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CENTER FOR INTERNATIONAL SCIENCE AND TECHNOLOGY POLICY

ELLIOTT SCHOOL OF INTERNATIONAL AFFAIRS

Strategy for a Modern Russian Remote Sensing Industry

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Executive Summary

This paper proposes how the Russian United Rocket and Space Corporation (URSC) can expand and refine its presence in the field of satellite remote sensing. Satellite remote sensing is an aspect of the space industry that has moved beyond purely governmental military and intelligence purposes toward supporting other economic sectors and industries. With the development of more refined data analysis and information technology, remote sensing is shifting towards building various applications analyzing information gathered in space for smarter governing of assets on Earth. The distribution of remote sensing capabilities across nations is skewed, and the cost of developing satellites and imagery analysis forces international cooperation among the emerging space powers.

Despite its historic status as a major space power, Russia represents only a small share of the global remote sensing market through URSC. The key obstacle to improving the Russian position in the international Earth observation market is a lack of a defined and distinct remote sensing strategy with measurable mechanisms for implementation. This policy paper focuses on addressing three primary challenges faced by the United Rocket and Space Corporation: industry structure in the global market, finding clientele domestically and abroad, and nurturing skills for business development and commercialization. By partnering with universities, industry, and local municipalities, the URSC can position itself more strategically in the global remote sensing market.

Remote Sensing: An Overview

Satellite remote sensing was initially developed as a military endeavor during the Cold War as a means of spying on adversaries. Today, Earth observation satellites have a broader range of function that includes both science and commercial as well as military purposes. The development of space-based Earth observation capabilities has inevitably created numerous policy questions. For example, the development of commercial remote sensing technologies has blurred the previously distinct line between military and civilian space capabilities. Nations and corporations alike can now launch satellites to take images of anywhere on Earth. Commercially, the advancements in remote sensing technologies open a wide range of opportunities in many economic sectors, a small sampling of which includes forestry, fishing, conservation, agriculture, planning and construction, mining, and regional governance.

The Earth observation market is a considerable part of the space economy with about $2.3 bln in revenue out of $122.58 bln in total revenue for all commercial space products and services (2014 data).[1] According to the 2014 annual report sponsored by the Satellite Industry Association (SIA), remote sensing accounted for 13% of the operational satellites worldwide out of about 1200 total on orbit.[2] This industry is expected to nearly triple in the next decade (up to $6 bln by 2022).[3] Despite the growing number of various commercial remote sensing companies, the industry is largely concentrated in a small number of firms. The market leader, DigitalGlobe, accounts for 60% of the global market.[4] Together, the three largest firms serve 78% of the world market. By contrast, Russia has a very small position in the world remote sensing market, accounting for only 0.2% of the market share.[5]

Technology trends

Due to technological advances, remote sensing service providers have been able to provide services that offer a more nuanced view of Earth resources with higher levels of detail and lower costs. These changes stem from the introduction of new technologies that are more sensitive, higher in resolution, and lower in volume and weight. Growth in the hardware capability of remote sensing has subsequently led to a newer trend in software development for utilizing remote sensing information. Currently, the remote sensing industry's most promising area of growth and innovation is in the development

[1] The Space Report: The Authoritative Guide to Global Space Activity (p. 26). (2014). Space Foundation.
[2] State of the Satellite Industry Report 2014. (p. 7). (2014, September 1). Retrieved May 7, 2015, from http://www.sia.org/wp-content/uploads/2014/09/SSIR-September-2014-Update.pdf
[3] Ibid, p. 35
[4] Satellite-Based Earth Observation (EO): The Leading Analysis of EO Vertical Markets Across all Regions (5th ed.). (2013). Northern Sky Research.
[5] Operating Satellites, Remote Sensing Satellites. (2013). Earth from Space, 150-1. Retrieved May 7, 2015, from http://www.zikj.ru/images/archive/no17/zik17.pdf

of software tools and "value-added" applications using remote sensing data.[6]

Hardware

Over the past 50 years, remote sensing satellites have trended toward detecting objects with increasingly fine resolution while the satellites themselves have been shrinking. DigitalGlobe anticipates sales of imagery at up to 25 cm panchromatic and 1.0 m multispectral ground sampling distance (GSD) from WorldView-3.[7] American corporations Skybox and Planet Labs produce and launch miniaturized satellites for Earth observation. Planet Labs placed 73 "smallsats" (30x10x10 cm with 3-5 m resolution) in orbit in under two years. Skybox, with the help of a student-founded company from Stanford, developed a miniature satellite system called "SkySats" that offers imagery with less than 1 m resolution. Skybox has since been acquired by Google and its technology will be used to support Google's mission as well as provide data for nonprofit organizations in the Google for Good program.[8] By producing and deploying satellites in this way, both companies have been able to substantially reduce the cost of launching and keeping satellites in orbit as well as development times.

Software

The expansion of the remote sensing industry has lead toward current trends in developing software-based "value-added" applications and are changing remote sensing in a number of key ways. By enhancing the utility of existing remote sensing systems, data is being combined and refined in innovative ways. Remote sensing sensors and platforms placed in orbit years ago, with the aid of modern computing, are being enhanced to produce valuable data. For example, in 2013, researcher Antonio Tomaselli published a method for utilizing low-cost digital camera technology that used automated calibration software to combine multiple images to generate synthetic ones.[9] Additionally, with the influx of remote sensing information over the past few years, researchers are able to analyze large volumes of data to discover trends and relationships. This involves using multiple techniques in big data analysis such as pattern recognition and data mining. Finally, remote sensing applications are able to distribute information via the internet allowing for quick access and the ability to combine with other forms of data.

There is high demand for products and services at the cross-section of IT and space industry that utilize data mining software to create automated imagery analysis.

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[6] Weeden, B. (2015, February 19). [Interview].

[7] Imagery Completeness. Retrieved May 6, 2015, from https://www.digitalglobe.com/imagery-completeness

[8] Google's New Skybox for Good PRogram Gives Real Time Satellite Imagery to Nonprofits. (2014). Techcrunch. Retrieved from http://techcrunch.com/2014/10/25/googles-new-skybox-for-good-program-gives-real-time-satellite-imagery-to-non-profits/

[9] Tommaselli, A.M.G.; Galo, M.; de Moraes, M.V.A.; Marcato Jr., J.; Caldeira, C.R.T.; Lopes, R.F. Generating virtual images from oblique frames. Remote Sens. 2013, 5, 1875–1893.

