satellites

from Encyclopedia of Intelligence & Counterintelligence

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The intelligence business has become increasingly technically sophisticated, and arguably, the most important of the new technologies are satellites. Satellites can provide intelligence on enemy weapons programs to guard against surprise attacks, on specific targets to plan pre-emptive strikes, and on verification of arms control agreements or United Nations disarmament obligations.

During the Cold War, the superpowers engaged in an arms race, seeking technologies to guard against surprise attack. The U-2 spy plane overhead surveillance came into operation in 1956, the year both the United States and the Soviet Union initiated projects to develop satellites. On October 4, 1957, the Soviets launched the first artificial satellite, *Sputnik 1*, into orbit using an intercontinental ballistic missile (ICBM). The launch shocked the world.

As with many intelligence "surprises," top-level U.S. officials knew the Soviets were going to launch a satellite. Yet with Sputnik, for the first time, the United States, a continent-size nation formerly invulnerable to attack, aside from outlying areas like Pearl Harbor, seemed at risk, given what appeared to be a massive Soviet ICBM lead. This so-called missile gap created the sense of national emergency that helped drive the arms race.

Early Soviet and American programs

Sputnik represented only the beginning of Soviet innovation. In the late 1960s and early 1970s, the Soviet Union orbited the first radar and electronic-intelligence ocean and reconnaissance satellites (called *Rorsat and Eorsat*, respectively), designed to detect Western warships. The Soviets also created communications satellites in what was called a Molniya orbit, rising over the Arctic up to 24,000 miles above the surface of the earth and coming down to just 200 miles above it while shooting through the southern hemisphere. Then, in the 1980s, the Soviets sent up Cosmos satellites, believed to have had digital transmission in "real near-time."

The first U.S. satellite and earliest one to use photo-reconnaissance technology was the Discoverer, ostensibly built for peaceful experiments and authorized by President Dwight Eisenhower in 1958. The true purpose was to respond to Sputnik by providing cover for the U.S. development and launching of the first spy satellite, replete with photographic capability (and eventually electronic intelligence as well): Corona. The CIA-led project was overseen by its Deputy Director of Plans, Richard Bissell, Jr., with the U.S. Air Force's help. Eisenhower attempted to end infighting over the burgeoning satellite program and related strategic intelligence information (the equivalent of bureaucratic gold to the national security community) by creating a new agency.

The National Reconnaissance Office (NRO), whose very existence was a highly classified secret for some 31 years, was given the task of developing satellites, related technology, and establishing security procedures, the latter constituting the Byeman Control System. The Corona series of satellites, the first being the KEYHOLE system referring to the codename for U.S. photo-reconnaissance satellites, had hundreds launched, conducted missions over China, the Soviet Union, and around the globe.

Early U.S. satellite programs came from many sources in the bureaucratic competition for budget and influence. The U.S. Air Force went forward in 1961 with Samos, relaying television pictures from film, but was so disappointed by the results that the effort was regarded as a failure and ended. Corona, in contrast, was a dramatic success, with a single flight able to cover over a million-and-a-half square miles of the Soviet Union, greater than the entire two-dozen previous U-2 spy flights combined. Different satellites in the KEYHOLE series specialized in taking different kinds of pictures, from specific targets to broad areas.

Almost immediately, the flights brought dramatic revelations, as in the photos of Soviet ICBM and strategic forces that led to a new September 1961 National Intelligence Estimate (NIE). The new NIE revealed that earlier estimates had been totally wrong. The much touted missile gap predicted by many in the intelligence community did exist, but it was dramatically in America's favor. Yet given the special, higher than top-secret classification of Corona, the clearance that mandated that information exchanges only be shared with the relatively few persons on the list for its product, this gap fact was so closely held that few knew.

Thus, despite the revelation that the Soviets obviously did not have a crash program as previously thought, the John F. Kennedy administration went ahead with a decision to build 1,000 ICBMs. This number was far less than the 10,000 requested by General Tommy Powers, commander in chief of the Strategic Air Command (SAC) from 1957 to 1964.

