



**NORTH
RAVEN**
CONSULTING LTD

Leadership in the Remote Sensing Satellite Industry

U.S. Policy & Foreign Competition

By

J. Christian Kessler
NorthRaven Consulting, Ltd.

Prepared for U.S. Department of Commerce
NOAA Satellite & Information Service
Commercial Remote Sensing Licensing Program

Leadership in the Remote Sensing Satellite Industry U.S. Policy & Foreign Competition

Executive Summary

For decades the United States held clear leadership in building and operating remote sensing satellite systems, and it was to the United States that others turned for imagery, for technologies, for capabilities. It is the formal policy of the United States to maintain that leadership. In the last several decades a number of other countries have developed their own independent capabilities, with increasing sophistication, and several now challenge U.S. leadership in many aspects of satellite remote sensing. Any first entrant in a new area of technology must of course expect that others will rapidly seek to follow suit and develop similar capabilities themselves. But is current U.S. policy effective in providing the tools and opportunities for U.S. firms to most effectively strive to maintain U.S. leadership, or are U.S. firms being unduly constrained?

U.S. policy is that the U.S. should maintain leadership, and that U.S. firms should do so on a strictly commercial basis, without subsidies or other special support from the U.S. Government. In doing so, U.S. industry must compete internationally within the context of U.S. security policies to protect key technologies that can also have military applications. And of course, military uses were the primary basis for early development of high resolution satellite remote sensing. Thus one key question is whether the U.S. is properly balancing national security interests in protecting technologies with the national security interest in maintaining international leadership in those technologies.

Many other governments have active programs to develop their own independent capabilities in space, including high resolution remote sensing capabilities. And in many cases those national programs include the objective of leadership in the commercial production and distribution of high resolution remote sensing imagery and imagery products. Thus most of the foreign competition in the satellite remote sensing market is from imagery providers operating satellites built with substantial governmental funding, and in many cases built by domestic firms. U.S. firms providing commercial imagery compete with foreign imagery providers operating satellites built and launched with significant national government subsidies. And U.S. firms that build remote sensing satellites do not have an opportunity to compete to build those satellites.

Interviews with executives in U.S. firms that operate satellites to provide imagery and imagery products on a commercial basis, firms that build remote sensing satellites for domestic and foreign clients, and firms that participate in the launch services industry provide strong evidence that the U.S. Government is not providing effective support and is not in fact actually implementing the enunciated policy of striving to maintain U.S. commercial leadership in all aspects of remote sensing. The main critiques offered by U.S. industry are:

- ✚ U.S. Government agencies remain focused on maintaining their traditional roles and missions, even when that involves new programs that run counter to the purposes of presidential policy. There is no centralized monitoring or coordination of programs that impact the U.S. remote sensing industry.
- ✚ The U.S. is overly protective of capabilities and technologies, with the result that foreign governments and firms develop independently the capabilities that they cannot readily acquire from the U.S. The U.S. treats essentially all components and technologies for remote sensing (and all) satellites as munitions items, and those munitions export controls are applied too stringently.
- ✚ U.S. policy requires that a government-to-government agreement must first be negotiated for the export of a remote sensing satellite or certain key technologies before the U.S. firm(s) can be licensed to export the satellite or key system. However, this formal agreement between the U.S. Government and the purchasing government does not guarantee that the required export license(s) will be issued. Thus the purchasing government faces uncertainty even once it has formally agreed to U.S. legal and policy requirements.
- ✚ U.S. regulations concerning imagery or data dissemination would appear to be more liberal than those of major foreign competitors, which generally control imagery distribution on some form of case-by-case basis, rather than providing blanket authorization for most distribution once the satellite system has been authorized for operation. However, U.S. imagery providers state that they confront a sense among clients that the U.S. is more likely to curtail access at some unforeseen point than are the governments of other imagery providers.
- ✚ The U.S. Government is not a strong and effective advocate of U.S. firms in international competitions. U.S. advocacy is handled largely by the Commerce Department. The State and Defense Departments have the legal authority to permit or stop the proposed U.S. export, and advocacy without assertive roles by the State and Defense Department's can be perceived by the purchasing government as more pro forma than indicative of strong unified U.S. Government support.
- ✚ The priorities for U.S. exports – imagery if possible, if not imagery then satellites delivered on a turn-key basis, and finally the transfer of key components, but not technological knowledge – established in policy make sense to most in industry. However many noted that because foreign governments judge that owning and independently operating their own national reconnaissance systems is necessary for their security interests, U.S. policy does not address the key needs of even close military allies.

In sum, in the view of executives in the U.S. remote sensing related industries, many key practices of the U.S. Government run counter to the stated policy objective of the U.S. Government, and are fostering the developments that policy is intended to minimize.