These products and services also utilize cloud-based architectures for storing information and distributing information. The key is to develop capabilities for re-processing and analyzing the information based on the customer's needs: one example here is OmniEarth, a US private company that is developing "smart systems" that can be used by businesses and governments.

Industry Structure and Markets

Commercialization efforts: US example

Commercialization of the remote sensing industry has brought new and unforeseen functionality to remote sensing equipment and data. The added functionality in many instances was a supplement added to existing infrastructure, developed with a focus on a specific objective or set of objectives for gathering information.[10] Recognizing the effects of commercialization and the new ways to use and gather data, future systems development should incorporate this type of activity in order to make modifications to a system easier and more relevant.

The White House Office of Science and Technology Policy released a set of guidelines for remote sensing in the National Strategy for Civil Earth Observations, which brought attention to the role of independent technologies in influencing remote sensing. The remote sensing sector is simultaneously stimulated by existing and developing technologies ("observing systems") as well as specific needs for a particular "Social Benefit Area" (twelve are listed, including climate, disaster management, energy, and mineral resources).

There are more than 100 American remote sensing programs in operation as of 2015. Most are controlled by Federal agencies. However, a growing number of these remote sensing activities are conducted by private entities that are not part of the government; rather "under the purview of Federal agencies and non-Federal entities that produce and use Earth-observation data".[11] The key principle the U.S. government applies to stimulate the commercialization of space activities in the Earth-observation segment is the issuing of licenses that are used to regulate the "back-end" – data collectors, while the front end – service providers are less restricted in their activities. Essentially, it divides the industry between data collectors and service providers. Data collectors face stricter rules due to address national security concerns with remote sensing imagery and because they operate within the legal domain of the space industry. Service providers on the other hand are loosely regulated to encourage growth of commercialization.[12] Establishing policy in this way has helped develop the remote sensing sector and addressed some of the major concerns over that hurt earlier attempts at promoting commercialization.

The Russian government identified the commercial opportunities for remote sensing in the early 1990s. During this time Russia started selling imagery from its military satellites. However, as American and European private enterprises began amassing significant portions of the market, Russia has not kept up with this growth in

[10] White House Office of Science and Technology Policy (2013). National Strategy for Civil Earth Observations.Retrieved April 15, 2015:While Earth observations are typically produced for a specific purpose, they are often found to be useful for additional purposes not foreseen during the development of the observation system.
[11] Ibid.
[12] Nesdis.noaa.gov,. 'NOAA CRSRA Licensing'. N.p., 2015. Web. 5 May 2015.

technological capability or market integration as the major commercial players have.

Collaboration with other sectors: IT business mindset

As was mentioned in the earlier sections, the IT sector is shaping the remote sensing industry. In doing so, it is also changing the management structure of remote sensing business and mindset of leaders in the field. Value-added applications have brought new ways to use remote sensing data and competition beyond just providing imagery itself. Analysis of the information and how it cause be used is now a part of the market structure. This is in addition to the market demands for data to be delivered quickler, cheaper, and at competitive imagery resolution (sometimes satisfying a particular niche). The success of American businesses in this market can be partially explained by the rapid growth of the IT industry alongside the remote sensing industry.

International collaboration

By the end of 1997, the United States had arranged to cooperate with 76 countries and six multinational organizations for Earth observation activities primarily concerned with weather.[13] Smaller countries have also realized the value and made especially good use of collaboration. Such countries tend to be emerging space powers and those that do not have a significant share of the global Earth observation market. They are not able to bear the cost of full-fledged remote sensing programs, despite its value for the overall economy.[14]

A notable instance of cooperation between developing space powers is the China-Brazil CBERS program.[15] [16] The China-Brazil cooperation dates back to the late 1980s-1990s when both countries independently considered developing national Earth observation systems. CBERS launched a single multi-purpose satellite in December 2014 for the purpose of monitoring land, forestry and agriculture monitoring.[17]

Experts disagree about the motives behind this program. Some claim that it was initiated to increase China's influence in Latin America.[18] Others claim that it is a joint research effort aimed at tackling a task jointly that was never achieved by either of the

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[13] Wagner, Caroline S. (1998). International Agreements on Cooperation in Remote Sensing and Earth Observation. Santa Monica, CA: RAND Corporation, 1998. Retrieved May 8, 2015, from http://www.rand.org/pubs/monograph_reports/MR972.

[14] Bailey, G., Lauer, D., & Carneggie, D. (2011). International collaboration: The cornerstone of satellite land remote sensing in the 21st century. Space Policy, 161-169.

[15] EIAST: The United Arab Emirates Space Program. (2014, October 13). Retrieved May 7, 2015, from http://www.spacesafetymagazine.com/space-on-earth/national-space-programs/eiast-uae-space-program/

[16] Hereher, M. (2012). Land Cover Classification of Hail—Saudi Arabia Using Remote Sensing. International Journal of Geosciences, 349-356.

[17] China launches Multi-purpose Satellite. (2014, December 7). Retrieved May 7, 2015, from http://economictimes.indiatimes.com/news/science/china-launches-multi-purpose-satellite/articleshow/45402315.cms

[18] Delgado Lopez, L. (2015, February 20). [Telephone interview].

two parties.[19] No matter the nature of the political motivation, the program has been successful for remote sensing activity. Similar programs, especially within developing countries, may be an important tool for advancing domestic industry.

[19] Uzinsky, I. (2015, March 13). [Interview].

Policy Background

Despite its status as a major space power, Russia holds a weak position in remote sensing with only 0.2% of the global remote sensing market. Several factors have prevented Russia's growth in this area. A few of these factors have persisted since the 1990s with little change. These factors include a lack of necessary skills, limited access to operate in the private market, and a lack of demand for remote sensing services. These are areas that need to be addressed in order to improve the Russian position in the remote sensing industry.

