

Tel Aviv University
Yuval Neeman Workshop for Science, Technology and Security

SPACE 2015: A YEAR IN REVIEW

Deganit Paikowsky,
Ariel Reichard, Gil Baram, Isaac Ben Israel

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Room 417, Naftali Building
Tel Aviv University, P.O. Box 39040
Tel Aviv, 6997801, Israel
E-mail: degan@post.tau.ac.il

Abstract

This report reviews the principal events of 2015 in the field of space, and analyzes the major trends that can be identified in the space activities of governments. Such areas as cooperation in space activity, space security, space exploration and research, technological development and more are addressed. In addition, the principal occurrences in the pre-eminent countries are also presented. One of the significant processes of 2015 is the tension between the private and public sectors, especially regarding the growing awareness of the challenge to assure a sustainable space environment. Another trend is the inherent tension between the need to improve and enhance cooperation, and the desire to establish self-reliance and ensure independent access to space. Third, the growing attention among a large number of spacefaring nations which have marked the moon as their focal point for the coming years shapes the field of space exploration, and most likely force the U.S. to reconsider its plans.

Introduction

Eighty-Seven launches were carried out in 2015, of which 82 were successful and only five failed.¹ Russia had the most launches (29), followed by the U.S. (20) and China (19). Europe had nine launches, India five, Japan four, and Iran one. These launches sent 161 satellites into space. Expectations at the beginning of the year were that a greater number of satellites would be launched. However, due to launch failures, a number of launches were delayed and many satellites were never launched.

This report reviews the principal events of 2015 in the field of space, and analyzes the major trends that can be identified in the space activities of governments. Such areas as cooperation in space activity, space security, space exploration and research, technological development and more will be addressed. In addition, the principal occurrences in the pre-eminent countries are presented in this report

Exploration and Human Spaceflights

In the year just passed, many nations have strongly re-committed to the national goal of reaching the moon. Russia, China, and the European Space Agency [ESA] all decided that the moon was their next objective, which led to a great deal of cooperation between them. In January, the Chinese Spacecraft Service Module entered into orbit around the moon, with the aim of identifying appropriate landing sites for the Chinese Change'e-5 mission, planned for 2017.² Japan, South Korea, and Mexico, each announced its plan to launch a space mission.³

Research into asteroids, via dedicated missions, has gathered momentum and interest. These events constitute a continuation of the developing trends amongst the leading spacefaring nations, to go further away from earth and deeper into space in both unmanned and human spaceflights.

¹ The data is based on information published in Space News throughout 2015, and on the UCS database on satellites.

² Leonard David, Chinese Spacecraft Enters Orbit around the Moon, Space News, January 20, 2015. <http://spacenews.com/chinese-spacecraft-enters-orbit-around-the-moon/> Accessed on January 25, 2015.

³ Staff Writers, South Korea to Launch Lunar Exploration in 2016, Land by 2020. Moon Daily, December 31, 2015.

http://www.moondaily.com/reports/South_Korea_to_launch_lunar_exploration_in_2016_land_by_2020_99.html Accessed on January 2, 2016. Astrobotic Technology Press Release, Agencia Espacial Mexicana (AEM) and Astrobotic Partner to Facilitate Payload to the Moon, SpaceRef, June 10, 2015. <http://spaceref.com/news/viewpr.html?pid=46063> Accessed on June 20, 2015.

Despite the crisis between the U.S. and Russia, the two countries managed to agree to extend the activities of the international space station to 2024;⁴ the other participating countries agreed as well.

During 2015, the U.S. signed agreements with Boeing and Space-X to launch astronauts into space on commercial flights.⁵ These flights are expected to take place in another two years.⁶ Progress in commercial spaceflights has encouraged the U.S. regulatory system to address the challenges facing it. NASA continues to develop tools for human missions into deep space, which will require humans to live in space for extended periods. Russia, too, is active in this field, and announced that it will undertake a number of simulations for lengthy human flights to the moon and Mars in the coming years.