Top U.S. officials did use the knowledge, though, during the period when the Kennedy and his advisers were seriously debating the possibility of a U.S. first strike against the Soviets during the Berlin Crisis, as newly declassified documents reveal. In the famous speech, largely written by RAND analyst Daniel Ellsberg, and delivered by Deputy Secretary of Defense Roswell Gilpatric to the Business Council of Hot Springs, Virginia, the U.S. announced its vast strategic superiority to the Soviets. The speech is believed to have played a major role in ending the Berlin Crisis.

After one last push by the Soviets, they backed down from threats to conclude a peace treaty with East Germany and halt U.S. access to West Berlin, and from claims of strategic superiority. Soon thereafter, the Soviets began to denounce the U.S. satellite program as a threat to peace, with diplomatic battles over the issue ensuing in the United Nations (UN), though the actual programs of both sides went ahead. The Soviets put up the first of their own spy satellites in 1962, while following this up with a proposed ban on such satellite reconnaissance systems to the UN Committee on Peaceful Uses of Outer Space, along with a host of related items, the next year. In actuality, though, the Soviets backed off from this issue.

American satellite development takes off

Other satellites in the *Corona* series included *Gambit*, launched in 1963, a “close-look spotting” satellite, the first of its kind. *Gambit* could hone in on a small area. This allowed for data analysis by the CIA's National Photographic Interpretation Center (in 1996 folded into the new National Imagery and Mapping Agency, a combat-support agency of the Department of Defense). *Gambit* was designed to complement the broader swathe of the .KH-4 *Corona*, which paved the way for its future close-look missions. *Corona* sent back hundreds of thousands of images from the Soviet Union and across the globe during these years. By the summer of 1964, the United States had photos of every single one of the Soviet's 25 ICBM facilities.

The MIDAS system

A surveillance satellite developed and launched during this same period was the Missile Defense Alarm System (MIDAS), operational throughout the 1960s and early 1970s. The system was designed to use infrared scanners to detect blasts from ballistic missiles and for early-warning against the threat of a Soviet surprise attack. MIDAS development was actually phased-out for a host of reasons in the mid-1960s, especially when it became clear that new systems would be needed to pick up submarines and intermediate range ballistic missiles (IRBMs).

For this new post-MIDAS task, Program Code 949 was developed. It was tasked with placing a geostationary (staying over one earth location) satellite at an orbit of roughly 20,000 to 25,000 miles above the earth in a program lasting until 1972. By this time, the new Program 647 (soon renamed the Defense Support Program, DSP) was up and running, able to give near-immediate warning of Soviet ballistic missile launches and related data on their trajectories minutes thereafter. In the mid-1970s, the orbits of these, by then geostationary, satellites covered both the western and eastern hemispheres, allowing for surveillance of both the Soviet Union and China.

In the summer of 1973, 1,014 missile launches had been detected by DSP satellites, and 18 months later the program had achieved a perfect record of recording ICBM launches. Another low-altitude satellite developed during this period, the Hexagon, or Big Bird, combined both infrared photo and signals-intelligence capabilities. Weighing some 15 tons, the first of these satellites was launched in 1971, and then roughly two were orbited ever year thereafter until 1984. The late 1960s and early 1970s saw the orbiting of two satellite geostationary systems by the NRO, Cannon and *Rhyolite. Canyon*, first sent into orbit in 1968 from Cape Canaveral, was both the first high-altitude signals-intelligence and communications-intelligence satellite of the United States, and had its final launch in 1977. In 1970, the first of four *Rfryolite* signals-intelligence spacecraft satellites were launched, it is believed close to the Horn of Africa and over Borneo, offering coverage of practically the whole globe except the western hemisphere. This system was capable of capturing even the lightest of microwave signals.

The satellite was thus used to collect microwave “point-to-point” communications transmissions within China and the Soviet Union, along with their key target (telemetry intelligence), including from missile tests and space launches. Communications intercepts from the satellites included from parts of the Middle East, central Asia, as well as southeast and east Asia. All this data was then transmitted to ground stations in the United States, United Kingdom, and Australia.