Additionally, the Russian government has done little to support remote sensing. The government has generally viewed the space industry as a means for reaching a destination rather than as an institution that could support an industry. As a result, it has not developed a mature policy for remote sensing as an independent and worthwhile tool.

The Russian Federal Space Agency (Roscosmos) plays the primary role in defining the overall national space strategy and policies. Roscosmos was also responsible for the oversight, funding and management of the space industry production facilities which, after coming under criticism, split into a separate entity.[20] The Russian United Rocket and Space Corporation was created to take control over the industrial aspects of the national space program.

The United Rocket and Space Corporation is a state owned enterprise, which means that the state has a predominant position in ownership and also in resource allocation and operation control, limited market competition, and hierarchical structure. The key goal was to consolidate and facilitate the advancement of the space industry. It is overseeing all the key industrial facilities: 10 integrated structures consisting of 48 enterprises as well as 14 independent facilities both joint stock companies and government owned ones. This list includes the largest space industry producers - RKK Energiya, TsSKB-Progress and others. Remote sensing is one of the sectors under URSC purview.

However, the URSC is soon merging again with Roscosmos as decided by President Vladimir Putin. Due to unclear reasoning and lack of transparency in the decision-making process, this merger increases the level of uncertainty across the industry. At the same time, the key characteristics of those implementing the policy in remote sensing sector are quite clear.

Currently, the civilian remote sensing fleet in Russia is comprised of 7 satellites: 2 "Resurs-P", 1 "Resurs-DK", 1 "Kanopus-B", 2 "Meteor-M", 1 "Electro-L". These are different satellites which were originally developed for various economic purposes and,

[20] Zhukov, S. (2015, March 9). [Internet interview].

therefore, overseen by various agencies. Now the URSC is trying to integrate the existing satellite fleet into one efficient system.

Despite the high level of centralization within the remote sensing industry in Russia, there are several independent players. Skolkovo Innovation Center is perhaps the most noteworthy player involved in technological innovation. This is a government initiative oriented at modernizing the industry (including remote sensing) and building strong commercialization institutions. It started as a Skolkovo Foundation that provides support for start-ups and technology designers divided into five main clusters, with space being one of them. Skolkovo's space cluster is attempting to stimulate the development of commercial space and remote sensing technologies through partnerships with industry at home and abroad as well as universities across the nation. Among the residents of the Skolkovo space cluster are remote sensing companies; the most considerable players would be Scanex (remote sensing applications and data analytics) and Dauria Aerospace (a manufacturer of remote sensing satellites).

Problems facing the industry

Given the landscape, the key problems of the Russian remote sensing industry fall into three main groups: lack of skills, an underdeveloped market, and a shortage of clients. First, the industry lacks skills necessary to build the competitive products and services mostly in the sphere of commercialization, interdisciplinary interactions, and business development. Second, the structure of the industry has limited the development of the market. Third, the Russian remote sensing industry's products and services are lacking in demand both domestically and internationally. These three groups of problems are interconnected, thus change in any of these areas affects the others.

Shortage of skills

The Russian remote sensing sector currently lacks specialists and other highly skilled individuals specific to the field of remote sensing. This lack of skills is exacerbated by an industry that is weak, fragmented, and without incentives for workers to obtain and improve their skills. Without a skilled and specialized workforce, the industry struggles to develop new technology in this field. Russia has attempted to remedy this in recent years with initiatives such as the Skolkovo project, but progress is slow and there are few other programs in place to address the skills drought.

While the US began to adjust its strategy to incorporate the growing remote sensing commercialization in the 1980s, Russia did not implement an active strategy for developing private sector remote sensing companies. Even following the dissolution of the Soviet Union, the country did very little to promote the industry. Many remote

sensing companies purposely tried to develop an independent strategy without any reliance on the state but found little institutional support.[21] Because of a lack of strong government guidance, the Russian remote sensing industry is still lagging behind in business development and technology commercialization as compared to the today's market leaders.

Industry structure and market formation

Due to the industry structure inherited from the Soviet Union, space industry is generally isolated from other sectors of the economy. Military space is isolated from the public sector and the space industry has little interaction with other economic sectors. This is especially harmful for remote sensing as is in essence a service industry.

This degree of isolation is troublesome because it limits technological development and innovation. In remote sensing, technological advancements worldwide are occurring at the intersection of the information technology and space industries. At this intersection, companies create new remote sensing applications by combining software, computing and satellite technologies. In Russia, the major institutions only consider the satellite fleet when they discuss the development of remote sensing. This discussion rarely considers the influence of information technology and is rarely concerned with the integration of sensor technology with practical applications.

The public is also harmed by the divisiveness of remote sensing from the rest of the economy as only low quality remote-sensing satellite data is generally accessible. Even though Russia has improved some services, such as the Resurs-P satellites, remote sensing is generally left to itself and thus struggles to improve.

The isolation has also led to a lack of competition in the remote sensing industry. The state actors, satellite manufacturers, producers of remote sensing applications, and the end users do not communicate that encourages competition, nor do they likely realize the potential for a competitive market. As a result, applications companies, including the market leaders, are unable to get data from national satellites, thus they have to rely mostly on the data from foreign satellites (even for the pictures of the Russian territory) – overall, Russia purchases up to 95% of its images.[22]

[21] Gershenzon, V. (2015, March 17). [Interview].
[22] Operating Satellites, Remote Sensing Satellites. (2013). Earth from Space, 150-1. Retrieved May 7, 2015, from http://www.zikj.ru/images/archive/no17/zik17.pdf

Diversifying clients

Functionally: narrow usage

According to a study conducted in 2009,[23] the Russian economy has not utilized remote sensing in as many facets as the United States or European Union. In Russia, it is used for three main purposes: weather forecasting, preventing and responding to forest fires, and responding to river floods. In the United States, remote sensing data is applied in a broader range of functions, to include construction and planning, disaster forecasting and response, regional development, exploration and extraction of natural resources, and ecological management. In the current Russian policy, satellites are supposed to be used for a larger range of purposes. Individual satellites are assigned to a larger number of ministries. Each ministry is supposed to have access to a certain amount of data from each satellite and be able to use it for its own purpose. This policy has only a limited effect, however. Many ministries make little to no use of their satellite data. The situation is worse in the private economy, where there seems to be little demand and where the data and services are not integrated into the economy.

