Spy Satellites

Is Law Enforcement Use of this Once-Secret Technology

on the Horizon?

Article

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Spy satellites have been used by the military to help keep the United States safe from its enemies for over 40 years. But, could this same technology be used by local law enforcement to help keep citizens safe from criminals?

While law enforcement satellite surveillance may seem far-fetched, there are now American and foreign companies which have lofted high-resolution surveillance satellites into orbit. Images from these satellites are commercially available to consumers of all sorts, including law enforcement. These commercial spy satellites can be tasked to obtain images of just about anywhere on Earth, with the ability to identify objects less than one meter across.

Putting aside the Big Brother aspects of this technology for a moment, it is obvious that law enforcement surveillance satellites could offer real advantages for the prevention and investigation of crime. If ubiquitous real-time, high-resolution satellite surveillance were utilized by law enforcement over major population centers in the United States, street crime would presumably realize a significant downturn because there would always be an eyewitness-in-the-sky. The ability for law enforcement to track vehicles – and potentially people – from space would deter tremendous numbers of street crimes, provide solid investigative leads for crimes which did occur and afford significant advantages for surveillance of suspected criminals. By the use of radar and infrared imaging, satellites could even be effective in darkness and through cloud cover.

Crime control in a free society, however, necessitates a tug-of-war between public order interests and concern for civil liberties. The inherent tension between these societal forces gives balance to the criminal justice system in

America and in other free nations.[1] A practical political system in a free country cannot endure unrestricted expression of civil liberties. Reasonable limitations on some civil liberties must be implemented so that crime can be controlled and public order maintained. Without such limitations, a free society would devolve into anarchy.

In the United States, individual civil liberties are often limited to a reasonable extent for the greater good of the general public. For example, one cannot enter a public airport terminal without consenting to a search of his or her person and items being carried. In this example, the greater good of air travelers to be free from acts of terrorism outweighs the individual freedom of unhampered access to a public airport terminal. Another example of reasonably limiting civil liberties may be found at DUI checkpoints. At such checkpoints, motorists are detained without probable cause for a short time to determine if they are intoxicated. Repeatedly, courts have held that the greater good of the community to have safe motorways takes legal precedence over a brief police detention at a DUI checkpoint.

It is into this dynamic environment that law enforcement use of satellite surveillance technology is emerging. The idea of a Big Brother eye-in-the-sky that is all-seeing, is an obstacle, even to the most strident law and order advocate. Yet, upon further examination, it may be revealed that just as with airport screening and DUI checkpoints, the greater good of the public may outweigh the limiting of some civil liberties through the use of law enforcement satellite surveillance technology. Americans, as evidenced in the post-

September 11th era, are willing to accept wider law enforcement surveillance in an effort to keep the country free from terrorism.[2] The same may also be true when it comes to law enforcement's effort to keep our communities free from street crime.

Historical Perspective

On October 4, 1957, the United States was shocked when the Soviet Union launched the first satellite into orbit. Spuntik I was a small sphere carrying a radio transmitter that beeped a signal for all the world to hear of the supremacy of Soviet technology.[3] Since that time, thousands of satellites have been launched into space.

The history of aerial surveillance goes back to the American Civil War, when Union troops used hot-air balloons to catch glimpses of the Confederate Army over a tree line or a horizon. Most military spying in the First and Second World Wars was done from aircraft flying low, close to the front lines. The era of spy satellites, however, began very soon after the space race started. The first of the United States' series of Keyhole spy satellites were built at the height of the Cold War, beginning in 1960. Corona, the first of these spy satellites, was capable of about two meter spatial resolution.[4] Resolution, as used in this article, refers to the smallest objects discernable in an image produced from a satellite. A satellite photo with two meter resolution could depict objects two meters across or larger.

Only 66 years, less than an average lifetime, took us from the Wright brothers' first airplane flight in 1903, to a walk on the Moon in 1969.[5] But, atmospheric flight and space flight are fundamentally different. While propulsion for atmospheric flight can come from spinning propellers or jet engines, to put a satellite or any other spacecraft into orbit, it takes a rocket. And, even in the present day, rockets are risky business.

The ancient Chinese invented gunpowder, which was the genesis of the rocket. As early as 1212, Chinese armies fired rockets carrying flaming materials into Mongol encampments to start fires.[6] Over the next several hundred years, the art of war shaped the development of rockets into powerful engines which would ultimately lead to putting objects and humankind into space.