The *Rhyolite* program was renamed *Aquacade* after intelligence on the satellite was sold by two Americans to the Russians. The story is told in Ralph Lindsey's book, made into a movie, *The Falcon and the Snowman* (1979). The Canyon and Rhyolite/Acquacade programs were eventually replaced by the *Chalet* (launched in 1978 and later renamed *Vortex*) and Magnum programs, the latter launched in 1985 from the *Discovery* space shuttle.

Differences between the U.S. and Soviet launching procedures affected the rapidity and flexibility with which they could be sent into orbit. The United States tended to send relatively few, yet complex satellites out each year, using expendable launch vehicles or the space shuttle, while the Soviets relied more on rocket boosters, with some 35 or more launches of simple models per year.

The U.S. *Vortex* satellites covered the Soviet Union itself and the Soviet empire in Eastern Europe, as well as the Middle East, where they gave essential support to Anglo-American forces in the Persian Gulf region, including up to the period during the Persian Gulf War of 1990-91 and the Iraq War of 2003.

Satellite improvements

By the 1980s, satellites had vastly improved from the designs of the early 1960s and 1970s. Even the satellite imagery of the early 1970s had severe limitations. Most problematic was the lack of real-time transmission that rendered many intercepts only of historical interest rather than useful for crisis decision-making. This was evident when photos from Corona showed clear evidence of Soviet preparations for an invasion of their Warsaw Pact ally, Czechoslovakia, during the 1968 Prague Spring uprising that threatened to topple the Soviet-controlled government, but the satellite evidence was only available after Soviet tanks crushed the uprising. Similar problems ensued during the 1973 Arab-Israeli war.

Even prior to this, the intelligence community had begun examining the problem. In 1969, the Committee on Imagery Requirements and Exploitation (COMIREX) launched a study looking at the possible benefits of near real-time imagery for crisis decision-making, including the 1962 Cuban Missile Crisis, the 1967 six-day Arab-Israeli war, and the Soviet's 1968 invasion of Czechoslovakia. The findings were promising enough that the CIA's Directorate of Science and Technology (DST) moved ahead with a project to develop just such a near real-time capability, approved by President Richard Nixon.

The first new system to have real-time viewing, transmitted digitally through a charged-coupled device (CCD) to ground stations via relay satellites, was known alternately as KH-11, *Byeman, Kennan, or Crystal*, in the 5500 series. The CCD served as a light-meter, zeroing in on radiated-energy emissions, out of which pictures were created from their amplification. The first product of the system was delivered to President Jimmy Carter the day after his inauguration in 1977. While a leap in technological capability, the real-time transmission of the system could only function between two to four hours a day. Nevertheless, the system was a real improvement, helped too by the use of computers to analyze pictures, which added significantly to the ability to interpret the data retrieved.

The last KH-11 satellite came down in 1996, having been in orbit for over seven years. Already up in orbit were, minimally, two more satellites (advanced KH-11s) capable of infrared and thermal-infrared imagery, as well as an Improved Crystal Metric System (ICMS), which marks imagery so it can be mapped. A new breed of satellites using imaging-radar, first launched in the late 1980s, from the space shuttle *Atlantis* under a program called Indigo, Lacrosse, and Vega in succession, allowed for the penetration of cloud cover which had been a major problem. First designed to monitor the order of battle of Soviet and Warsaw Pact forces, it was later used to monitor Iraq's weapons programs and troop movements.

In July 1990, numerous U.S. satellites were zeroing in on the Iraq-Kuwait border as Iraq's threats against Kuwait escalated. The data from the satellites convinced the CIA and Defense Intelligence Agency (DIA) that an Iraqi invasion of Kuwait was imminent. DSP satellites also played an important role in the U.S. victory over Iraq in Operation DESERT STORM, detecting Scud missiles and their launch location sites.

Commercialization and innovation

The end of superpower confrontation at the end of the 20th century resulted in dramatic transformations to the U.S. and global satellite industry, with vast implications for intelligence. As William Broad of *The New York Times* has noted, President Bill Clinton's administration, in 1994, approved the use of satellite spy technology developed at public expense during the Cold War for private corporations to use for commercial profit. Specifically imagery, at a resolution of under a meter and hence of spy quality, was to be made available for a price to the public and foreign states. The commercialization of this technology was done both to soften the downturn in the aerospace industry in the early 1990s, and from the U.S. desire to challenge foreign rivals in the emerging commercial satellite industry.

