABSAT, of which Iraq and Kuwait are members), as well as companies offering international service such as PANAMSAT.

NAVIGATION

DOD is establishing a system of navigation satellites called the **GLOBAL POSITIONING SYSTEM (GPS)** or **NAVSTAR.**[12] A "constellation" of 21 satellites (18 operational and 3 in-orbit spares) is planned which will provide 24-hour-a-day, seven-day-a-week coverage so that anyone, anywhere on the globe

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[9] War Drives Up Demand for Satellite Communications, Remote Sensing. Space Commerce Bulletin, Jan. 25, 1991. p. 1.

[10] Mobile communications means that the ground antenna is mobile (not the satellite). A "fixed" system has a stationary ground antenna. Mobile antennas includes those on ships, trucks, and cars.

[11] Robichaux, Marion and Gilbert Fuchsberg. 'Desert Storm' Demand Buffets Satellite-Phone Firm. Wall Street Journal, Feb. 1, 1991. p. B2. One manufacturer of such devices, Mobile Telesystems, of Gaithersburg, Md., reportedly is besieged with orders for its $52,000 "single-suitcase" antenna, the smallest on the market.

[12] The operational GPS satellites also carry sensors that can detect nuclear explosions, called IONDS (Integrated Operational Nuclear Detection System).

can determine their exact location in three dimensions (latitude, longitude, and altitude). Fifteen GPS satellites are now operational, although some are relatively old and were launched as part of the test program rather than the operational segment.[13] GPS is operated by Air Force Space Command.

GPS satellites transmit data from which special ground receivers can calculate the user's location. Four satellites must be in view of the ground receiver at any one time to obtain three-dimensional data and there are not enough satellites in orbit now to provide that coverage around the clock; two-dimensional data (latitude and longitude) can be obtained with only three satellites in view. Nevertheless, GPS already is proving very useful to air, sea and ground forces in fixing their positions and targeting weapons. Users reportedly can get two-dimensional coverage almost any time, and three-dimensional coverage is available 19 hours a day.[14]

Although GPS was designed, developed and funded entirely by DOD, it was always intended to be available both to civilian and military users.[15] Thus, GPS has two channels, one providing 100 meter accuracy for civilian users, and another providing 16 meter accuracy for the military (the signal would be encrypted so civilian receivers could not access it). GPS receivers are available on the commercial market already for civilian users, but the special receivers for the military to receive the encrypted channel are not. Hence, DOD is purchasing the commercially available receivers and is not encrypting the 16 meter channel so Desert Storm forces can access the more precise channel. Hence, at the moment, all GPS users can get the 16 meter channel.

The GPS receivers most commonly in use by Desert Storm forces today are called "Sluggers" (after their acronym, SLGR, for Small Lightweight GPS Receiver) and weigh about 4 pounds (1.8 kilograms). The user need only turn on the receiver and the positioning data are displayed. Up to 1,089 waypoints can be stored in the unit's memory and the user can be sequentially guided to

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[13] A 16th satellite malfunctioned in December; it was ten years old. A problem with the most recently launched (Nov. 1990) GPS satellite has led DOD to postpone additional GPS launches until they can remedy the problem, which affects control of the satellite's solar panels. A backup system is being used, so the satellite is still operational.

[14] Henderson, Breck W. Ground Forces Rely on GPS to Navigate Desert Terrain. Aviation Week and Space Technology, Feb. 11, 1991. p. 77.

[15] DOD developed the Transit navigation satellite system in the 1960s and it is still in use today. Transit provides data only on latitude and longitude, however, not altitude, and with less precision than GPS. It has been estimated that more than 90 percent of the users of Transit are civilian (individuals who own their own boats, for example). Thus, the design of GPS for use by both the military and civilian sectors is in keeping with the Transit tradition.

them.[16] Horizontal steering information (at velocities above 2.2 kilometers per hour), cross-track error, and estimated time of arrival at waypoint or destination is also provided.

WEATHER FORECASTING

DOD operates its own weather satellite system, the **Defense Meteorological Satellite Program**, which consists of at least two polar orbiting satellites (three are operating now). Each DMSP satellite flies over the Gulf region twice a day. The main DMSP sensor is a visible/infrared system to provide detailed cloud imagery. Other sensors measure temperature and moisture content of the atmosphere and soil, and location and intensity of aurora (to assist with the operation of military radars and communications systems that could be adversely affected).[17] DMSP is operated by Air Force Space Command.

