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Committee on Science, Space, and Technology,
Subcommittee on Space
U.S. House of Representatives

"Commercial Remote Sensing: Facilitating Innovation and Leadership"

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Thank you, Mr. Chairman and Members of the Subcommittee, for providing an opportunity to discuss the important topic of U.S. commercial remote sensing, especially how we can sustain U.S. leadership and facilitate innovation through our policy and decision-making processes. This topic cuts across vital American commercial, economic, and national security interests in many different ways.

Personal Perspective and Experience

The views that I will present today are my own based on more than 20 years of experience with U.S. commercial remote sensing. Briefly, I began to look at this issue back in 1993 for the Director of Central Intelligence to understand the national security equities associated with commercialization, as input to Presidential Decision Directive 23 (March 1994), and again later as the Staff Director of the Independent Commission on the National Imagery and Mapping Agency (1999-2000). During a decade at RAND, I conducted research on the nature of global geospatial markets and international activities. This culminated in a number of reports, such as "Commercial Observation Satellites: at the Leading Edge of Global Transparency" (ASPRS/RAND: 2001) with Mr. John Baker and Dr. Ray Williamson.

In 2011, I co-authored a report for the Department of Commerce that summarized U.S. policy and regulatory history, and postulated alternative futures for the U.S. commercial remote sensing satellite industry. We are in the process of updating that report right now, given the speed of change in the industry and global markets. Finally, I am proud to have been a member and most recently Chairman of the Advisory Committee on Commercial Remote Sensing (ACCRES) which was created by the Secretary of Commerce to advise NOAA on matters related to the U.S. commercial remote sensing industry, including their regulatory responsibilities.

The Current Context

The technology of remote sensing, and related processing, and analysis are changing dynamically. As a direct result, companies like Black Sky Global, DigitalGlobe, Hera Systems, OmniEarth, Terra Bella and others now stand to leverage the cutting edge of the U.S. commercial remote sensing market. Even within a small but growing slate of U.S. licensees, there is remarkable diversity of technical approach, operational concepts, and business models. While U.S. firms have world-class satellite technology, they also benefit from fast-breaking developments in areas like cloud computing, communications, launch, machine learning, advanced analytics and others. Increasingly, they benefit from the interest and participation of venture and private equity capital in the market. And they can also leverage the emergence of a broad, global geospatial ecosystem that includes other capabilities like navigation and geographic information systems. These allow us to understand remote sensing data in the context of readily available and interoperable information sources.

There are some broad trends underway in the market that are important to understand. These are not uniquely American trends, although several U.S. firms are leading the way. For potential vendors, investors, users, and regulators of commercial remote sensing data and information, these trends are occurring across the entire remote sensing value chain. Among the most important are the following:

- *Growing demand for new specialized applications:* The geospatial industry is expanding, with new applications spurring demand for highly precise, unique and timely imagery data, such as radar and additional electro-optical bands (such as hyperspectral). Applications are becoming more and more diverse: they range from consumer-driven, location-based services to companies that are exploiting these unique data sources with advanced analytics of sensed data (e.g. commodities, finance, and insurance). New applications are emerging that leverage both geospatial and temporal precision. Similarly, applications are emerging in support of both government and commercial needs.
- *The rise of analysis*: As with other information sources, the real value lies in the insights we can gain from remotely sensed data, not just the data themselves. This includes not only satellite data, but, increasingly, data from aircraft, drones, and other sources. Almost every U.S. firm has made the leap from being a data collector to becoming an analysis provider. Further, as data users, new firms such as Orbital Insight are creating analytic insights based on any data sources that they can acquire without specifically possessing the satellite infrastructure. It seems that we've gone in a few short years from a worry about data overload to a worry that we don't have enough data to feed models as the basis for sophisticated understanding and decision-making.