Already in the mid-1980s, France had developed the civilian Systeme Pour 1'Observation de la Terre

(SPOT) satellites. The satellites were also useful in espionage and, indeed, they were also used during the Persian Gulf War. The Soviets, also began selling satellite photos in the late 1980s. After the breakup of the Soviet Union, the renewed nation of Russia began, in 1992, to sell even better imagery that gave a glimpse of troop movements, planes, and tanks. By January 1992, excluding the United States and Russia, there were 17 states and five international organizations that owned and operated 77 commercial or civilian communication satellites. Some of this activity came from Europeans pooling resources for space development within the European Space Program.

The new U.S. satellites that came into operation in 1997 allowed, for the first time, private individuals and firms to purchase their product, as the United States joined other countries commercializing this technology. Increasingly, the former monopoly on satellite intelligence, once held exclusively by national governments, was being broken. These developments also allowed governments unable to afford their own systems to benefit from this technology. Still, the U.S. federal government retained the authority to shut the satellites down during crises, in what is called "shutter control," as well as the ability to limit purchases from foreigners, though the strictness of export controls is another matter.

Many of the lead U.S. companies in this new commercial satellite business were the same firms that developed the technology for the federal government in the heyday of the Cold War. The biggest player in the field in the late 1990s was Space Imaging, Inc. (which, in the early 2000s, managed the *Ikonos* satellite), headed by Jeffrey K. Harris, former director of the NRO, which built and managed the government's highly secret satellite programs during the Cold War. The company sold its entire archive of Afghanistan imagery to the National Imagery and Mapping Agency (NIMA). NIMA has since issued Space Imaging, Inc. and Digital Globe, Inc. up to $1 billion in future contracts.

The Chinese connection

In the aftermath of the U.S. decision to jump on the commercial satellite bandwagon, many of these same U.S. companies at the forefront of commercial applications developed anti-satellite weapons to destroy satellites owned by hostile powers during wartime. The issues posed by these new developments erupted into public view in the late 1990s following newspaper reports, and related Congressional investigations, of the easing of national security restrictions on China's ability to launch U.S.-made satellites on Chinese rockets for U.S. companies. In a dramatic decision, which surprised many, the U.S. satellites were taken off the restricted munitions list, something opposed by the Pentagon and many in the U.S. intelligence community.

It has been suggested the decision may have been related to political donations by a Chinese national, Colonel Liu Chaoying, heading up one of China's state military-industrial firms. Liu, the daughter of General Liu Huaquing, the highest-ranking member of the People's Liberation Army, apparently funneled a large amount of funds from Chinese military-intelligence into Democratic Party coffers and President Bill Clinton's campaign for a second term. At the same time, donations from U.S. companies involved in the project, in excess of $1 million, were also going to the Democratic Party.

Another issue at stake during this period was the question of possibly lifting sanctions on China's ability to buy U.S.-made satellites, that had been imposed, in part, due to Chinese missile sales to Pakistan in 1991 and 1993. The Chinese sales were believed to be quite useful in Pakistan's developing a nuclear weapons program. Since the encryption technology in the commercial satellites were similar to that used in U.S. spy satellites, the military and intelligence community feared that such sales could potentially allow hostile powers to gain control over spy satellites.

Battles thus erupted over plans by U.S. corporations to sell well over a half-a-billion dollars in satellite exports to China. China desperately needed the technology, as its own domestically produced satellites, first orbited in the early 1990s, starting going into retirement by the decade's end. At the time, their planned replacements were beset by technical problems rendering them unworkable. One of the major contractors for the proposed sale, Hughes Electronics, the CEO of which headed the president's Export Technology Control Panel, had hired the son of the head of China's military satellite program, Army General Shen Rongjun, as a manager on the project.

The waivers, which were granted by the Clinton administration, followed numerous waivers issued by President George H.W. Bush allowing China to buy U.S. satellites in the early 1990s. This was all made public in various articles in *The New York Times* in May and June 1998.