Geographically: no clear international strategy

While many countries define their priorities for building alliances in regional terms, partnerships are now being formed beyond typical regional lines in favor of strategic goals, such as the CBERS program outlined previously. Entities involved in the global remote sensing market are looking to define a niche in the international market both geographically and functionally. Russia so far has not looked beyond the area of the Commonwealth of Independent States (CIS) in its international strategy. Because it lacks a global strategy, especially in the context of globalization and increasing demand in remote sensing technologies among small and medium space powers, Russia is in danger of falling further behind in its market standing.

Forces to address

Russia's United Rocket and Space Corporation as well as the national space industry as a whole are under reform. These reforms are aimed at altering the aging industrial complex and introducing new schemes of doing business. For remote sensing, this mostly means the intent to develop commercialization mechanisms and market the new technologies.

However, the unclear industry structure, lack of long-term vision, and the ongoing reforms increase the level of uncertainty for the policy makers and potential businessmen and scientists as the decision-making is performed within the "top-down"

[23] Lavrov, V.N. (2009, December). Analytical review of space remote sensing programs of Russia and foreign countries. Retrieved from https://innoter.com/scientific-articles/1092

approach. Although institutional resistance to change is to be expected, implementing some degree of defined strategy is necessary to combat the isolation currently stifling growth in the Russian remote sensing market.

Past proposals

The Russian government has attempted to reform the space industry and remote sensing sector in the past with limited success. It is still searching for effective mechanisms to ensure the competitiveness of the Russian space sector.

Russia took a substantial step to attempt to improve the space industry in 2014. It adopted a roadmap entitled "Foundations of the state policy in the sphere of using the results of space activities in the interests of Russia's economy modernization and regional development up to 2030." This document argued that integration of the space industry into other economic sectors was a necessary step to expand the industry. It discusses how to use the experience and products of the space industry for regional development. Though it is a useful step, the report is limited to describing broad, high-level goals. It does not identify the areas into which technology coming from the space industry can be integrated nor does it provide examples of exact mechanisms or metrics for quantifiable results.

The Russian government has also created an integrated complex for receiving, processing, and distributing data from remote sensing satellites. This complex, created in 2010, is a unified territorial system for remote sensing data (ЕТРИС ДЗЗ in Russian). This complex differs from others in several ways. Perhaps the most important difference is that Russia owns the rights to the remote sensing data collected by Russian satellites. As a result, the Russian government has been able to create an integrated complex with unified interface for all the regional authorities, ministries and other state entities to use the data from Russian and foreign satellites. The geoportal created for Roscosmos serves as a basic source for other agencies' information platforms. It contains the information from all the main Russian remote sensing satellites (2 Resurs-P, Resurs-DK #1, 2 Meteor-M, Kanopus, Electro-L, Monitor-E). Despite the active efforts of the Russian government, there remain a number of problems with this system: lack of initial data from the satellites; lack of computation power to process the data; and no integrated access for the data.[24] In April 2015 Roscosmos announced that it will start openly selling the imagery from the Russian remote sensing satellites.[25] Though this is seen as an important step in commercializing the remote sensing industry, many

[24] Gladkov, □ . (2014). Tekuscheye sostoyaniye servisov geoportala Roskosmosa.Perspektivi ispolzovaniya v ETRIS DZZ oblachnih servisov dlya obespecheniya potrebiteley informacionnimi productami DZZ. [Current state of the Roscosmos geoportal services. Prospects for using cloud servers in ETRIS DZZ for supplying the customers with remote sencing data products.] Retrieved May 7, 2015, from ftp://ftp.sovzond.ru/forum/2014/reports/Gladkov.pdf

[25] ITAR TASS. (2015, April 21). Goscorporatsiya Roscomos zaymetsya torgovley kosmicheskimi snimkami [Goscorporation Roscosmos will do commercial trade of space imagery]. Retrieved from: http://tass.ru/kosmos/1919922

of the details remain uncertain especially for independent commercial companies that might have potential initial interest in this data.

There have been a number of efforts on the state level to improve the commercialization institutions working in the space industry by integrating members of academia and top-level researchers, industry, and government officials, a grouping known as the "triple helix". The key players in this process are the Skolkovo Foundation and Skolkovo's space cluster, which lists "information-navigation and geoinformational systems, program-apparatus complexes for using the space information in other sectors of economy" as part of its mission.[26]

Another proposed structural solution was the introduction of "technological platforms" in 2010. Technological platforms were intended to be interdisciplinary systems for communication concerning the new potential technologies between governments, industry representatives, academia, and others in the field. Space technology is one such existing platform. This platform was designed to be centered on the largest space sector production facility, Information Satellite Systems Reshetnev. However, there still are a number of challenges. According to Irina Gennadyevna Dezhina, group leader of Skoltech's Scientific and Industrial Policy Group, the Russian innovation system "appears to be stubborn to changes, hindered by path dependency and belief in exclusively federal support."[27] Due to the fact that the participants of technological platforms have not changed their operations, this endeavor did not create stimuli for coordination and communication in the innovation process.

There have also been several attempts to organize a professional society among those involved in remote sensing in Russia. The current iteration of this organization is known as "Earth from Space," which consists of members of large remote sensing companies in Russia. Members of this association claim that such a professional community can create a force to encourage domestic industry to develop. The organization states that it intends to cooperate with the state authorities and create recommendations on the legislations for remote sensing sector. It is also working to integrate the professional community in Russia and ensure representation abroad, give a voice to success stories to encourage others in the industry, and hold forums, seminars and conferences related to global information systems (GIS) technologies, remote sensing, and related applications.[28] A crucial factor to be examined is how these activities are integrated with the priorities and strategies elaborated by the state and whether or not they succeed.