Leadership in the Remote Sensing Satellite Industry U.S. Policy & Foreign Competition

Introduction

The Soviet Union opened space as a new frontier with the launch of Sputnik in 1957. Caught flat-footed, the United States launched a massive response that included science education programs in elementary and secondary schools, the creation of the National Aeronautics & Space Administration (NASA) in 1958, and a broad range of new space programs. Among these were programs to use satellites to take imagery of the earth, first secretly for national security purposes, but also for scientific and weather prediction purposes. The U.S. launched six scientific satellites in 1958 alone. These efforts led to the Landsat program in 1972. In September 1999 the U.S. firm SpaceImaging (now merged into GeoEye, Inc.) opened high resolution commercial space remote sensing with the launch of Ikonos, providing 1 meter resolution imagery for public sale.

The U.S. efforts to open this “New Frontier” led many other governments to develop their own space and satellite remote sensing capabilities, resulting in extensive cooperation among national space agencies on civil programs, and an increasingly robust competition in the area of commercially distributed earth imagery. Today general opinion among experts is that U.S. national reconnaissance capabilities continue to be superior to those of any other government, but that the gap between the U.S. and others is narrowing. Civil governmental uses of remote sensing data have grown exponentially since Landsat was initiated, and the trend has been away from discrete national programs to multi-national cooperative efforts. U.S. leadership turned into partnership. While these partnerships have leveraged substantial capabilities for all participants, one important issue for the United States is whether we remain a leader in those partnerships. U.S. firms invented commercial remote sensing and continue to operate the most capable and highest resolution electro-optical satellites. The durability of that leadership is in question. Other countries are closing the gap with the U.S. industry on the resolution, quality, and availability of electro-optical imagery. And commercial/governmental partnerships in other countries are now launching and operating synthetic aperture radar (SAR) satellites with equivalent resolutions but superior technical capabilities, while the U.S. has no commercial high resolution SAR system in prospect.

The officially stated policy of the United States Government is to maintain U.S. leadership in all aspects of the commercial remote sensing satellite arena. This report will look at the foreign competition, and will examine whether the actions of the U.S. Government provide effective support to that objective or create impediments to the efforts of U.S. firms to maintain their leadership positions.

U.S. Leadership in Commercial Remote Sensing

Leadership in commercial remote sensing satellites requires leadership in each of three technical areas: satellite building, satellite operation on a commercial basis, and satellite launch services. Leadership implies not only that the remote sensing satellites U.S. firms are operating on a commercial basis are among the most advanced in the world, it also implies that foreign governments and foreign firms utilize satellites built by U.S. firms, or incorporate major subsystems and components from U.S. suppliers in the satellites that they build, and that U.S. launch services are sufficiently competitive with foreign providers to be attractive on a commercial basis. Hence the health of each of these three commercial sectors in the U.S. is important to continued U.S. leadership.

The U.S. Government first established a formal policy concerning support for the commercial remote sensing industry in 1994, in Presidential Decision Directive 23. A decade later the consensus among Federal agencies, the U.S. industry, and outside observers was that this policy was failing in its objectives. On April 23, 2003 the White House announced a new U.S. Commercial Remote Sensing Policy (also known as NSPD-27). That policy identified five goals:

- ◆ Rely to the maximum practical extent on U.S. commercial remote sensing capabilities for filling imagery and geospatial needs for both national security and civil agencies;
- ◆ Focus USG remote sensing space systems on meeting needs that cannot be effectively, affordably, and reliably be satisfied by commercial providers;
- ◆ Develop a long-term, sustainable relationship between the USG and the U.S. commercial remote sensing space industry;
- ◆ Provide a timely and responsive regulatory environment for licensing the operations and exports of commercial remote sensing space systems; and
- ◆ Enable U.S. industry to compete successfully as a provider of remote sensing capabilities for foreign governments and foreign commercial users, while ensuring appropriate measures are implemented to protect national security and foreign policy.

In addition to this policy specifically focused on commercial remote sensing space systems, there are two other policy documents of relevance: the U.S. National Space Policy (August 2006), and the U.S. Space Transportation Policy (January 2005). The National Space policy states that space capabilities are vital to U.S. national interests and that the U.S. “is committed to encouraging and facilitating a growing and entrepreneurial U.S. commercial space sector.” A policy goal is to “Enable a dynamic, globally competitive domestic commercial space sector in order to promote innovation, strengthen U.S. leadership, and protect national security, homeland security, and economic security.” The Space Transportation Policy states the same goals and objectives with respect to that sector.

In practice, the U.S. has sought to establish that leadership through U.S. firms competing for market share and financing on a strictly commercial basis, without governmental

subsidies. And to do so in the context of a regulatory structure that includes stringent export controls on essentially all technologies relevant to the satellites being controlled as munitions items, and in accord with U.S. commitments in the Missile Technology Control Regime and other relevant multilateral commitments.

The fundamental question, and the subject of this report, is whether, especially in the view of U.S. industry leaders, the actions of the U.S. Government do in fact provide a timely and responsive regulatory environment and enable U.S. industry to compete successfully in the international market for remote sensing satellite imagery and for remote sensing space systems purchased by foreign governments and firms.