⁴ Peter B. de Selding, Russia — and Its Modules — To Part Ways with ISS in 2024, Space News, February 25, 2015. <http://spacenews.com/russia-and-its-modules-to-part-ways-with-iss-in-2024/#sthash.xZIQ3BIu.dpuf> Accessed on March 2, 2015.

⁵ NASA Press Release, NASA Orders SpaceX Crew Mission to International Space Station, NASA.gov, November 20, 2015. <http://www.nasa.gov/press-release/nasa-orders-spacex-crew-mission-to-international-space-station> Accessed on March 12, 2015.

⁶ Eric Berger, Quietly, the New Space Race Between SpaceX and Boeing Burns Hot, Arstechnica, November 10, 2015.

Industry and Technology

Several trends are worth mentioning in the fields of industry and technology. First, the trend toward developing and utilizing satellites with full electric propulsion is intensifying. In 2015, a number of satellites of this type were launched, and others are in various stages of development. In September, the first communications satellite with an electric propulsion system, the ABS-3A, successfully entered its orbit only six months after its launch, a month earlier than anticipated.⁷ China announced that by 2020, it planned to launch its first communication satellite with a complete electrical propulsion system. Even before that, by the end of 2016, it plans to launch a communication satellite with a hybrid propulsion system. A totally electric propulsion system will apparently be the technology that China will utilize in the space station it is planning for the future.⁸

<http://arstechnica.com/science/2015/11/quietly-the-new-space-race-between-spacex-and-boeing-burns-hot/> Accessed on November 6, 2015.

⁷ Peter B. de Selding, ABS All-electric Satellite Arrives Early at Operating, Space News, September 10, 2015. <http://spacenews.com/abs-all-electric-satellite-arrives-early-at-operating-orbit/#sthash.kpJTiy27.dpuf> Accessed on October 6, 2015.

⁸ Staff Writers, Electric Thruster Propels China's Interstellar Ambitions, Space Daily, June 9, 2015. http://www.spacedaily.com/reports/Electric_thruster_propels_Chinas_interstellar_ambitions_999.html Accessed on June 10, 2015.

Second, progress continues to be made in the development of small satellites. The great challenge is to develop dedicated, efficient and inexpensive launch capabilities that will significantly reduce the cost of launching these satellites.⁹ This challenge is being addressed by both the public sector and the private sector.¹⁰

The increase in the number of small satellites that are launched each year requires adapting regulation of space activities to the new conditions. Specifically, aspects of launch, frequency, movement in space and removal of space waste and debris need regulating. As a result, the manufacturers of satellites have been calling for an oversight and approval path specifically designed for small satellites.¹¹ Alongside the accelerated utilization of small satellites, a discussion is going on regarding the effectiveness and technological feasibility of their use.

The third area of increased activity that has raised a great deal of interest is the integration of three dimensional printing in the development and production of space systems, sub-systems and component parts. Although still in its infancy, predictions are that this will bring about important and substantial changes in the space market. Three dimensional printing for space-related activities is already used in various places around the world; many examples can be cited. For instance, China used this technology to produce vent pipes and flanges for the space suits used in space walks. NASA's Marshall Flight Center contracted with Made in Space, Inc. to develop a 3-D printer that will work in space, enabling astronauts to produce tools or component parts.¹²

⁹ DARPA Plans to Launch Satellites from Jets, Fox News, February 06, 2015. http://www.foxnews.com/tech/2015/02/06/darpa-plans-to-launch-small-satellites-from-jets.html?cmpid=NL_SciTech Accessed on February 10, 2015. Jeff Foust, DARPA Space Efforts Address U.S. Reliance on Space, Space News, Mars 30, 2015. <http://spacenews.com/darpa-space-efforts-address-u-s-reliance-on-space/> Accessed on April 11, 2015.

¹⁰ Jeff Foust, Virgin Galactic Claims Progress on Smallsat Launch Vehicle, Space News, September 28, 2015. <http://spacenews.com/virgin-galactic-claims-progress-on-smallsat-launch-vehicle/#sthash.8sIkCDxK.dpuf> Accessed on September 30, 2015.