- *Increased access by a broader range of participants*: Expanding access to small satellite technology, including constellations of "cubesats," is lowering barriers to entry and enabling experimentation and open system learning with innovative imagery architectures. At the same time, remote sensing industry participants are becoming more diverse. They increasingly include university researchers as well as large, commercial data interests (e.g., Google). Foreign remote sensing systems (e.g., TanDEM-X, ASNARO) continue to be developed and ambitious privately funded systems (e.g., Planet, Terra Bella) are in various stages of development, testing, operations, and flight. The data from these emerging private remote sensing systems are more likely to be integrated into large-scale data mining, analysis and geospatial data operations rather than being standalone entities, as was the case with early U.S. commercial remote sensing firms. Increasingly, the ready availability of open standards from the Open Geospatial Consortium, for example, help to make these data *plug and play*, thereby lowering both cost and time to market.
- *Increased globalization of the space remote sensing market*: There are an increasing number of cooperative partnerships beyond the space programs of the United States, Europe, Russia and China. For example, the United Arab Emirates acquired remote sensing technologies from South Korean companies, Algeria launched its first remote sensing satellite on an Indian space booster, and Vietnam is seeking to acquire a radar satellite and launch from Japan. Similar efforts in other regions are being discussed. This is a global marketplace with many aspects of the remote sensing value chain now available from multiple sources.
- *Changing business models*: The days of selling imagery pixels alone are long gone. The traditional model of selling the single image at high value with only limited regard for the rest has given way to completely different valuations of current, near-real-time, archival, fused and other kinds of information. Satellite providers and other commercial vendors today demonstrate a wide range of products and services. For many commercial providers, the image itself is purely an artifact, just as the phone service user thinks little about a satellite as the means of transmission. Look for rapidly changing business models and investment opportunities in this area. Venture capital is growing in space and geospatial markets as opportunities arise: this is likely to bolster innovation as investors seek improved risk/reward opportunities.[1]
- *Growing importance of non-technical factors*. Ownership of a remote sensing capability – even a small one –is increasingly seen as a matter of national prestige, particularly for emerging space states. This is true even if the bulk government imagery needs are met by commercial or foreign sources. Some states seek to have individual systems with

[1] See, for example, *Space Review*, Jeff Foust, "The Commercial Remote Sensing Boom", published June 16, 2014. Also see Peggy Hollinger, "UK Space Start-ups to Get Boost from Venture Capital Fund" published in *Financial Times*, July 15, 2015.

some local content (e.g., Bolivia, Turkey), while other countries seek to acquire turn-key systems for immediate national needs (e.g., Vietnam, UAE). Some countries are willing to participate in a regional system (e.g., European *Pleiades*) where they share other transnational political ties. Even as we discuss the U.S. regulatory environment, other countries are beginning to promulgate their own, both as a source of cooperation and competition. A number of countries are recognizing the importance of aligning their workforce with these technologies.

At first glance, an observer might think that the situation is optimized for the innovation and leadership that this Committee wishes to discuss today. Some U.S. licensees flying satellites, others in advanced state of development, all of them leveraging a broad slate of new technologies and pursuing unique market segments. However, the exciting developments that I have highlighted here lie atop a more uncertain foundation created, generally, by traditional bureaucratic mindsets, by an outdated statutory and regulatory system, and by deep concerns controlling the tradeoffs between innovation and national security. As in other areas, the speed of technology and innovation is rapidly outpacing the ability to keep up with policy and regulatory developments.

This uncertainty is paradoxical, of course: U.S. policy has been consistently forward looking and bipartisan over the past twenty years – and arguably longer -- and clear on the nation's intent: U.S. policy statements declare that our fundamental goal is "to advance and protect U.S. national security and foreign policy interests by maintaining the nation's leadership in remote sensing space activities, and by sustaining and enhancing the U.S. remote sensing industry."[2] Further, the U.S. government needs to benefit from leveraging, vice solely creating, the kinds of capabilities, information and analysis increasingly available in the market. This is already reflected, for example, in the National Geospatial-Intelligence Agency's Commercial GEOINT Strategy (October 2015) and even NOAA's commercial weather data policy as spotlighted by this committee. Commercial remote sensing developments represent an additional source of experimentation and learning from the space segment to the analytic tradecraft, and should drive new approaches to the government's approach to investment in unique remote sensing capabilities. For many years I have argued that, rather than see government and commercial interests in competition, that they are highly complementary, especially as commercial ventures propose more and more innovative ideas. As in the case of many other information technologies, the government must reformulate its approach and practices if it wants to stay remain on the cutting-edge of these technologies.

[2] The White House, Fact Sheet, "U.S. Commercial Remote Sensing Policy," (April 25, 2003), http://www.nesdis.noaa.gov/CRSRA/files/Commercial%20Remote%20Sensing%20Policy%202003.pdf

On the U.S. Government's Many Role(s) in the Marketplace

The U.S. government plays many different roles in how our nation's commercial remote sensing satellite industry develops. Implementing policy and regulatory functions in a coherent manner is challenging because of these different roles, partly because they sometimes can conflict with each other, and partly because the weight and relevance of them has shifted over time.