U.S. Industry's Issues

The nearly universal judgment among U.S. industry executives is that the U.S. industry is falling, or in the case of synthetic aperture radar remote sensing satellites and commercial launch services, has fallen behind the foreign competition, and they ascribe the cause as being that the U.S. Government is overly protective of the capabilities and technologies involved. Several interviewees made the point that in practice the USG is “very focused on preventing bad things from happening, not making good things happen.” Instead of viewing leadership in remote sensing satellite capabilities and technology as a basis for influence and leverage, the U.S. Government views those capabilities as something to be rigorously protected lest others learn too much. And as a consequence, other countries develop the capabilities independently at the expense of U.S. political, security, and commercial advantage. In an effort to protect technology, these commentators say, we create the competitors and foreign capabilities we seek to avoid.

Is the Policy Actually Implemented? The majority of interviewees stated that USG agencies do not in fact implement the formal announced presidential space policies. Instead, each agency implements programs and activities that further its own concept of its specific mission. No central authority in the Executive Branch monitors how individual agencies conduct their programs and responsibilities to ensure that the presidential policies are the basis for agency activity. One industry official commented that “NSPD-27 has all the right words” but that officials in government agencies in effect “shrug their shoulders when it comes to implementation.”

No U.S. agency was exempt from this criticism, but several were flagged in particular. The National Reconnaissance Office (NRO) gained the most comment, perhaps at least in part because of its role in the Defense Department's current internal debates regarding the Broad Area Satellite Imagery Collection (BASIC) program. The BASIC program raises a number of issues with respect to exactly what was intended in NSPD-27, whether that intent is being implemented, and the intended roles of the commercial data providers and the satellite prime contractors respectively. While these issues are complex and in many respects beyond the scope of this short study, it is clear that serious disagreements exist both among defense and intelligence agencies and among sectors of industry as to what is meant by NSPD-27 when it states “Focus USG remote sensing space systems on meeting

needs that cannot be effectively, affordably, and reliably be satisfied by commercial providers.” Many in industry judge that NRO in particular (but not alone among involved agencies) is striving to maintain its traditional role with respect to all national reconnaissance systems, and that the standards being used to evaluate “effectiveness” and “reliability” have been redefined from those intended in NSPD-27.

One commentator noted that NASA continues to purchase and operate remote sensing satellites and then distribute the imagery, in many cases free of charge. As that commentator noted, the national space agencies in most of our major allies partner with their domestic private industry to build satellites that push the boundaries of national capabilities and develop new technologies. These space agencies contribute funds toward development, construction, and launch of the satellite system in exchange for a portion of the imagery. The private sector partner is permitted to own and operate the satellite and sell imagery commercially.

The National Geospatial-Intelligence Agency (NGA) is generally considered the agency most actively pursuing the objectives of current policy, and received plaudits from many for its substantial programs (ClearView and NextView) to procure imagery on a commercial basis from U.S. providers. At the same time, a number of those interviewed noted that NGA’s contracts focus too much on the technical details of how imagery is to be collected – defining specific satellite architecture and operational modes – rather than defining what imagery it requires and permitting innovation by firms in designing the satellite systems. This contracting approach was judged to seriously inhibit innovation by the U.S. industry, both those operating commercial satellites and those building satellites for this market.

Export Controls Another major concern for U.S. commercial firms is export control policies. While Commerce Department “dual-use” controls are a concern, only a few satellite components are subject to Commerce controls. By law, essentially all satellite related components and technologies, and many related services, are controlled as “munitions” items subject to State Department’s International Traffic in Arms Regulations (ITAR). Items commonly used in civil satellites (and other civil applications) are controlled the same way battlefield weapons are controlled. ITAR controls were identified by almost all interviewees in the satellite building and launch services sectors as a substantial impediment to their firms’ ability to compete with foreign counterparts. According to those interviewed, ITAR controls are applied to too many components and technologies that have substantial civil applications. As one interviewee noted, restrictions on sensitive defense materials does not reduce international demand for those items in civil activities, restrictive controls only foster indigenous capabilities that then become competitors with the original U.S. producers. Several noted that the 1999 National Defense Authorization Act amendment transferring all satellite and launch service related items, technologies, and services to ITAR jurisdiction is the primary reason for the current regulatory situation, as it prevents the State Department from being able to acknowledge the degree to which many such technologies and services are today dual-use and vital to many civil space activities (e.g., communications satellites as well as remote sensing satellites), and imposes munitions

related export controls on a broad range of technologies and services treated by many allies in their controls as primarily civil dual-use.

Interviewees noted two additional serious consequences of current ITAR controls, and to a lesser extent, current U.S. visa policies. First, the difficulties and uncertainties foreign satellite manufacturers face when seeking to obtain components and subsystems from U.S. suppliers makes them more inclined to accept a close second best from a foreign vendor; as several commented, we are creating our own competitors. Second, controls on technical discussions and technical cooperation are sufficiently stringent as to make cooperation between U.S. firms and foreign counterparts very difficult, at a time when many believe that the future of the industry lies in multilateral commercial enterprises.