¹¹ Peter B. de Selding, U.S. Satellite Group: Simplify Regulatory Procedure, Create New Regime for Smallsats, Space News, February 3, 2015. <http://spacenews.com/u-s-satellite-group-simplify-regulatory-procedure-create-new-regime-for-smallsats/#sthash.SogSgMp0.dpuf> Accessed on March 5, 2015.

¹² Staff Writers, 3D Printer Making Chinese Space Suit Parts, Space Daily, May 08, 2015. http://www.spacedaily.com/reports/3D_printer_making_Chinese_space_suit_parts_999.html Accessed on May 9, 2015. Jeff Foust, Rocket Lab Unveils Battery-Powered, 3-D-Printed Rocket Engine, Space News, April 14, 2015. <http://spacenews.com/rocket-lab-unveils-battery-powered-3d-printed-rocket->

Another field that has been gathering momentum and is likely to change the market is the development of reusable launchers and rocket engines. In April, an attempt to return the first stage of the Falcon-9 launcher, undertaken by Space-X, failed.¹³ In June, another launch of the Falcon-9 failed; it was on a supply mission to the international space station.¹⁴ As a result, the company suspended its launch program for a few months, but by the end of the year, the Falcon-9 was successfully launched, and the company proved its ability to successfully land the first stage.¹⁵ A few weeks before that, the Blue Origin company successfully launched and re-landed a rocket it had produced.¹⁶ In 2015, progress in this area centered primarily in the U.S., but other places saw activities in this

[engine/#sthash.e1dyX2R.dpuf](http://www.spacedaily.com/reports/Jeff_Bezos_Take_s_Another_Step_Toward_Realizing_Reusable_Commercial_Space_Flight_999.html) Accessed on May 9, 2015. Jeff Foust, Aerojet Looks To 3-D Printing For AR-1 Engine Development, Space News, April 18, 2015. <http://spacenews.com/aerojet-looks-to-3-d-printing-for-ar-1-engine-development/> Accessed on May 9, 2015.

¹³ Jeff Foust, Throttle Issue Blamed for Falcon's Hard Landing, Space News, April 20, 2015. <http://spacenews.com/throttle-issue-blamed-for-falcons-hard-landing/> Accessed on April 29, 2015.

¹⁴ Keith Cowing, SpaceX Falcon 9 Mishap: More Details Emerge, SpaceRef, June 29, 2015. <http://spaceref.biz/company/spacex-falcon-9-mishap-more-details-emerge.html> Accessed on June 30, 2015.

¹⁵ Staff Writers, SpaceX to Launch Rocket Dec 19, Six Months After Blast, Space Daily, December 10, 2015. http://www.spacedaily.com/reports/SpaceX_to_launch_rocket_Dec_19_six_months_after_blast_999.html Accessed on December 20, 2015.

¹⁶ Launch Space Staff Writers, Bezos Takes Big Step Towards Reusable Commercial Space Flight, Space Daily, December 02, 2015.

field, too. Russia announced that it was exploring the possibility of reviving its development of a multi-use spacecraft. According to announcements, funding for this project will be allocated beginning in 2021 and will continue for four years.¹⁷ The ESA successfully completed a test flight of a reusable spaceplane, the IXV, which landed in the waters of the Pacific Ocean as planned.¹⁸ In January, the French Space Agency, in cooperation with Germany and other countries, announced that it had begun to develop a multi-use launcher. At this stage, reusable launchers are not among the project aims of the launcher, the Ariane-6, that the ESA is developing,¹⁹ but in June, the Airbus company presented a first-stage multi-use engine for the Ariane launcher.²⁰ India is also

http://www.spacedaily.com/reports/Jeff_Bezos_Take_s_Another_Step_Toward_Realizing_Reusable_Commercial_Space_Flight_999.html Accessed on December 20, 2015.

¹⁷ Staff Writers, Russia Eyes Reviving its Reusable Space Shuttle Program, Space Daily, August 21, 2015. http://www.spacedaily.com/reports/Russia_eyes_reviving_its_Reusable_Space_Shuttle_Program_999.html Accessed on August 30, 2015.