There is momentum going forward toward advancing the remote sensing industry. While significant barriers exist, there are steps the United Rocket and Space

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[26] Directions - Skolkovo Community. (n.d.). Retrieved May 7, 2015, from https://sk.ru/foundation/space/p/directions.aspx

[27] Dezhina, I. (2014). Technology platforms in Russia: A catalyst for connecting government, science, and business? Triple Helix, 1(6). Retrieved May 7, 2015, from http://link.springer.com/article/10.1186/s40604-014-0006-x

[28] Ash, E. (2011). "EARTH FROM SPACE": THE PROFESSIONAL COMMUNITY AS A VEHICLE FOR NATIONAL ERS INDUSTRY. In Earth From Space (pp. 126-31).

Corporation/Roscosmos can take to not only improve their own capability in this sector, but also help progress the industry as a whole. The following section will explain factors we have determined to be the primary areas in need of improvement and steps that can be taken to move forward.

Policy Statement

The policy goal

The goal of this paper's policies is to make United Rocket and Space Corporation a successful commercial remote sensing service provider in the global market.

The policy itself

Our proposed recommendations center around three elements that address the weakest areas of the Russian remote sensing industry.

First, we encourage the creation and support of university remote sensing laboratories to develop the necessary skills within Russia.

Second, we propose that URSC form strong partnerships with IT companies to develop new products that can be sold in the commercial market.

Finally, we propose that USRC should build a larger clientele through agreements with other nations (both for developing technologies together and for direct distribution) as well as nurturing domestic clients.

The owner of the policy

The owner of the policy is the Russian Federal Space Agency which has recently acquired the United Rocket and Space Corporation. This agency will be responsible for articulating the policy as regulations, for implementing these regulations and for enforcing them.

Step 1: Building skills

The pace of technological change in remote sensing and respective applications is rapid. This makes a top-down approach inefficient. The remote sensing industry is lagging behind because of a lack of integration with other sectors of economy. Building centers of excellence for IT and space specialists is key for tackling this issue.

Another set of skills that need to be developed are commercialization and business development. An example of the Russian institutions working on this issue is the Skolkovo Foundation and its space cluster that aims at developing commercially viable remote sensing technologies through developing commercialization institutions for the ideas developed at the top Russian universities. Skolkovo is developing as an

integration and commercialization platform, taking the best initiatives around the country to transfer them into commercial technologies.

To support this endeavor, the URSC needs to initiate the process of creating remote sensing centers at the most advanced Russian universities where students would be able to conduct research related to their specialties and develop new commercial technologies. The universities should be incentivized through integration of this idea of remote sensing centers with the government initiative "5/100" aimed at developing the universities. The idea of remote sensing centers at universities was already mentioned in 2009 by E. Ash from the Scanex Research and Development Center.[29] These centers could be a nexus for local commercial space initiatives as well as local centers of excellence.

The integration of university, business, and local authorities is a key principle to make this project successful. Though the centers should be based at the universities, they should not be isolated entities. On the contrary, the remote sensing centers should be crucial aspects of research and commercialization infrastructure in the regions.

Step 2: Expand market products

To expand its presence in the global remote sensing market, Russia should shift heavily toward the development of value-added applications and data sales moreso than satellites and other hardware. Internationally, data and information analysis technologies are concentrated in the more dynamic and flexible private sector. In order to achieve this goal URSC should implement the following steps.

Firstly, URSC should instigate and enable partnerships with the information technology industry to foster development in remote sensing. Through partnerships with universities, satellite manufacturers, application developers, and other industry leaders in remote sensing technologies and applications, the URSC can work to grow a community of technical, legal, and commercial remote sensing specialists with the skillsets to advance the industry in Russia. URSC can achieve this integration through the development of the framework agreements between research entities and industrial companies.

The Russian space industry currently consists of large industrial holdings inherited from the Soviet Union that are inflexible and resistant to change in face of the global competition. However, the goal of industry integration still can and should be achieved. While the large industrial holdings are concentrated in the satellite production sector, there exist several more flexible and independent commercial companies developing geoinformation services for the domestic market. The URSC can coordinate the process of interaction between the two forces to discuss the demand for the satellites

[29] Ash, Elena. "Remote Sensing Technologies at Universities." Education and Accreditation. Retrieved April 8, 2015.

production as well as the terms of using the information produced by satellites in the commercial companies.

Secondly, the URSC should address the problem of unclear property structure for imagery production from the remote sensing satellites. The uncertainty and lack of access to the data is a key obstacle for the development of competitive commercial companies. Therefore, open access to the data from the Russian remote sensing satellites is seen as a catalyst for the development of private remote sensing companies.

A third mechanism for the development of market in remote sensing is the introduction of some elements of a federal contracting system. A federal contracting system, as opposed to the existing system of federal procurement, enables signing contracts with commercial companies for certain services at the stated level of technological complexity. The owners of the contracts in the remote sensing industry should be government entities such as government ministries, agencies or regional authorities. A federal contracting system could act as a mechanism for enacting industrial strategy with identified target technologies and technological goals. This mechanism would also enable market competition.

Step 3: Develop clients

A key to success in the market is having a regular supply of clients interested in the services and goods provided. Therefore, Russia should pursue a more active strategy towards international markets, as well as reconsidering the demand for Earth-observation data at home.

In the current geopolitical situation with unstable relations with major developed space-faring nations, it is important for Russia to find partnerships in the developing world. First of all, this means founding technological alliances with countries to develop technologies similar to the type of cooperation in the CBERS program. An alliance for the development of new technologies with countries such as India (traditionally quite strong in remote sensing) or China are seen as necessary tools for advancing the competitiveness of the industry. Instead of attempting to sell the data, joint technological development programs can be more productive in the long-term strategy.

Secondly, Russia can provide services internationally by signing distribution agreements with developing countries that cannot afford to have a domestic remote sensing satellite or constellation. At the same time, for scientific Earth observation, maintaining positive relationships with the leaders of established remote sensing nations remains an important aspect of international strategy, even during periods of geopolitical instability where possible.

Third, Russia should also give consideration toward its policy in terms of utilization of remote sensing technologies domestically. To date, regional governments have been utilizing individualized strategies for applying remote sensing portals,

platforms, and other initiatives. However, it seems that there is a need for a national standard on how the regional governments should use the remote sensing data in different sectors of administration and governing. This should be done in the form of framework agreements that regional governments can adopt in the future when developing contracts with private service providers.