Satellite Imaging Overview

To understand how satellites orbit the Earth, it is helpful to imagine the following scenario. A person climbs a very lofty mountain, say 100 kilometers high, and picks up a rock. Assuming, for simplicity, that the Earth is spherical and non-rotating, the person then throws the rock horizontally at a speed of approximately eight kilometers per second – a very fast pitch, indeed. Since gravity is still almost as strong at this altitude as at sea level, this rock tends to fall at much the same rate as one thrown at sea level. In fact, after being in flight for one second, the rock falls about five meters. Clearly, if the Earth were flat the rock would be five meters nearer the surface. But the Earth is nearly spherical, and in a horizontal distance of eight kilometers the Earth beneath also falls away

about five kilometers. So the rock maintains its height above the Earth and becomes a satellite in a very nearly circular orbit at a height of 100 kilometers.[7]

While this simplified example illustrates how an object rotates the earth as a satellite, one must understand that the speed necessary to achieve a horizontal path that doesn't intersect the earth - eight kilometers per second - is over 17,000 miles per hour. And, even today, it is still quite a technological feat to accelerate a spacecraft to this speed.

It was the military development of heavy-lift nuclear tipped missiles that allowed the first satellites to be launched into space. The military advantage of launching satellites into space was immediately recognized by both the U.S. and the Soviet Union. Communications relay, photoreconnaissance, electronic intelligence gathering, weather observing, navigation and warning of missile launches were the military catalyst for satellite launches. Today, a network of military reconnaissance satellites covers the globe.

Most surveillance satellites, the Space Shuttle and the International Space Station are in low earth orbit (LEO) with an orbiting period of approximately 90 minutes. LEO satellites are still within the outer reaches of Earth's atmosphere. At such altitudes they encounter slight air drag so they must be boosted to a higher orbit from time-to-time or they will reenter the denser portions of the atmosphere and eventually burn up.

Satellites in geostationary orbit (GEO) are generally used for communication purposes, broad imaging or for military use in detecting missile launches. GEO satellites' horizontal speed matches the rotation of the Earth, hence they appear

to remain in a fixed position relative to the Earth's surface. Because GEO satellites must have a very high altitude, approximately 22,400 miles, imaging uses for such satellites have been limited to monitoring weather conditions or where lower resolution images are appropriate.

Satellites placed in a polar orbit are very suitable for LEO surveillance imaging as they can orbit at relatively close range yet still see the entire surface of the Earth in a span of days. This is because every time the satellite orbits on a North-South axis, some rotation of the earth has occurred. This means that the satellite will trace a path over the entire surface of the Earth in one or more days due to the earth's rotation.

Until the late 1980s, the United States restricted the resolution capabilities of non-defense satellites to keep sensitive images from falling into enemy hands. In 1988, President Reagan removed those restrictions, and in 1993, the Commerce Department issued EarthWatch, a private commercial surveillance satellite company, a license to build a three meter resolution satellite. In 1994, President Clinton signed Presidential Directive 23, permitting the Commerce Department to license the newest round of one meter and sub-meter commercial satellites.[8]

Commercial Satellite Imaging

The Space Imaging Corporation is a current provider of LEO satellite images. Space Imaging successfully launched their Ikonos satellite on September 24, 1999, the first private one meter resolution photoreconnaissance

satellite to orbit the globe. Space Imaging believes that greater access to this growing collection of visual information will allow for a deeper understanding of the environment, international security, and economic change.[9]

Another commercial satellite image provider is Orbimage. Orbimage is a leading global provider of Earth imagery products and services, with a planned constellation of four digital remote sensing satellites complemented by data from other optical, aerial and radar sources.

Orbimage currently operates the OrbView-1 atmospheric imaging satellite, launched in 1995, the OrbView-2 ocean and land imaging satellite, launched in 1997, and an integrated image receiving, processing and distribution system. Currently under development, Orbimage's OrbView-3 high-resolution satellite will offer one meter panchromatic and four meter multispectral digital imagery. Orbimage is the exclusive United States distributor of imagery from the planned Canadian Radarsat-2 satellite. In addition, Orbimage distributes satellite imagery from the French SPOT Image satellite, Radarsat International and Russia's SPIN-2, two meter satellite program. Orbimage also offers the SeaStar Pro Fisheries Information Service, which provides fish finding maps, derived from OrbView-2, to fishing customers worldwide.[10]