NOAA also has a system of polar orbiting satellites, called **NOAA**, as well as satellites in geostationary orbit, called the **Geostationary Operational Environmental Satellite** (GOES) system. Currently, two NOAA and one GOES satellites are operating. The NOAA satellites have four main instruments: a radiometer (called AVHRR) for day and night cloud cover, sea-surface temperatures and snow mapping; a visible/infrared system to provide temperature profiles, atmospheric moisture content, and ozone measurements; a system to collect data from fixed and moving platforms on the surface of the planet; and a system that monitors the state of solar activity. The GOES satellites also carry visible/infrared sensors to provide cloud cover data, and sensors for temperature and moisture profiles. The AVHRR data from the NOAA satellites are available to anyone in the world who purchases a relatively inexpensive receiving antenna called an Automatic Picture Transmission (APT) terminal. Iraq is thought to have APT terminals and thus can receive data from the NOAA satellites. While it is possible to turn off the satellites, doing so would also deprive allied forces of the data, and NOAA states that it has not been asked to cease operations.[18] DMSP data are not available through APT antennas.

Other countries also have weather satellites, including Europe's geostationary Meteosat Operational Programme (MOP) satellite operated by the European Meteorological Satellite Organization (EUMETSAT).

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[16] Data from Trimble Navigation brochure. According to the brochure, the accuracy available using the SLGR, which they formally call the Trimpack, is 25 meters (not 16).

[17] Covault, Craig. USAF Space Command Weather Satellite Images Persian Gulf Facilities at Night. Aviation Week and Space Technology, Nov. 26, 1990. p. 29.

[18] Iraqis Still Receive Weather Data From U.S. Satellites. Aviation Week and Space Technology, Jan. 21, 1991. p. 26.

LAND REMOTE SENSING

Although weather satellites are "remote sensing" satellites, the term commonly refers to civilian/commercial satellites that study features on the land (and sometimes the oceans). Military photographic reconnaissance satellites are close cousins of civilian remote sensing satellites, with better resolution,[19] and are discussed in the next section. The civilian satellites also can be useful for military intelligence gathering, but that is not their main purpose.

The United States, France, and the Soviet Union have civilian/commercial land remote sensing satellites. The U.S. system, Landsat, is operated by a private company, EOSAT, under contract to NOAA.[20] Data are sold commercially and, by law (P.L. 98-365, the Land Remote Sensing Commercialization Act), must be made available to anyone on a non-discriminatory basis (often called "open skies"). The Secretary of Defense, however, is "responsible for determining those conditions, consistent with this Act, necessary to meet national security concerns of the United States and for notifying the Secretary [of Commerce] promptly of such conditions." (Section 607). Thus, presumably, the Secretary of Defense could request the Secretary of Commerce to restrict data dissemination. There are 13 foreign ground stations that can receive Landsat imagery directly from the satellite, however, so to restrict data availability, the satellites would have to be turned off, which would deny their use to DOD as well. Landsat data are only in color and the best resolution is 30 meters. Two Landsats are now operating.

France's SPOT system provides 20 meter resolution in color or 10 meter resolution in black and white. Images are sold commercially through the SPOT Image company. At the beginning of the Persian Gulf crisis, SPOT Image ceased selling images of the region apparently to all customers except the U.S. (and presumably French) Governments, an action that sparked criticism from civilian users (such as the media) who had understood SPOT Image's policy to be that of "open skies." SPOT Image is the only one of the three distributors of civilian remote sensing data to change its policy because of the Persian Gulf situation. It has been reported that DOD is making considerable use of SPOT imagery.[21] One SPOT satellite is now operating.

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[19] Resolution is the ability to "see" or discriminate an object. An overly simplistic explanation is that with 30 meter resolution, one can discriminate between objects larger than 30 meters in diameter.

[20] The U.S. Government built and paid for the first 5 Landsat satellites, after which the program was "privatized." A private company, EOSAT, now operates the existing Landsat 4 and 5 satellites under contract to NOAA, and is paying for development of Landsat 6 (scheduled for launch in 1992-1993). Landsat privatization has been very controversial, and the future of the system beyond Landsat 6 is currently being debated in Congress and the Executive Branch.

[21] War Drives Up Demand for Satellite Communications, Remote Sensing. Space Commerce Bulletin, Jan. 25, 1991. p. 2.