In principle, government organizations play multiple roles in any market: customer, patron, regulator, competitor, and advocate[3]. Importantly, the policy framework and government bureaucracy has a critical role in how these are coordinated and implemented. The following is a brief discussion of these distinctive roles within the context of how the U.S. government interacts with the American commercial remote sensing industry.

- *Customer*. The U.S. government is an important customer in the commercial imagery market and can exert a substantial influence on business prospects. For example, through its EnhancedView contract and other activities, the National Geospatial-Intelligence Agency has played a major role in shaping the commercial imaging satellite market for the past several years. As new international capabilities and business models emerge, U.S. government agencies are likely to remain a major customer for any commercial remote sensing satellite data as long as it satisfies identified requirements.

- *Patron*. While U.S. government agencies are naturally a customer, they often cannot only be a casual consumer of the commercial market and hope to fulfill their particular needs. There are times when government agencies need to take a proactive role in understanding, shaping, and adapting market capabilities for their own purposes. This role involves formal business relationships and small investments in order to shape the market, whether based on the need to encourage experimentation, unique capability development, or an analytic process that helps government agencies satisfy mission requirements or anticipate future developments.

- *Regulator*. Given the complex array of U.S. government organizations that have or perceive equities in commercial remote sensing, each has an important role in informing policy and regulatory processes about the impact of any proposed U.S. or foreign satellite capability. The lead responsibility for licensing the operation of U.S. commercial remote sensing satellites belongs to the Secretary of the Commerce and is managed by personnel in the National Environmental Satellite, Data and Information

[3] As adapted from Charles V. Wolf, *Markets or Governments: Choosing Between Imperfect Alternatives*, RAND Corporation, 1993.

Service (NESDIS) of the National Oceanic and Atmospheric Administration (NOAA).[4] In comparison, government decisions concerning exports of U.S. commercial remote sensing satellite systems or technologies are the purview of the U.S. State Department. In either case, the review of licensing or export applications involves a broad interagency process involving relevant experts in the Department of Defense, the intelligence community, and several other government agencies. But the large number of participants in the regulatory process demands efficiency and speed where possible, as well as transparency of process to all.

- *Competitor*. In some less obvious ways, the federal government is involved in activities that compete with the efforts of the commercial remote sensing satellite industry. For example, the U.S. Geological Survey (USGS) has traditionally played a major role in collecting, processing, and disseminating lower-resolution, multispectral imagery data produced by Landsat imaging satellites, which was initially viewed a competing with potential commercial provider of comparable data. Along with ensuring continuity in this important source of Earth observation data for civil purposes, the government viewed the availability of lower-resolution Landsat data to have broader public benefits while helping to develop the satellite remote sensing market.[5] Similarly, at times NGA may compete with the commercial market, consistent with its national security responsibilities to collaborate with allied and friendly government on overhead imagery data and analysis.

- *Advocate*. Finally, in some instances, government agencies have formal responsibilities to serve as an advocate for the commercial remote sensing industry. For example, by congressional statue, the Office of Space Commerce, another NOAA office within the Department of Commerce, is responsible for fostering the conditions for the economic growth and technological advancement of the United States space commerce industry, including the export of space-related goods and services.[6] Similarly, NGA has been assigned the primary responsibility for acquiring and disseminating commercial remote sensing space products and services for meeting the U.S. government's national security or foreign policy requirements.[7]

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[4] The licensing process for U.S. private remote sensing satellites is specifically managed by Commercial Remote Sensing Regulatory Affairs (CRSRA) office within NOAA/NESDIS. http://www.nesdis.noaa.gov/CRSRA/licenseHome.html

[5] John C. Baker, Kevin M. O'Connell, Ray A. Williamson, *Commercial Observation Satellites: At the Leading Edge of Global Transparency*, (RAND Corporation and the American Society for Photogrammetry and Remote Sensing, 2001), pp. 37-51, and 139-146.

[6] U.S. Department of Commerce, "Legal and Departmental Authorities of the Office of Space Commerce," http://www.space.commerce.gov/law/office-of-space-commercialization/

[7] The White House, Fact Sheet, "U.S. Commercial Remote Sensing Policy," (April 25, 2003), p. 5; http://www.nesdis.noaa.gov/CRSRA/files/Commercial%20Remote%20Sensing%20Policy%202003.pdf.