The effects of ITAR on the U.S. space industry more generally were recently examined in a report issued by the Center for Strategic & International Studies. The reader is referred to the “Briefing of the Working Group on the Health of the U.S. Space Industrial Base and the Impact of Export Controls” by Pierre Chao and colleagues.

Government-to-Government Agreement & Layers of Uncertainty Several interviewees noted that for the firms that build and might export remote sensing satellites, the problem is deeper than for other industries subject to ITAR controls. In practice, the market for high resolution remote sensing satellites is foreign governments seeking a national reconnaissance capability (and secondarily, a capability to collect satellite imagery for other governmental purposes, such as disaster assessment and response, environmental monitoring, and land use management). (Quite unlike the situation for communications satellites, commercial firms planning to procure and operate a remote sensing satellite do not seek bids from foreign satellite manufacturers.) When a U.S. firm competes to win the procurement planned by an allied government, that firm cannot receive a license to build and export the satellite until the State Department has negotiated a formal agreement in which the purchasing government makes a number of commitments on a government-to-government basis. Some interviewees expressed the view that the commitments required are too intrusive on the purchasing government’s sovereignty (e.g., “shutter control”). Perhaps more problematic is that even once the foreign government has signed a formal satellite cooperation agreement, the U.S. has not made a commitment that the satellite system will in fact be licensed for export. Authorizing the actual transfer of the system and related capabilities is a separate process, and one that may in some cases entail several licensing procedures, any one of which may be denied in the course of the project. Because a U.S. firm faces these multiple decision nodes in competing with a foreign counterpart, while foreign satellite manufacturers appear to need only one export licensing decision from their governments, these “layers” of uncertainty place the U.S. firm at a competitive disadvantage beyond the well known constraints of the ITAR licensing process.

Imagery Dissemination Policies: The Remote Sensing Land Policy Act of 1992 authorizes the National Oceanic & Atmospheric Administration (NOAA) to regulate the operation of remote sensing satellites by private enterprises and provides that the ability of such a firm to disseminate imagery data and products would be essentially unrestricted

once the imagery was collected. Thus the U.S. Government controls commercial remote satellites primarily by limiting the resolution at which imagery can be collected. For electro-optical imagery, the policy involved one resolution (currently 0.5 meter) for imagery that can be marketed generally and a second resolution (currently 0.25 meter) for imagery that can only be disseminated with specific authorization and to recipients individually authorized by the USG. This is known as the “two-tier” policy. To date, the 0.5 meter control has permitted U.S. imagery providers to collect and distribute imagery at higher resolutions than foreign competitors have been capable of, but this advantage has been a result of technical capabilities in electro-optical imagery as much as deliberate regulatory policy; the technical capabilities of foreign imagery providers is rapidly approaching that of the U.S. firms.

Before a firm can be authorized to disseminate the highest resolution “tier 2” imagery the State Department must first obtain assurances from the foreign government (tier 2 data is only authorized for foreign governments) that the imagery will not be disseminated further without authorization. Several interviewees questioned why these assurances could not be a required part of the commercial contract instead (firms commonly impose contractual limitations on further dissemination of imagery for strictly commercial reasons). Doing so could speed up the contracting and authorization process.

In contrast to the U.S. regulatory approach, other governments have almost universally adopted a different approach to control dissemination of imagery. They have various forms of case-by-case review, or filters that indicate when a case-by-case review is to be initiated. Certain imagery may not be authorized for certain recipients. While one might expect a case-by-case approach to foster greater uncertainty on the part of recipients as to what they might actually be able to obtain, especially in crisis situations, industry officials indicate that the perception is basically that the governments of their foreign competitors are viewed less restrictive. These doubts concerning U.S. reliability stem from legal provisions concerning “shutter control” (the Secretary of State can request that imaging of some area be stopped temporarily for foreign policy reasons, and the Secretary of Defense can request the same for national security reasons), and past requirements for a 24 hour delay in disseminating the highest resolution imagery. Issues concerning direct foreign tasking of the satellite and direct down-link of the data to foreign ground stations, and the prohibition on imaging the territory of Israel at higher resolutions than commercially available from foreign providers (the “Kyl-Bingamen” amendment) may also be involved in shaping these perceptions.

While no U.S. firm currently operates a synthetic aperture radar (SAR) satellite, SAR imagery can provide substantially more kinds of information than can be derived from electro-optical imagery, and is particularly valuable for a range of environmental and maritime applications (e.g., monitoring ice or oil slicks), as well as for military reconnaissance. For this reason U.S. licensing policy would apply more stringent controls on operation and dissemination of SAR data, and in particular on the “phase history data” that are the raw data collected by the satellite and most valuable for interpretation for other than simple pictures. Many in the industry believe that the more restrictive data dissemination policies of the U.S. is one reason no U.S. firm has sought to

enter the SAR market, and that current U.S. policies are substantially out of step with the data available commercially from U.S. allies (see below regarding Canada, Germany, and Italy).