Despite the difficulties with property rights regarding imagery data and the eagerness of the private companies to participate in this process separately from the state, this regional dimension should be an important frontier for fostering regional development as well as the Russian Earth observation industry.

Our fourth proposal is to identify the key areas ("social benefit areas") where the remote sensing technologies can be applied as was done in the American case (See Appendix 1). Such a document with identified realms where remote sensing products can and should be used would stimulate not only the remote sensing companies to search for clients, but would also initiate the process from the other side – from potential clients. Notable partners here are the large corporations (for instance in the oil and gas industry) that have a clear need for remote sensing data in their operations; instead of developing the remote sensing capabilities on their own they should be encouraged to outsource this function.

Fulfillment of the goal

As discussed, these policy recommendations are intended to assist the USRC in developing a commercial remote sensing strategy by increasing the opportunity to build expertise, improve access to the commercial market, and forge beneficial partnerships with various clients.

Where Russia has proposed platforms in the past for space policy, it has not developed a strategy with measurable or quantifiable goals or one specifically addressing remote sensing as a cross-industry tool for Russian economic benefit. The policy we propose is not a comprehensive solution but it does provide a framework for bringing the URSC into the commercial remote sensing market as a fully capable player. This tri-fold platform proposal offers guidance in improving three key areas: skills, market function, and client base.

The USRC will acquire skills by promoting the establishment of remote sensing center at Universities within Russia and by collaborating with centers like Skolkovo. Foundation. Working with these entities will help foster a remote sensing community and develop the expertise within Russia and the URSC. The USRC can improve its market position by working with application developers and independent commercial companies and by providing open access to remote sensing data. In addition, introducing some elements of a federal contracting system would enable the URSC to encourage the creation of target technologies and technological goals. Although in

different capacities, other countries successful in the remote sensing industry follow similar paths and illustrate why these recommendations will be successful. Finally, pursuing a greater presence in both the international and domestic remote sensing will help establish a client base.

Policy Analysis

Strengths

To expand in the area of remote sensing, expert understanding of the technology and how it can be applied is necessary. Pursuing partnerships with universities and industry will help foster the growth of knowledge and expertise in the field and enable URSC to more easily acquire these skillsets.[30] Public-private partnerships are common in the US and in Europe. In forming these relationships, there are abundant examples and case studies of successful partnerships the URSC can use as a basis upon which they can model their partnership for future success.[31] If such partnerships are spread to locations in the Far East, for example, Russia can also reach out to specific regional needs and encourage advanced skills in underrepresented areas.

Russia has lagged behind other countries in forming these types of partnerships; however, it still has precedents for their creation. One example is the Biotechnology for Medicine and Agriculture program instituted in 2001.[32] This program brought together government, university, and industry organizations to collaborate on around 300 biotechnology projects. The program spawned a non-profit partnership, the "Biotechnological Consortium on Medicine and Agriculture (BIOMAC)". The creation of the consortium illustrates how the basic conditions and legal hurdles of a public to private sector partnership can be navigated.[33] Moreover, efforts put into these partnership frequently result in mutually beneficial outcomes and often both parties have much to gain.[34]

By working with outside partners, the URSC will have an opportunity to help shape the direction and research goals related to remote sensing in Russia. If the USRC joins in partnerships they will have a stake in the research goals and can choose to support initiatives that are in their best interest. At the same time, partnering organizations will have the opportunity to work with space experts from the USRC and, depending on the arrangement, receive funds for research initiatives.[35]

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[30] Measuring the Impact of University Business Cooperation. (2014). European Commission. Retrived on May 7, 2015 from http://ec.europa.eu/education/library/study/2014/university-business_en.pdf.
[31] Fostering public-private partnership for innovation in Russia. (2005). Paris: OECD.
[32] Ibid.
[33] Ibid.
[34] Sutton, S. (2010). The Changing Landscape of International Partnerships. Retrieved from http://www.iie.org/~/media/Files/Corporate/Publications/Partnership-Intro.ashx
[35] Principles. (n.d.). Retrieved May 7, 2015, from http://www.skoltech.ru/en/kto/principles/

Weaknesses

The strengths of building partnerships as a strategy come from the potential shared benefits between the USRC and its partners. Trends toward greater collaboration and the promotion of innovation help lend credibility in pursuing these efforts. There are, however, weaknesses within the URSC that may preclude them from building the necessary environment to establish partnerships. In Russia, most research and development efforts have primarily been conducted via government labs.[36] Universities generally account for a small percentage of research/development activities and many Russian companies conduct little to no research and development at all.[37] Due to the limited number of potential organizations the URSC can establish partnerships with, they will have to undertake the challenge of making of the most of the partnerships they can establish. There are industries and university organizations in Russia that have seen past attempts at public-private partnership fail and produce little benefit. The URSC will need to overcome these perceptions and break previous trends by government organizations to view industry partnerships as simply an additional source of funding.[38] In order, to develop a successful commercial remote sensing strategy, URSC will have to approach industry as both a potential partner and client. Maintaining these two distinctions poses a challenge, but would enable the transfer of skills and technology to the URSC while promoting research and innovation for remote sensing uses within Russia.

Additionally, there are two other major challenges to success. The first is capability within the URSC to develop, reach out, and maintain partnerships with other Russian organizations. The URSC may not have enough experience or resources to commit to and build these partnerships. The URSC will have to assess what is possible and the make a concerted effort in establishing these relationships. Careful management will be required to balance the correct people and funding needed.

The second major weakness the USRC faces in regards to developing partnership is a lack of experience and organizational leadership. Members of the organization will need to understand the purpose for undertaking these proposals and the value they bring. Changing focus and taking on new initiatives are naturally met with resistance.[39]

To overcome these challenges those in charge of instituting the new initiatives will have to clearly articulate the value they bring and provide evidence of their benefit going forward. They will also need to identify any bureaucratic or structural barriers that would hinder progress.[40] The smoother the implementation, the easier future known barriers, such as cost and workload, will be to overcome. The restructuring of the

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[36] OECD reviews of innovation policy Russian Federation. (2011). Paris: OECD.
[37] Fostering public-private partnership for innovation in Russia. (2005). Paris: OECD.
[38] Cohen, A., Benovic, I., & Roberts, J. (2014). Russia's Avoidable Economics Decline. Special Report #154 Russia and Eurasia. Retreived from Http://www.heritage.org/research/reports/2014/09/russias-avoidable-economic-decline.
[39] Fostering public-private partnership for innovation in Russia. (2005). Paris: OECD.
[40] Ibid.