Another major company currently offering commercial satellite images is TerraServer.com. TerraServer.com provides images for commercial or residential real estate, city government, construction or engineering projects via a subscription-based internet website. All imagery can be viewed for free, down to eight meters of resolution, and TerraServer.com subscribers can view high-

resolution images of one or two meters of detail and then purchase the images immediately.[11]

Of special interest to Americans who lived through the Cold War is the Russian corporation Sovinformsputnik. From the time of its founding in 1991, Sovinformsputnik has provided it customers with Russian spy satellite images and Earth surface remote sensing data, not previously allowed for commercial distribution and use. Many of the internet-available satellite pictures of the United States have been taken by Sovinformsputnik satellites.[12]

A final private corporation that this article will detail is DigitalGlobe. After two previous satellite launching failures, DigitalGlobe successfully placed QuickBird, a .61 meter resolution satellite, into orbit in October, 2001. This means that there are now commercially available images with a spatial resolution of approximately two feet. DigitalGlobe hopes to put into orbit a constellation of high-resolution Earth imaging satellites that will offer comprehensive geo-information products. Currently, DigitalGlobe's QuickBird satellite features several technical advantages for providing clear and accurate imagery – highest available resolution; highest collection capacity; highest accuracy; and the largest high-resolution swath width. DigitalGlobe customers can also task QuickBird to collect up-to-date information relevant to their specific requirements.[13]

Law Enforcement Satellite Imaging

Law enforcement application of satellite imaging has already begun. A January 27, 1998, article in the Wall Street Journal chronicled the growing

phenomenon of federal and state law enforcement agencies using NASA and Russian spy photos for prosecution of minor offenses, including building backyard porches without construction permits.[14] In 1997, in Arizona, Floyd Dunn was cited by the Arizona Department of Water Resources for growing cotton on his property without a permit. The Department of Water Resources obtained photographs from the French government's SPOT satellite of 750,000 acres of central Arizona farmland. State officials then compared the images with a database of water-use permits to determine which farmers might be exceeding water-use rules.[15]

Environmental law and building code enforcement are only a small portion of the potential uses of satellite imagery by law enforcement. Because satellite imagery provides a three-dimensional representation of ground features, emergency preparedness can be greatly enhanced. Impediments to the mobilization of public safety resources can be anticipated and alternatives developed in advance of a catastrophe. Search and rescue operations can be improved because of the ability to experience topography, through three-dimensional computer modeling of satellite images, prior to the insertion of rescuers. Planning for police tactical operations can also be enhanced, especially where officers must move through large open areas that cannot be effectively photographed by aircraft.

Putting civil liberties concerns aside for a moment, and taking into consideration the increased use of commercially available satellite imagery by the private sector, it appears reasonable to infer that federal, state and local law

enforcement agencies will increasingly find productive uses for this technology. Accepting this inference, one must then consider whether it is more desirable for these agencies to launch proprietary law enforcement satellites or to become consumers of images from commercial providers.

Considering proprietary law enforcement satellites as an option, and since most surveillance satellites are in low Earth orbit and quickly circumnavigate the globe, the international application of this technology becomes apparent. The cost for development, launch and maintenance of law enforcement satellites could be shared by all of the law enforcement agencies in an international consortium of subscribers. If a law enforcement satellite was launched into a polar orbit, nearly anywhere on Earth could be photographed within a matter of days. If more frequent surveillance of targeted metropolitan areas was desired, satellite orbits could be tailored to pass over several major population centers of the world, and the consortium of law enforcement agencies funding such a project could be limited to these population centers.

Another consideration for proprietary law enforcement satellites is the use of geostationary (GEO) satellites. Currently, commercial GEO satellites are used for communications purposes such as DirecTV and XM Radio. Sea Launch, based in Long Beach CA, is an international company of American, Russian, Ukrainian and Norwegian partners that provides cost effective, heavy-lift launch service for commercial GEO satellite customers and potentially for law enforcement.[16] If imaging advancements allowed GEO satellites to be useful for

law enforcement purposes, a regional, rather than international, consortium of agencies could be formed to bear the associated costs.