The Soviets launch several remote sensing satellites and also use cameras onboard their space station Mir for studies of the Earth. Much of these data are sold commercially through one of two government entities, Glavcosmos or Soyuzcarta. The best Soviet data are from the KFA-1000 camera on satellites called **Resurs** and have a resolution of 5-6 meters. Following SPOT Image's decision not to sell data of the Gulf region, some users are turning to the Soviets for imagery of the region.[22] The Resurs satellites take actual film pictures and the film is returned to Earth and processed, unlike Landsat and SPOT which return data digitally. Thus, Resurs satellites have only 2-4 week lifetimes and are launched essentially on demand.

INTELLIGENCE GATHERING

The intelligence community has an array of satellites for obtaining photographic and radar imagery, and electronic intelligence.[23] Air Force Brig. Gen. Don Hard has spoken about a system called **Constant Source** which he said provides "mission essential information on enemy order of battle" in "near real-time directly to the field" allowing "information and accurate decisions for mission planning and battle management."[24] This reportedly is a reference to portable ground stations that can receive data directly from a variety of photographic and radar reconnaissance intelligence gathering satellites.[25] Others, however, have complained that shortage of appropriate equipment makes it difficult to disseminate intelligence information--including photo, communication, electronics and radar--to field commanders,[26] so it is not clear which users have the requisite receiving antennas.

Photographic Imaging Systems

The U. S. intelligence community has satellite systems that take images of features on the Earth's surface. These satellites, called "photo recons" (photographic reconnaissance) or "recces" (reconnaissance satellites) transmit their data to ground receivers digitally. Sometimes data are relayed through the

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[22] Media Tap NOAA, Soviet Birds For Gulf Views. Military Space, Jan. 28, 1991. p. 7.

[23] Intelligence satellite activities are reportedly managed by the interagency (some would say supra-agency) National Reconnaissance Office (NRO). See, for example: Richelson, Jeffrey T. America's Secret Eyes in Space. New York, Ballinger, 1990. p. 46 ff.

[24] Quoted in: Six Satellite Systems Support Desert Shield. Aerospace Daily, Aug. 28, 1990. p. 340.

[25] Covault, Craig. Space Recon if Iraq Taxes CIA Operations. Aviation Week and Space Technology, Sept. 3, 1990. p. 30.

[26] U.S. Struggles to Distribute Satellite Data in Gulf. Defense Daily, Nov. 30, 1990. p. 339.

Satellite Data System to a ground station at Ft. Belvoir, Va.,[27] although it has been reported that the newest photo recon satellites can transmit directly to some users.[28] Data also may be relayed through NASA's Tracking and Data Relay Satellite System (TDRSS).

The two U.S. photo recon satellite systems identified as operational today are the KH-11 and the advanced KH-11 (sometimes called the KH-12). Both have sensors operating in the infrared and visible wavelengths. The resolution of these satellites is classified, but presumably is much better than the civilian/commercial systems discussed above (a customary comment is that they can read license plates). Reportedly there are three KH-11 and two or three advanced KH-11 satellites operating today.[29]

Photo recon satellites are in polar (or near-polar) orbits typically at an altitude where one orbit takes approximately 90 minutes, so each satellite orbits the Earth 16 times a day. The Earth rotates underneath the satellite, so it passes over a particular spot on only some of the orbits and is over the area for only a few minutes. These satellites cannot hover over a target. With multiple satellites, more passes can be made over a particular spot, but round-the-clock coverage of one location is not feasible. Thus, they are not very useful in tracking moving targets, such as the mobile Scud launchers. Also, the sensors on the photo recon satellites cannot penetrate clouds (or smoke or dust or darkness), so their effectiveness is limited under some circumstances.

Space-Based Radar

DOD also reportedly has an imaging radar satellite called Lacrosse. Radar imagery is not affected by the day/night cycle or obstacles such as clouds or sand. Lacrosse carries a synthetic aperture radar whose resolution apparently is not as good as that of photo recon satellites, and may be able to see "jeep-sized" or larger objects.[30] Lacrosse is in a near-polar orbit.

Electronic Intelligence

The United States reportedly has satellites that can listen in on various forms of electronic transmissions, including some telephone calls. (The satellites detect signals transmitted through the air; they cannot intercept signals

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[27] Covault, Craig. Space Recon of Iraq Taxes CIA Operations. Aviation Week and Space Technology, Sept. 3, 1990. p. 30.

[28] Furniss, Tim. Spying on Saddam. Flight International, Aug. 28, 1990. p. 28.