URSC and the Roscommon also possess a significant challenge in building buy it for the policy recommendations. Since leadership is appointed by the government rather than competitively selected, their motivations and concerns may not fall in line with proposed direction of the policy. This is where the case needs to be made strongest concerning the value and future benefit of implementing the strategy.

Opportunities

In addition to partnering with universities and industry there are opportunities to development relationships with municipalities that have strong scientific capacity and research capabilities. These are often referred to as "science cities". They offer the potential to be direct partners or clients for the USRC.[41] Since these municipalities are already capable of supporting research ventures, they have a low cost for creating new research initiatives. Working in these areas, the USRC also has the potential to create favorable conditions for innovation, increased business, and investment.[42] As it forms partnerships, it will help identify what are promising research projects and areas of potential future growth in remote sensing. By doing so, these partnerships may be able to create either initial or additional demand for supportive industries that provide high-tech tools and various services. As research initiatives take hold in these cities, the extra funding and activity has the potential to spillover and generate new commercial ventures in remote sensing or space industries areas. The municipalities will also gain from the increased actively through economics growth, increased taxes, and the commercialization of new industries.[43]

Threats

The largest threat to implementing the proposed policy is the changing economic environment within Russia. The economy is currently in decline and the nation is facing prolonged international sanctions. If the economy continues to suffer, a threat lies in the USRC facing uncertainty of its budget. Leadership of the URSC may take into account the changing economic climate and operate with caution. Often organizations facing budget reduction causes their priorities to shift and the internal capability to take on new initiatives diminishes.[44] The international sanction also strains Russia's capacity to

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[41] Akinfeevaa, E., & Abramovb, V. (2015). The Role of Science Cities in the Development of the National Innovation System in Russia. Studies on Russian Economic Development, 26(1), 91-9. Retrieved May 7, 2015, from http://link.springer.com/article/10.1134/S1075700715010025#page-1

[42] Frolov, I.E.. (2010) Opportunities and Challenges of Russian High-Technology Complex and Modernization. Science and Technology 22(3) Print.

[43] Akinfeeva, E., & Abramov, V. (2015). The Role of Science Cities in the Development of the National Innovation System in Russia. Studies on Russian Economic Development, 26(1), 91-9. Retrieved May 7, 2015, from http://link.springer.com/article/10.1134/S1075700715010025#page-1

[44] Jick, T. & Murray, V. (1982). The Management of Hard Times: Budget Cutbacks in Public Sector Organizations. Organizational Studies 3(2). 141-69. Print.

form partnerships in remote sensing and participate in certain areas of the global market.

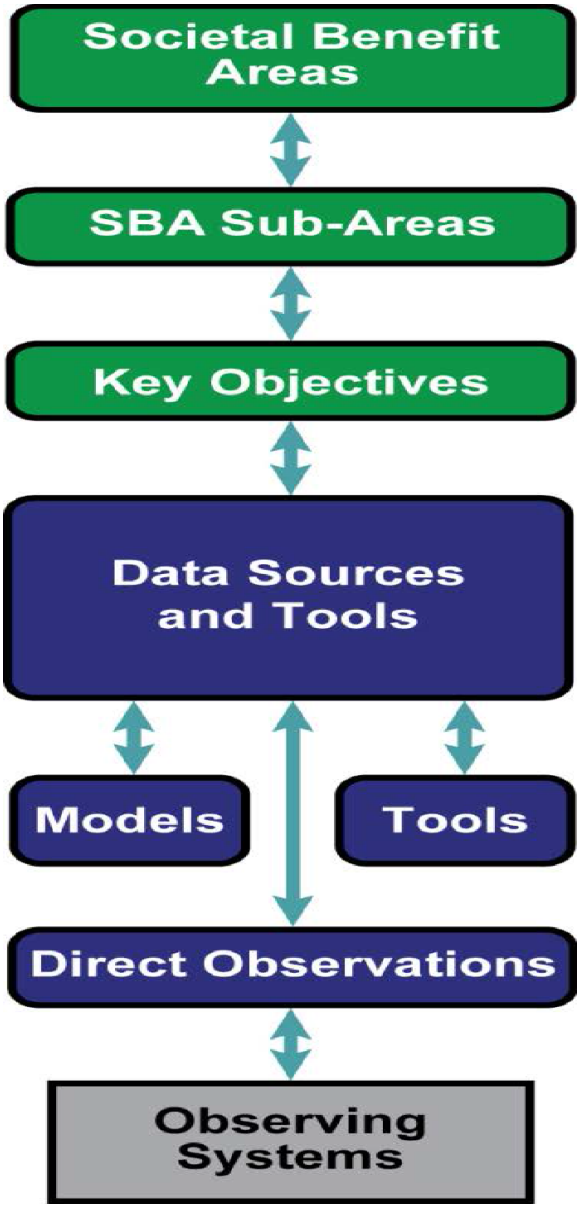
Summary

Despite global progress in remote sensing, Russia is notably lacking a strong presence in the increasingly commercialized industry. There are numerous factors that have prevented Russia from progressing in remote sensing. Some of these are still major challenges today. If the URSC wishes to increase its capability in remote sensing it will need to overcome the three main issues discussed in the policy: lack of know-how, lack of market presence, and limited clientele.

To address this weakness, this paper proposes a three part policy that will strengthen skills, build new products and expand the market. It will do this by building centers of excellence for IT and space specialists via partnerships with university and research center such as Skolkovo. Through collaboration with application developers and independent commercial companies, opening of remote sensing data, and the introduction of element of a federal contracting system. Lastly, by establishing a domestic and international presence in the remote sensing industry through outreach and partnerships. Engaging in these policy recommendation outlined will progress the USRC toward becoming a successful commercial remote sensing service provider.