Aggressive Advocacy Many interviewees expressed concern that foreign governments are far more vigorous in their advocacy for their national firms than is the U.S. Government. Several noted that the USG appears reticent to advocate vigorously when two or more U.S. firms are competing for the same contract, or when a U.S. firm is competing as a sub-contractor to a foreign prime, even when the U.S. firm may be providing a key enabling technology (such as the bus or the payload itself). In addition, when the USG does advocate for U.S. firms, the view is that the advocacy comes across as tepid and pro forma in comparison to what other governments do. In part this is due to the fact that the Commerce Department has lead responsibility for commercial advocacy, while the State and Defense Departments are the key decision-makers in permitting the export. When State and Defense do not also advocate for the U.S. firm(s) at senior levels, their absence raises suspicions within the purchasing government that USG support for the U.S. firm is doubtful. In this respect, several of those interviewed opined that the U.S. has done little to press the case of U.S. firms seeking to provide a national reconnaissance capability to the United Arab Emirates. By contrast, it was noted, when Russian President Putin visited Abu Dhabi remote sensing satellite cooperation appeared to be a major item on his agenda and the two countries signed an agreement on cooperation in satellite remote sensing (the text of the reported agreement has not been made public).

Policy Priorities Finally, several interviewees noted that current policy identifies priorities for the U.S. role in the international market. The first preference is that foreign entities purchase imagery and imagery products (data) from U.S. firms. If the foreign entity prefers to operate its own remote sensing system, then the preference is for a U.S. firm to build that system and transfer the complete system on a turn-key basis (i.e., deliver the satellite on orbit). Finally, if the foreign entity is intent on building a satellite system offshore, then the policy acknowledges the need for U.S. firms to be able to sell subsystems and components. The interviewees did not disagree with this ranking of priorities as the most desirable, but several stated that it was an impractical approach to effective competition in the international marketplace, especially with the existing U.S. policies regarding technology transfer. The more a foreign entity sought to obtain a complete satellite system (i.e., satellite, ground station, and training in operation and data analysis) it could operate as needed to meet its specific imagery requirements, the more difficult it becomes for U.S. firms to compete effectively with foreign competitors.

Our Competitors

In considering the ability of U.S. industry to maintain leadership in the remote sensing arena, one must also note the nature of the competition. What are the capabilities of foreign governments and foreign firms? How do other governments support and regulate their roles in high resolution remote sensing activities and in the related industries and

activities necessary for a vigorous and active role? This section will provide snap-shots of the respective programs of other countries that have significant capabilities regarding high remote sensing satellites, or that are otherwise important factors in the international arena.

Canada – has a relatively small but active national space reconnaissance program. Two SAR satellites, RadarSat-1 (1999) and RadarSat-2 (2007) were built and are owned and operated by the Canadian firm MacDonald Dettwiler Associates (MDA). The Canadian Space Agency (CSA) provided 80% of the funding for RadarSat-1 and the associated ground system (launch was provided by U.S. NASA in exchange for imagery). CSA also provided funds toward the construction and launch of RadarSat-2 in exchange for imagery from the satellite. The Canadian Government uses RadarSat imagery for maritime surveillance (homeland security) and national reconnaissance. MDA is authorized to sell imagery and imagery products on a commercial basis under the regulatory control of the Canadian Government. Canada's controls on distribution of RadarSat imagery are based on a bilateral agreement with the United States, concluded in 2000, and on national legislation and regulations brought into force in 2007. The Canadian Government maintains a close and highly cooperative relationship with USG agencies involved in U.S. remote sensing policy. Specified types of imagery products are authorized for distribution to specified customers on the basis of governmentally approved agreements. Canada plans a next generation constellation of three satellites to become operational before end-of-service of RadarSat-2; it appears that this constellation will be built and operated with the same joint public/private arrangement as utilized for RadarSat-1 and -2. Canada does not have the capability to provide satellite launch services.

China – has an aggressive space program that includes a range of remote sensing satellites (both electro-optical and synthetic aperture radar) for national reconnaissance and civil applications, a substantial program of communications satellites, and has the third most advanced man-in-space program (after the U.S. and Russia). China is also actively pursuing business in the commercial space launch market with its Long March booster. China has no privately owned commercial space sector. All China's space programs are under the direct sponsorship and control of the national government. China's civil satellite programs are well known, but public information on China's military (including national reconnaissance) satellite programs is extremely limited. To date China has not made a substantial entrance into the commercial market for satellite imagery, but has taken some preliminary steps in that direction. China is actively cooperating with other governments in civil and scientific remote sensing satellite applications. China has teamed with Brazil to establish the CBERS (China-Brazil Earth Resources Satellite) program, with four satellites currently operating and two additional satellites planned for launch in 2009 and 2011. China launched eight satellites during 2006-2007, and plans to launch ten more during 2008. The two electro-optical satellites in China's planned three satellite Small Multi-Mission Satellite system were successfully launched in September 2008. A SAR satellite is planned to be added in 2009.