The other law enforcement satellite surveillance option is to utilize commercial satellites to provide images as needed. Because commercial satellites are limited in number, the ability of such satellites to meet the varied demands of law enforcement has yet to be determined. But, as the number of commercial satellites increases so, too, will the chances of obtaining archived images crucial to solving crimes. As an example, one might imagine a different outcome in the O.J. Simpson criminal trial if a satellite image of his white Bronco was obtained as it sat parked near his estranged wife's condominium during the time she and her acquaintance were murdered.

Satellite Images as Evidence

As stated earlier in this article, there has been some limited law enforcement use of satellite surveillance images. At the present time, however, there is no definitive statutory or case law regarding use of satellite surveillance images by law enforcement. It is likely that at some point, a satellite image will be proffered as evidence in a criminal case and that defense counsel will file a motion to exclude such evidence based on an assertion that Fourth Amendment protections against unreasonable search and seizure were violated. Whether or not the motion is granted, an appeal will most certainly follow, resulting in landmark case law concerning satellite surveillance images.

The U.S. Supreme Court has ruled that law enforcement use of an infrared imaging device to see heat emanating from a dwelling requires a search warrant for such evidence to be admissible in court.[17] In reasoning this decision, the court held that advancing law enforcement technology cannot be used to erode Fourth Amendment protections. The court went on to say "…just as a thermal imager captures only heat emanating from a house, so also a powerful directional microphone picks up only sound emanating from a house and a satellite capable of scanning from many miles away would pick up only visible light emanating from a house." By this reasoning, it appears that the Supreme Court considers law enforcement use of a high-technology device "…to explore details of a private home that would previously been unknown without physical intrusion…" to be a search, where viewing the same home by the naked eye, even while flying in an aircraft, is not. According to Presiding Justice Paul Turner, California Court of Appeals, the admissibility of satellite surveillance evidence should be similar in nature to evidence obtained from an airplane or helicopter. Justice Turner added "it's difficult to know how the Supreme Court will rule, given the high-tech nature of satellite surveillance. It's clear that high-tech surveillance will be looked at differently by the Supreme Court."[18]

Law Enforcement Satellite Technology Feasibility Assessment

LEO satellites currently provide all of the high-resolution satellite imagery. These satellites balance orbital altitude with increased or decreased spatial resolution of objects on Earth. If a satellite orbits at a higher altitude, it will have

a longer dwell time over a target, but will be farther away, producing lower resolution images. If a satellite orbits at a lower altitude, it will produce higher resolution images, but will move across the sky faster relative to the ground. Current classified military imaging satellites reportedly dip down to as low as 90 miles and have a resolution of 2.5 centimeters.[19] But, such satellites can cost up to $2 billion to put into space. The cost of putting a commercial one meter resolution imaging satellite into space is approximately $110-150 million.[20]

Because imaging satellites are costly, they are generally placed in polar orbits so that one satellite can view the entire Earth in a matter of days. In this way, timely images of a target can be obtained from a single satellite with a return time to the target within days. If two or more satellites are placed in similar orbits, the return time can obviously be shortened commensurately.

GEO satellites, on the other hand have zero orbital speed relative to the surface of the earth. But to achieve this apparent fixed position in space, GEO satellites must be positioned 36,00 kilometers above the surface of the Earth. At this time, and for the foreseeable future, GEO satellites must be positioned far too high to offer one meter or less resolution images.[21]

Absent some technological breakthrough, the cost of putting up sufficient numbers of LEO satellites to offer real-time constant surveillance for law enforcement purposes is prohibitive. And, the prospect of putting up a GEO satellite over a region that would offer resolution sufficient for law enforcement purposes is also not within the realm of possibility.[22] Unfortunately, the state-of-the-art in satellite technology will not provide law enforcement with the ability to

prevent crimes through pervasive satellite imaging nor routinely solve crimes by obtaining evidence from a plethora of frequently updated archived satellite images.

The most likely use of satellite imagery by law enforcement in the foreseeable future will be as subscribers of commercially available imagery. As described earlier in this article, such technology is currently available and has been used in limited law enforcement applications. The most obvious use for this technology would involve enforcement of laws concerning management of resources such as water use, illegal mining operations, farming regulation and in management of ecologically sensitive areas. With the proliferation of illicit methamphetamine super-labs in the Southwest and the widespread cultivation of marijuana crops in the Northwest, infrared and multispectral satellite imaging could also prove useful in the enforcement of narcotics laws.