Appendices

Appendix I: Two fold approach to developing the remote sensing system: from technologies to clients, from societal beneficial areas to technologies.



Source: White House Office of Science and Technology Policy, 2013

This flow chart shows the US approach to stimulate the usage of remote sensing technologies. The OSTP identified the key Societal Beneficial Areas (SBAs) for using the remote sensing. For each SBA the team preparing the 2013 National strategy for civil

Earth observations identified the key existing data sources (satellites, aerial data etc.) and the key tools (models, programs, applications etc.). This serves as a basis for formulating the recommendations for various agencies as well as ensuring the interagency interaction.

Overall, there are 12 identified SBAs and a reference measurements section supporting the activities in the 12 areas:

1) Agriculture and Forestry: Supporting sustainable agriculture and forestry.

2) Biodiversity: Understanding and conserving biodiversity.

3) Climate: understanding, predicting, mitigating, and adapting to climate variability and related global change.

4) Disasters: Reducing loss of life, property, and ecosystem damage from natural and human-induced disasters.

5) Ecosystems (Terrestrial and Freshwater): Improving the management and protection of terrestrial and freshwater ecosystems.

6) Energy and Mineral Resources: Improving the identification and management of energy and mineral resources.

7) Human Health: Understanding environmental factors affecting human health and well-being.

8) Ocean and Coastal Resources and Ecosystems: Understanding and protecting ocean, coastal, and Great Lakes populations and resources, including fisheries, aquaculture, and marine ecosystems.

9) Space Weather: Understanding, assessing, predicting, and mitigating the effects of space weather on technological systems, including satellites, power grids, communications, and navigation.

10) Transportation: Improving the safety and efficiency of all modes of transportation, including air, highway, railway, and marine.

11) Water Resources: Improving water resource management through better understanding and monitoring of the water cycle.

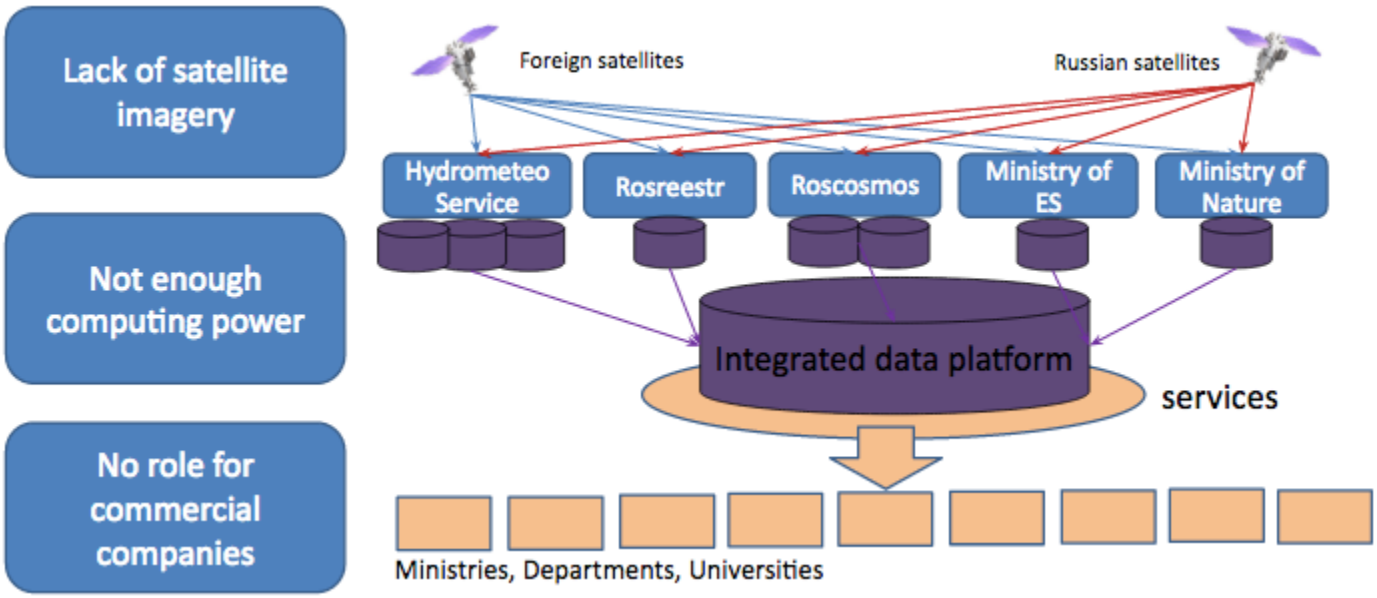
12) Weather: Improving weather information, forecasting, and warning.

13) Reference Measurements: Improving reference measurements—the underpinnings of all the SBAs—such as geodesy, bathymetry, topography, geolocation, and the fundamental measurement systems and standards supporting them.

Though in the Russian case the number of key area could be different, this approach seems to be very beneficial for stimulating the expert discussions, interagency process as well as coordination with potential players on the remote sensing market.

In terms of identifying the remote sensing strategy this approach helps to rely not only on the existing technologies but also to find out the potentially profitable areas of civil economy for using the remote sensing.

Appendix II: Existing Efforts to Integrate Industry Stakeholders to RS Platform



Source: adopted from Loshkarev & Zaichko 2011

This scheme was adopted from the complex report by Loshkarev and Zaichko on the state of the integrated territory-distributed information system of remote sensing data (ЕТРИС ДЗ - in Russian).

The creation of this system is an attempt to integrate the remote sensing technologies development (especially the applications segment) which was happening independently across different industries. Despite the importance of such endeavor it has a number of serious drawbacks.

Experts claim that among the most important disadvantages are the lack of satellite imagery as Russia does not have a big enough satellite fleet; the second problem concerns the application and services part: the lack of computing power makes it difficult to be competitive for all the potential clients.

The root cause of the weaknesses of this system is that it does not stimulate the development of market. This scheme even does not see the commercial companies as producers or designers of the “integrated data platform”. As a result, due to the lack of competition it is unclear how the integrated system could satisfy the potential clients.

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