France – The launch of SPOT-1 in 1986 established France’s role as a leader in the commercial remote sensing satellite industry. The SPOT (Satellite Pour l’Observation de la Terre) series of electro-optical satellites are owned and operated by SPOT Image, a French corporation created in 1982 as a partnership among the French space agency Centre National d’Études Spatiales (CNES), the French National Geographic Institute IGN, and several French space firms. The SPOT satellites (currently three satellites in operation) are dual-use satellites, providing national reconnaissance capabilities to the French Government as well as providing imagery for SPOT Image to distribute on a commercial basis. SPOT Image’s commercial distribution of imagery is monitored by the French Government and individual transactions deemed sensitive may be subject to governmental review.

As evidenced by the development of the SPOT satellites, France has a well established satellite construction industry, but recently French satellite manufacturers have slowly consolidated with German and Italian competitors as the Western European space/defense industry has sought to compete more effectively with North American firms. Currently the two major French firms are EADS Astrium (a joint French-German firm) and Thales Alenia Space (a joint French-Italian firm). Unlike many of its European Union partners, French export controls treat most components and technologies for satellites, including in particular high resolution remote sensing satellites, as munitions rather than dual-use items. French national policies concerning high resolution remote sensing satellites and capabilities are substantively very similar to those of the U.S. Government.

In 2001 CNES signed an agreement with the Italian Space Agency (ASI) to establish a new program, ORFEO, to fly a constellation of satellites for both civilian and military requirements. France’s contribution will be two electro-optical satellites named Pleiades, and the Italian contribution will be four synthetic aperture radar satellites named COSMO-SkyMed (see below). As with SPOT, other European space agencies will have minority participation in Pleiades (Austria, Belgium, Spain, and Sweden). Pleiades imagery will also be marketed on a commercial basis by SPOT Image. In July 2008 EADS Astrium acquired an 81% holding in SPOT Image, with CNES retaining a minority interest. This acquisition marks a significant transition towards a more commercial, vice government sponsored, remote sensing industry. It put the German imagery provider Info-Terra (Terra-SAR) and the French imagery provider SPOT Image under one corporate umbrella (EADS), although each will continue to operate as an independent firm, providing electro-optical and synthetic aperture radar imagery respectively.

France is a major provider of commercial satellite launch services, operating the Guyana Space Center (CSG) in French Guyana. France’s commercial space launch provider is Arianespace, a commercial firm originally established by the French Government in cooperation with the European Space Agency (ESA). Ten European governments have ownership interests in Arianespace, with France’s CNES holding the largest governmental share; EADS is the major commercial partner. CNES, Arianespace, and

the ESA utilize the Guyana Space Centre, and a recent arrangement with Russia's Soyuz permits launches from CSG using that Russian System.

Germany – Although a relative late-comer to remote sensing satellites, Germany has rapidly become a major player, now operating three remote sensing systems. The constellation of SAR-Lupe synthetic aperture radar national reconnaissance satellites (one launched in 2006, two in 2007, and two more currently planned) is strictly a national reconnaissance system. All imagery is treated as secret and distributed only among national intelligence agencies that are cooperating partners in the program. TerraSAR is a joint enterprise among the German Ministry of Education & Science, the German space agency DLR, which together funded half the program, and the firm EADS Astrium, which funded the other half and built the satellite. TerraSAR-X was launched in 2007, and a tandem satellite is planned, as are one or more additional independently operating TerraSAR satellites. EADS Astrium has the rights to commercial distribution of imagery, which it exercises through a subsidiary, Info-Terra. Germany's third program is RapidEye AG, a privately held commercial firm, which plans to provide comprehensive imagery products and data integration services on a strictly commercial basis, utilizing a constellation of 5 small remote sensing satellites, all of which were launched in August 2008.

The German Government authorizes and regulates the distribution of imagery and imagery products by TerraSAR and RapidEye on the basis of a 2007 law and Federal regulations. Controls are based on an evaluation of the sensitivity of a specific transaction considering the nature of the data to be provided, the location observed, and the recipient. Special cases are subject to review by the German Foreign Office and German Defense Ministry. These agencies maintain a close cooperative relationship with the USG agencies responsible for U.S. remote sensing policy.

Germany has two satellite manufacturing firms. The SAR-Lupe satellites have been built by OHB Systems, while the TerraSAR series of satellites are being by EADS Astrium. (The RapidEye satellites were built by Surrey Satellite of the UK.) Both OHB Systems and EADS Astrium are actively pursuing opportunities to sell SAR satellites outside Germany. All German built satellites are launched by foreign launch providers, as Germany has no national launch services provider.

India – Like China, India has an aggressive national space program that includes the full range of remote sensing and communications satellite applications, a man-in-space program, and an active space launch program that is offering launch services on a commercial basis. Also like China, all India's space programs are sponsored and directed by the national government, through the Indian Space Research Organization (ISRO). ISRO's website claims that "The Indian Remote Sensing (IRS) satellite system has the world's largest constellation of remote sensing satellites in operation today. It provides space-based remote sensing data in a variety of spatial, spectral and temporal resolutions, meeting the needs of many applications. There are six remote sensing satellites in operation - IRS-1C, IRS-1D, IRS-P3, Oceansat-1, Resourcesat-1 and Technology

Experiment Satellite, (TES).” In addition, ISRO is scheduled to launch a synthetic aperture radar satellite, RISAT, in 2008.