[29] Covault, Craig. Recon Satellites Lead Allied Intelligence Effort. Aviation Week and Space Technology, Feb. 4, 1991. p. 25. KH = Keyhole.

[30] Furniss, Tim. Spying on Saddam. Flight International, Aug. 28, 1990. p. 28.

transmitted via cables). These are called ELINT (electronics intelligence) or SIGINT (signals intelligence) satellites. The U.S. reportedly now has two **MAGNUM** and one **CHALET** satellites in geostationary orbit. (Some observers count the **VORTEX** satellite as operational. At the time it was launched in 1988, however, it was reported that the launch vehicle had left it in a useless orbit due to an upper stage failure. Since the satellite and its mission is classified, a definitive determination of its status cannot be accomplished using open sources.)

The Navy operates a polar-orbiting ELINT system for ocean surveillance called **WHITE CLOUD**. Three White Cloud satellites are clustered together, and there are reportedly four to five clusters now operational. Some observers report that the polar-orbiting advanced KH-11 satellites also carry an ELINT package.[31]

EARLY WARNING

DOD uses **Defense Support Program (DSP)** satellites for early warning of missile launches (DSP satellites reportedly have other functions as well). DSP is operated by Air Force Space Command. Originally designed to warn of long range Soviet intercontinental ballistic missile (ICBM) launches, the DSP system has proved useful in detecting shorter range Iraqi Scud ballistic missile launches. The DSP satellites have infrared sensors that detect the heat from rocket plumes after the rocket exceeds 50,000 feet (15 kilometers) altitude. There reportedly are three active and two backup DSP satellites now in orbit, and two have been positioned to optimize viewing of the Persian Gulf region,[32] and can provide 90-120 seconds warning of a Scud attack.[33] The DSP satellites observe the launch and relay the data to U.S. Space Command headquarters at Cheyenne Mountain, Colorado. Space Command analyzes the data to ensure that it is a Scud launch and predicts the impact zone, then notifies Central Command headquarters in Saudi Arabia (via a communications satellite). By the time the information is collected, analyzed and transmitted, the rocket has been airborne for approximately five minutes, providing about two minutes warning.

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[31] See, for example: Burrows, William E. Deep Black. New York, Random House, 1986. p. 307.

[32] Because of the satellite's design, it views a particular location every 12 seconds.

[33] Covault, Craig. USAF Missile Warning Satellites Providing 90-Sec. Scud Attack Alert. Aviation Week and Space Technology, Jan. 21, 1991. p. 60.

SATELLITES IN SUPPORT OF THE PERSIAN GULF WAR[1]	
FUNCTION	**SATELLITE OR SYSTEM**
COMMUNICATIONS (Military Systems)	Defense Satellite Communications System (DSCS) Fleet Satellite Communications System (FLTSATCOM) Air Force Satellite Communications System (AFSATCOM) Satellite Data System Macsat NATO (NATO) Skynet (U.K.) Telecom/Syracuse (France)
COMMUNICATIONS (Civilian/ Commercial Systems)	Tracking and Data Relay Satellite System International Telecommunications Satellite Organization (INTELSAT) International Maritime Telecommunications Satellite Organization (INMARSAT) *Other illustrative examples*: European Telecommunications Satellite Organization (EUTELSAT) Arab Telecommunications Satellite Organization (ARABSAT) Panamsat
NAVIGATION (Military and Civilian)	NAVSTAR Global Positioning System (GPS)
WEATHER (Military)	Defense Meteorological Satellite Program (DMSP)
WEATHER (Civilian)	National Oceanographic and Atmospheric Administration (NOAA) Geostationary Operational Environmental Satellite (GOES) Meteosat Operational Programme (MOP)--European system that may be supporting Desert Storm
LAND REMOTE SENSING (Civilian/Commercial)	Landsat (U.S.) SPOT (France) Resurs (Soviet Union)

SATELLITES IN SUPPORT OF THE PERSIAN GULF WAR[1]	
FUNCTION	**SATELLITE OR SYSTEM**
INTELLIGENCE GATHERING (Military)	*Photographic Reconnaissance*: KH-11 Advanced KH-11 *Space-Based Radar*: Lacrosse *Electronic/Signals Intelligence*: Magnum Chalet White Cloud Vortex? Advanced KH-11?
EARLY WARNING (Military)	Defense Support Program (DSP)

1. All information is from open sources. It is not clear exactly what foreign systems are in use for the Persian Gulf War; systems listed here are illustrative. Prepared by CRS.