Another potential law enforcement use for satellite imaging would be for tactical planning and emergency preparedness. While many agencies use aerial photography to scout locations for tactical missions, agencies that do not have this capability could be well served by satellite imaging technology. Also, imaging satellites have the ability to scan large areas with greater detail than is possible using law enforcement aircraft. For this reason, satellite imaging could become valuable for agencies with a large jurisdictional service area.

As commercial satellite image providers increase in numbers, the probability that an archived image would assist in the investigation of a criminal incident also increases. It is likely that private satellite image providers will routinely make

available date, time and location information regarding recently obtained images to federal, state and local law enforcement so that investigators may order images when appropriate for the investigation of unsolved crimes.

Conclusion

To summarize and expand on the information provided in this article the following questions and answers are provided for quick reference and review.

- Is it possible to launch a network of satellites that will give sub-one meter resolution, real-time surveillance capability above a major population center of the United States? Yes, but the cost and limitations of current LEO satellites make this impractical for the foreseeable future.
- If real-time satellite surveillance is possible, can orbits of satellites be designed so that law enforcement agencies in major population centers throughout the world will find it feasible to form consortiums to share the cost of launching and maintaining such networks? An international consortium of law enforcement agencies could put a network of proprietary law enforcement satellites into orbit to serve major population centers. However constant, real-time surveillance of major population centers is not feasible at this time.
- Is geostationary satellite surveillance of benefit to law enforcement agencies? Geostationary satellites would offer resource evaluation, weather prediction, mapping and communications benefits to law

enforcement. It is not feasible at the present time to provide one meter imaging capability from a geostationary satellite.

- Will the law enforcement use of satellite surveillance images be driven by increasing availability and application of this technology by the private sector? Private-sector satellite companies are increasing high-resolution imaging capability. Marketing their products to various corporations as well as to governmental entities and law enforcement presents an opportunity for profit. If their products prove useful to law enforcement increased use will result.
- Does the private sector have the ability to archive satellite images as their satellites regularly pass over a given area? If so, can law enforcement routinely access such images to assist in solving crimes which have already occurred? Archived images are provided by several satellite imagery companies. The timeliness of these archived images will undoubtedly continue to improve as greater imaging capability is achieved. It would appear reasonable to conclude that in the near future, law enforcement will be able to routinely search for images from recent timeframes as a crime solving tool. However, image resolution is directly related to the area being observed – the larger the area, the poorer the resolution.
- Can American law enforcement requisition satellite surveillance images without a court order or other legal process as an adjunct to a criminal investigation? While there is no specific case law on this

point, it appears likely that satellite surveillance images will be treated like surveillance images from other sources (aircraft and ground units). Typically, if an image is to be obtained for the purpose of seeing into the curtilage of a dwelling that cannot be viewed from a public area, a search warrant may be necessary.

- Can satellite surveillance imagery be used to assist with emergency preparedness, warrant service planning and other public safety issues? Yes. Probably the most tangible law enforcement use of satellite imagery is for emergency preparedness, search and rescue, and tactical operation planning purposes. The three-dimensional perspective of satellite imaging is far superior to two dimensional maps, charts or drawings.

The progress of commercial satellite imaging technology is beyond critical mass – it is upon us and driven by free market forces. Like stem cell research and human cloning, the American people will come to terms with the issue of commercial satellite surveillance over the United States – one way or another. And law enforcement use of this technology has just appeared on the horizon.

Police agencies, as consumers of commercial satellite imagery or as part-owners of law enforcement satellite systems, will find myriad uses for this technology. But, will law enforcement application of this technology resemble Big Brother or a friendly neighborhood beat cop? Only time – and technology – will tell.

Endnotes

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[17]*Kyllo v. United States,* 533 U.S. 27, 150, 121 S.Ct. 2038, 150 L.Ed.2d. 94.

[18]Paul Turner, Presiding Justice, California Court of Appeals, Second Appellate District, Division Five, telephone interview by author, Glendale, CA, 15 January, 2002.

[19]Michael A. Dornheim, "FIA Outline Takes Shape," *Aviation Week and Space Technology,* 10 December 2001, 73.

[20]Mark Brender, Executive Director of Government Affairs and Corporate Communications, Space Imaging Company, telephone interview by author, Glendale, CA, 19 December 2001.

[21]Tony Farmer, Deputy Program Leader, Q Division, Lawrence Livermore National Laboratory, telephone interview by author, Glendale, CA 2 January 2002.

[22]Ibid.

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