The commercial functions of ISRO are conducted through its marketing subsidiary, the Antrix Corporation. These functions include being the sole agent for all foreign sales of imagery from Indian remote sensing satellites and for all sales of foreign remote satellites imagery products within India, as well as being the marketing agent for ISRO’s launch services using its Polar Services Launch Vehicle (PSLV). The PSLV can only launch relatively small, light satellites. ISRO is also developing a much larger launch vehicle, the Geosynchronous Satellite Launch Vehicle (GSLV). In 2006 the first launch with this vehicle failed, resulting in the loss of a domestically built communications satellite, but ISRO Chairman Nair promised a second attempt “within a year.” To date a second launch of the GSLV has not been scheduled. However, India can be expected to become a significant provider of commercial launch services for both small and large satellites, in addition to being a major factor in the operation of remote sensing satellites.

Israel – Working from a small but robust industrial base, Israel has established a position as a significant builder and operator of high resolution remote sensing satellites. Israel operates both electro-optical (Ofek) and synthetic aperture (TECSAR) satellites for national reconnaissance purposes, and the EROS (Earth Resources Observation Satellite) electro-optical satellites for civil purposes, including the commercial sale of imagery. The two current EROS satellites are owned and operated by the firm ImageSat International, which markets imagery on a commercial basis. ImageSat International, a subsidiary of IAI and Elbit Systems, is a private firm registered in the Netherlands Antilles, with headquarters in Cyprus. ImageSat International is unusual in that it offers customers exclusive rights to imagery covering areas specified contractually. Israel’s first synthetic aperture radar satellite, TECSAR, was launched in January 2008 from India. Built as a technology development program, TECSAR is utilized primarily for national reconnaissance purposes. Israel’s satellites have been built by one of two Israeli firms, Israeli Aerospace Industries, Ltd. or Rafael Advanced Defense Systems, Ltd. (formerly a subdivision of the Israeli Defense Ministry, now reorganized as a corporation), some in cooperation with U.S. or other foreign satellite integrators. Israel’s Ofek series of national reconnaissance satellites have been launched using the IAI built Shavit booster, but the capabilities of Shavit are very constrained by the political need to launch westward over the Mediterranean, against the orbital rotation of the earth. Israeli civil satellites have been launched by Russian launch providers.

Italy – operates the COSMO-SkyMed constellation of four (two on orbit, two slated for launch in the next year) synthetic aperture radar satellites as part of the joint French-Italian ORFEO system. The COSMO-SkyMed program is funded by the Italian Ministries of Defense and of Education, Universities, & Scientific Research, and by the Italian Space Agency (ASI). The satellites were built by the joint French-Italian firm Thales Alenia (or its predecessor Alenia-Alcatel prior to acquisition by Thales). The COSMO-SkyMed satellites provide high resolution SAR imagery for Italian & French national reconnaissance, and also provide imagery for civil applications, including commercial sale. Commercial distribution of COSMO-SkyMed imagery, imagery

products, and analytical products will be through e-geos, a joint venture of Telespazio (a Finmeccanica/Thales subsidiary) and ASI, subject to regulatory controls by the Italian Government. Italian data dissemination policies and practices are similar to those of France and Germany. A second Italian firm, Carlo Gavazzi, built the AGILE scientific satellite, which was launched by ISRO in India (with some procedural complications related to U.S. export licensing regulations). Italy has no national launch services provider.

Japan – Separate agencies of the Japanese Government operate remote sensing satellites for national reconnaissance and for civil scientific purposes. Currently high resolution remote sensing satellites are operated only for national reconnaissance purposes, and details of this program are treated as classified national security information. Japan civil agencies operate several sophisticated satellites for scientific missions. Japan has no entity that operates high resolution remote sensing satellites to market imagery on a commercial basis. Japan operates both electro-optical and synthetic aperture radar satellites, and operates the space launch vehicles to place these satellites in orbit itself. Japan relies on Japanese industry (primarily NEC, Toshiba, and Mitsubishi Heavy Industries) to build these satellites and launch vehicles, so that the entire program is essentially domestic, although space-qualified components are purchased from U.S. and other foreign suppliers. Japan does not provide satellite launch services on a commercial basis.

Russia – The Soviet Union was once the closest rival of the United States in many aspects of space, including high resolution national reconnaissance satellites. Soviet space programs fell into serious disrepair immediately following the break-up of the Soviet Union, and for a decade Russia's space capabilities deteriorated. Currently Russia is pursuing a vigorous program to reconstitute those capabilities on a modern technical basis, and in commercial competition with Western counterparts. With one exception, Russia's remote sensing satellite programs are directed, managed, and funded by the Government of the Russian Federation. The exception is the SMOTR (Inspector) series of two electro-optical (operational) and two synthetic aperture radar satellites (to be launched in 2009), built by Energia Space & Rocket Corp. and operated by Gazkom to monitor the status of Russia's extensive oil and gas pipeline system. Russia currently has one high resolution civil satellite, Resurs DK1 (launched in 2006) providing imagery on a commercial basis. Imagery from Resurs DK1 and other remote sensing satellites operated by the Russian Federation is marketed on a commercial basis by SOVZOND JSC, a private firm established in 1992 to provide satellite imagery and related services (SOVZOND also serves as a regional distributor for several foreign systems). Several Russian companies provide satellite launch services on a commercial basis. These Russian companies are collectively second only to France's Arianespace as leaders in the commercial space launch industry.