These multiple roles are legitimate, but sometimes conflict, both in fact and appearance. And the number and variation in these roles sometimes creates an unnecessary burden in the process of regulation. Well-cited regulatory delays – such as Planet's delay in orbital slot allocation and Digital Globe's request to use short-wave infrared (SWIR) capabilities in the market – are examples that should be avoided, in order to minimize unnecessary uncertainty for all involved. The pace and process of review highlights and exacerbates the innovator's dilemma: it remains too easy for different elements of the bureaucracy just to say no.

Toward a More Effective Regulatory Environment

Given the focus of this hearing, it is important to address some key aspects of the regulatory environment for U.S. firms. How the regulatory system evolves will weigh heavily on the future of the entire U.S. industry, with attendant positive and negative benefits.

First of all, it has been my impression that NOAA does not apply sufficient resources to this problem. As the number of license requests has grown rapidly over the years, NOAA has been unable to devote additional resources to its regulatory and enforcement responsibilities. For example, based on data NOAA provided in 2015, they have reviewed about 50 license requests and stimulated the need for 22 others over the past six years, compared with approving 26 licenses between fiscal year 1996 through 2010. (That number is probably outdated and on the low side today). This problem is further exacerbated by NOAA's additional responsibilities to shepherd the views of the rest of government within the licensing process. Beyond that, the treatment of space and space commerce issues within the Department of Commerce is fractured across a number of agencies and organizations.

I understand that the President's budget for FY2017 includes a substantial increase in budgetary authority for both NOAA/NESDIS and the Office of Space Commerce. While at least some increase is welcome, there is no guarantee that more resources will be directed at the needed modernization of the regulations with more limited and efficient regulation of U.S. industry. The regulatory regime needs to be modernized to objectively reflect the current market and technology trends from both a substance and a process perspective. Technology often outpaces policy, but in this area our inability to modernize the regulations is triply harmful: it limits the advantage that we can collectively take from innovation, it reinforces conservative thinking, and it drives innovation overseas. Even in traditional slow areas like policy and regulation, we need to recognize that speed is an important market and even national security discriminator.

Why update the regulatory mechanism? Sadly, the current regulations are no more meaningful than the operator's manual for an old car or mobile phone: they don't extend beyond the electro-optical realm, they're out of date in terms of control and leverage mechanisms, and they don't reflect modern ideas about how to shape global markets and thereby enhance U.S. national security. Other than the consolidation of existing statutory authority in 2010, there have not been substantial modifications to the Department of Commerce's authorities in this area for over a decade, during which time novel technologies, operating concepts and unique business models have emerged.

Beyond the substance, any new approaches must include ways to remain agile and responsive in the regulatory process. Any new regulation needs to be objective about what can and should be regulated, not areas that we would like to be able to control but cannot, given the global diffusion of technology. Commercial space products are increasingly embedded in information products, so the practical effects of regulation are muted if not eliminated entirely. Clearly, equities like orbital slots, spectrum and debris mitigation require public scrutiny, but other regulatory mechanisms will not be meaningful in a world of foreign satellites, drones, and other proliferated sensors.

As stated, the U.S. national security establishment now relies more heavily on commercial satellite imagery, expanding the many ways that it is used. That is a very good thing, but only one dimension in an expanding global market. In spending scarce taxpayer dollars in the market, it is natural for government managers to assess risk, although they must do so in the context of fast-paced technology and marketplace nuances.

One of the natural questions that always arises is whether the commercial business models make any sense. Do they close? Will the companies survive? Will they be profitable? This is a legitimate question for anyone in government who is trying to evaluate a business relationship with a commercial remote sensing firm. But government evaluators rarely have the experience and perspective to make that kind of decision. The government should avail itself of an *independent* sense of business risk from organizations more familiar with the business world, like space insurance or the growing number of space finance companies.

Most importantly, as we think about future regulation, the government needs to reorient its thinking around future challenges, and objective realities, instead of looking backwards and fighting old battles. During a panel I moderated at this year's USGIF GEOINT Conference, Deputy Secretary of Defense for Space Policy, Mr. Douglas Loverro, talked about the primacy of U.S. government thinking and writing about commercial remote sensing as a source of risk, with the need to balance incentive for commercial success

against national security risk[8]. Twenty years of history have not borne out that risk, especially given the unprecedented cooperation of industry when the U.S. government provides clear details about national security concerns in in both space and time, for as limited a time as possible.

Rethinking Security Issues

Remote sensing has a rich and storied history with the security of our nation. The extraordinary legacy of remote sensing in U.S. national security history sometimes clouds our thinking about how to advance U.S. leadership through successful commercial remote sensing, in part by re-thinking its security basis. Let me illustrate a few key areas.