Satellites in the 2000s

The U.S. and global satellite industry are in rapid flux, with new technological innovations adding increased capability. For example, numerous new U.S. spy satellites now have measurement- and signature-intelligence sensors, designed to focus in on, track, and describe mobile or fixed targets.

In 1993, the CIA and Department of Defense created a Central MASINT Office (CMO) in the Defense Intelligence Agency, subsequently upgraded in 1998 to a quasi-autonomous DIA organization. This was also the year that the Defense Advanced Research Projects Agency (DARPA), the NRO and air force, moved ahead with plans to develop two satellites with synthetic-aperture radar (SAR) and moving-target-indicator (MTI) ability. This is for a planned constellation of 24-48 satellites in all, at 1-meter resolution for imaging of 29,000 square kilometers every hour, able to give the U.S. Air Force an all-weather surveillance capability.

Another innovation in recent U.S. geostationary satellite technology is the development of the Navstar Global Positioning System (GPS) made for nuclear-targeting and navigation, as well as detection of nuclear explosions, in a constellation of 21 operational satellites and three active spares, deployed in six arrays of four satellites. Increasingly, GPS data is also being sold for commercial use in a host of areas, and has entered the consumer satellite-image market.

Countries the United States is sharing or plans to share GPS satellite data with include Russia and Israel, though Israel is also now launching its own satellites. The data will also be shared with NATO allies through the 270 Linked-Operations-Intelligence Center, Europe (LOCE) terminals, servicing the United Kingdom, Canada, Norway, Greece, Belgium, France, and Spain. Data from the U.S. Space-Based Infrared System (SBIRS) High and Low, will go solely to allies cooperating with spaced-based military programs, such as Italy and Germany.

Satellites are becoming ever more integral for a wide range of U.S. foreign policy tasks, including global power projection capability. As warfare and related intelligence becomes more capital-intensive and high-tech, demands for satellites are increasing. As the *Wall Street Journal* has noted, the revival of unmanned spy planes such as Predators and Global Hawks, beaming live pictures of enemy forces, are dependent on bandwidth. Bandwidth refers to the capacity for satellites and related instruments to handle data flows. With financial troubles within the commercial satellite industry in the 2000s, the Pentagon faced a massive shortage of bandwidth.

The military estimated in the 1990s that by 2005 there would be some 1,000 new satellites for the Pentagon to use for weapons dependent on space-based wireless communications, and decided in 1996-97 to lease capacity from the then-burgeoning commercial satellite industry. Yet, of some 675 commercial satellite launches expected in 1998-2002, only 275 actually went into space. In 2000, the Pentagon's Defense Science Board noted that it needed 16 gigabytes per second of bandwidth, the rough equivalent of hundreds of thousands of simultaneous phone calls, if it fought a major conflict in 2010.

The needed bandwidth is growing exponentially, with a single Global Hawk, for example, requiring roughly 500 megabytes, five times more than that used by the entire Pentagon during the Persian Gulf War.

In early 2003, the *Wall Street Journal* also noted the state of U.S. space programs, including the satellites necessary for the U.S. anti-missile system over the continental United States, were in serious trouble. The SBIRS High and Low, critical for this capability, is not expected to be launched into space until 2006-07. In addition, the Advanced Extremely High Frequency Satellite, necessary to process high-speed video data transmission, will not be ready for deployment until 2007-08. The NRO's Future Imagery Architecture spy satellites have also been delayed, as have the new generation of GPS.

There is also the problem of proliferation. Today, firms such as the U.K-based Surrey Satellite Technology (SSTL) are able to make microsatellites weighing as little as 50 kilograms. Missile launchers able to send such satellites into orbit can cost as little as $8 million. Some of SSTL's recent customers include Nigeria, Algeria, and Pakistan. The plunge in prices for such technology now opens up the possibility of terrorist organizations buying and launching their own communications or spy satellites.

SEE ALSO: signals intelligence; communications; surveillance; photography.

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MLA

REIFER, THOMAS EHRLICH. "satellites." *Encyclopedia of Intelligence & Counterintelligence*, Rodney P. Carlisle, Routledge, 1st edition, 2005. *Credo Reference*, https://search.credoreference.com/content/entry/sharpint/satellites/0. Accessed 05 Dec 2017.