South Korea – has an aggressive national program to develop the capabilities to build, launch, and operate high resolution satellites. The Korean Aerospace Research Institute (KARI) currently operates two electro-optical satellites (one providing 1.0 meter resolution), a 3 meter resolution synthetic aperture radar satellite is scheduled for launch in the fourth quarter of 2008, and two higher resolution electro-optical (0.7 meter)

satellites are scheduled for launch in 2009 and 2012. Korea utilizes these satellites for national reconnaissance, civil, and commercial purposes. Imagery from KARI's satellites is marketed commercially through SPOT Image (except for the U.S., domestic, and Middle Eastern markets). While Korea is striving to establish a domestic capability to build remote sensing satellites, it still must depend on foreign suppliers for major systems (the KOMPSAT-2 camera was built by an Israeli firm, and EADS Astrium provided substantial design and construction support). Likewise, while developing a domestic space launch capability, KARI has to date utilized foreign launch providers.

Taiwan – Like other major Asia economic powers, Taiwan has an aggressive national space program. Taiwan's National Space Organization (originally National Space Program Office, and still known as NSPO) currently operates two high resolution electro-optical satellites for regional remote sensing for natural disaster and other civil governmental purposes and for ocean surveillance (national security reconnaissance). Taiwan is currently building a third system, Argo, which will be identical to and will supplement the German commercial RapidEye constellation. Taiwan relies on foreign firms to build and launch its satellites.

U.K. – The U.K.'s posture in the satellite remote sensing arena is primarily based on the capabilities of Surrey Satellite Technology Ltd. (SSTL), a privately held commercial spin-off from the University of Surrey. Originally SSTL established a market niche as a manufacturer of small satellites and provider of training in satellite technologies to foreign students as part of the whole program of building inexpensive and relatively simple to operate micro-satellites for national space programs, primarily in the Third World. More recently SSTL's business has evolved as it concentrates on building small high resolution remote sensing satellites using commercial-off-the-shelf (COTS) technologies rather than sophisticated components developed specifically for space applications and hence subject to rigorous national export controls. Development of the proprietary expertise to adapt COTS items for small remote sensing satellites has necessitated a new business model, in which SSTL builds satellites but no longer provides highly specialized training in satellite construction to nationals of the recipient organization. The significance of SSTL for the international market in remote sensing imagery is the wide dissemination of basic collection capabilities in the 2 – 4 meter resolution range, reducing the dependence of many Third World countries, and recently some highly developed countries as well, on the commercial imagery providers. Neither the U.K. Government nor any U.K. firms operate as either imagery providers or launch service providers.

Final Thoughts

The main conclusions to be drawn from these snap-shots are that many national governments, primarily operating through a national space agency:

- ✚ strive to develop a significant national capability in high resolution remote sensing satellite technology,

- ✚ do so either through government programs or through partnerships with domestic commercial firms in which government agencies provide substantial funding and support for the commercial effort,
- ✚ look to domestic firms to develop and build the needed satellites, and
- ✚ these national remote sensing efforts lead to some commercial distribution of high resolution satellite imagery.

These national programs define the competitive environment in which U.S. firms must operate as they strive to maintain U.S. leadership in satellite remote sensing.

Sources

The primary source for the section on U.S. Industry's Issues was interviews, most running from 60 to 90 minutes, with executives in U.S. firms that play a major role in the U.S. remote sensing related industries. Efforts were made to ensure that more than one executive was interviewed in most companies, and that a majority of the firms in any one sector of the industry were represented in the interviews. All interviewees were promised confidentiality, and thus direct quotations are used only when more than one individual used nearly identical words to express a thought or specific permission has been obtained.

Documentary sources include:

the web sites of foreign national government space agencies, the European Space Agency, and of foreign and U.S. firms participating in the remote sensing industry;

Futron's 2008 Space Competitiveness Index: A comparative Analysis of How Countries Invest in and Benefit from Space Industry, The Futron Corporation, 2008;

The Land Remote Sensing Laws & Policies of National Governments: A Global Survey, by The National Center for Remote Sensing, Air, and Space Law (prepared for U.S. Department of Commerce/National Oceanic & Atmospheric Administration's Satellite & Information Service Commercial Remote Sensing Licensing Program), 2007;

United States Commercial Remote Sensing Space Imagery Market Analysis, by M.A. Leon & J.L. Fortune, Economic & Market Analysis Center, Business & Operations Analysis Subdivision, The Aerospace Corporation, prepared for National Oceanic & Atmospheric Administration, Satellite & Information Service, 2006