First, and most important, we need to continue to attract top talent and investment to U.S. firms and the U.S. government. Under a reasonable, functioning regulatory structure, the United States can continue to shape global developments through technical innovation, new business processes and by encouraging new applications. In the process, industry is incentivized to pursue new concepts, which serve both as a source of leverage and experimentation in a cutting edge area. Failure to adapt our mindset, especially given the global nature of commercial remote sensing, will push U.S. offshore to more welcome environments. That will be a tactical victory for the bureaucracy, and, ultimately, a strategic failure for U.S. policy aims and the nation.

Second, we tend to look at enhancing security through the traditional lens, value and practice of imagery analysis, not the diverse slate of capabilities, operating concepts and business models that characterize remote sensing today. We have to think about information as a broader shaping mechanism within our national security toolkit, not only as individual inputs to national security decision-making. This happens through the increasing understanding of developments on our planet – including humanitarian relief, technical assessment, and other areas – as well as the sharing of that information in both government and commercial contexts. There is a unique value to transparency that these data and analysis can provide to frame, or even resolve, complex national security issues. While the canonical "killer app" for commercial imagery has not yet emerged, perhaps that app is more broadly defined as the need to understand a wide range of economic, environmental and security developments on the earth.

Third, at a time when we are increasingly concerned about space security, the national security establishment benefits from the resilience created by a robust and global

[8] Warren Ferster, "Regulation: A Double-Edged Sword – Panel Concludes Restrictions on Remote Sensing Activities Are Not Without Risk." Trajectory Magazine (United States Geospatial Foundation, May 17, 2016). http://trajectorymagazine.com/got-geoint/item/2185-regulation-a-double-edged-sword.

commercial market. U.S. and Allied firms become a complementary source to government systems, and global reliance on the information provided from commercial systems genuinely redefines the strategic environment for space. The recently released National Academy of Sciences study "National Security Space Defense and Protection"[9] (Summer 2016) highlights the many human activities that are dependent on space systems, including the need for updated policies to strengthen mission assurance in a space environment that is increasingly congested, contested, and competitive, and in a world where foreign counter space activities are growing.

Finally, even within our U.S. national security domain, we need to learn to live in a much more transparent world. When we wrote "Commercial Observation Satellites," over 15 years ago, we highlighted the new and unprecedented insights that many different actors – not just military and intelligence organizations -- would have from emerging information capabilities like commercial remote sensing and other advanced information sources, like location-based services and cloud computing, and thereby challenging traditional approaches to creating decision advantage.

This is a very big issue. We need to update our thinking about how to protect U.S. troops, facilities and operations in this increasingly transparent world, not fixate on information control as a source of security. In fact, unless commercial remote sensing or other types of information uniquely contribute to an adversary understanding, the risk that of limiting U.S. industry's participation in the market both harms industry and potentially creates greater danger by creating a false sense of security in a world with a multitude of complementary and substitute information sources. Of course, the U.S. government should and will always retain that option for circumstances of dire national security emergency.

Closing Remarks

In spite of the challenges mentioned here, the nation still holds a leadership position and a strategic advantage in commercial remote sensing, and a bipartisan policy to encourage it. Activity is taking place at an accelerated pace, given technology and market developments, including the leveraging of other fast-breaking technologies in an expanding geospatial ecosystem.

The 20-year modern history of U.S. commercial remote sensing tells us how and how not to proceed going forward. (As an aside, they are also illustrative to a whole variety of other

[9] National Academy of Sciences, Engineering, and Medicine, *National Security Space Defense and Protection: Public Report* (Washington, D.C.: The National Academies Press, 2016). Access at https://www.nap.edu/catalog/23594/national-security-space-defense-and-protection-public-report.

emerging commercial space areas, like space situational awareness (SSA), debris mitigation, weather, and others). U.S. policy and regulatory mechanisms need to be updated for the current technology and market factors, and even anticipate newer developments with an eye toward efficient and objective regulation and incentive creation for U.S. industry. The nation as a whole benefits from this.

As I see it, especially given our lead role in the idea of commercialization over the past twenty years, and beyond, the only long-term strategy is offense. Being defensive and apprehensive about the bold developments cited here only cedes advantage to U.S. competitors. A renewed U.S. vision is required that is then reflected in agile policy and regulation. To fail at this, including by inaction and indecision, will result in strategic failure. We can and must do better.

Thank you for your attention. I am prepared to answer any questions that you might have.