¹⁸ ESA Experimental Spaceplane Completes Research Flight, ESA.int, February 11, 2015. http://www.esa.int/Our_Activities/Launchers/IXV/ESA_experimental_spaceplane_completes_research_flight Accessed on February 13, 2015.

¹⁹ Peter B. de Selding, With Eye on SpaceX, CNES Begins Work on Reusable Rocket Stage, SpaceNews, January 5, 2015. <http://spacenews.com/with-eye-on-spacex-cnes-begins-work-on-reusable-rocket-stage/> Accessed January 7, 2015.

²⁰ Peter B. de Selding, Meet Adeline, Airbus' Answer To SpaceX Reusability, Space News, June 5, 2015. <http://spacenews.com/meet-adeline-airbus-response->

developing multi-use technology. In 2009, India began a program to develop a two-stage multi-use launcher. The first test was scheduled for 2011, but that has been postponed a number of times.²¹

Over and above these future trends, it appears that in the present launch market, the Arianespace and Space-X companies have become the leaders in supplying launchers. They each view the other as their primary competitor, and work to neutralize each other's advantages. For example, Arianespace has been working on reducing the cost of its launchers, while Space-X has been reinforcing its reputation for reliability. This year, the company completed the process of gaining approval to launch missions for the American Air Force, while upgrading its approval level to launch missions for NASA.²² The crisis in Russia's space industry, primarily in the field of

launches, contributes to the competition between the two leading companies. In fact, there are those who claim that they are gradually becoming a duopoly.²³

In the field of navigation, a trend is developing amongst producers of terminals that can simultaneously receive signals from a range of systems, among them the Chinese navigation system. Such technology will improve the reliability of navigation devices and contribute to their resistance to disturbances. On the other hand, the process will interfere with the efforts of national industries and governments to promote one system above others.²⁴

In the field of telecommunication, attention has been focused on huge systems to provide internet services. Two American initiatives were undertaken to establish mega-systems of small satellites to provide global broad-

[to-reusable-spacex-rocket/](#) Accessed on June 13, 2015.

²¹ K. S. Jayaraman, India To Fly RLV Tech Demo by June, Space News, March 5, 2015. <http://spacenews.com/india-to-fly-rlv-tech-demo-by-june/> Accessed on March 11, 2015.

²² Doug G. Ware, Report: SpaceX Falcon 9 Rocket Certified to Fly NASA Missions, Space Daily, May 16, 2015.

http://www.spacedaily.com/reports/Report_SpaceX_Falcon_9_rocket_certified_to_fly_NASA_missions_999.html Accessed on May 30, 2015. Mike Gruss, SpaceX Falcon 9 Certified for Military Launches, Space News, May 26, 2015. <http://spacenews.com/u->

[s-air-force-certifies-falcon-9-for-military-launches-2/](#) Accessed on May 30, 2015.

²³ Peter B. de Selding, SES, Eutelsat CEOs Vow To Do What it Takes to Avoid SpaceX, Arianespace Duopoly, Space News, June 12, 2015. <http://spacenews.com/ses-eutelsat-ceos-vow-to-do-what-it-takes-to-avoid-spacex-arianespace-duopoly/#sthash.2RCKvy8Y.dpuf> Accessed on June 13, 2015.

²⁴ Peter B. de Selding, China Official: Beidou Gear Will Receive GPS, Glonass, Galileo Signals, Space News, February 6, 2015. <http://spacenews.com/china-official-beidou-gear-will-receive-u-s-russian-and-european-gnss-signals/#sthash.VZTXpjZz.dpuf> Accessed on February 12, 2015.

band internet services. One, led by the OneWeb company, plans to launch and operate a constellation of 650 satellites weighing only 125 kg (275 lbs.) each in a Low Earth Orbit [LEO]. The enterprise enjoys financial backing from Virgin Galactic, as well as from the American semiconductor producer, Qualcomm.²⁵ The other leading company in this initiative is SpaceX, which plans to include some 4,000 satellites in its constellation, to be used to provide broad-band services to regions that today have no access to the internet.²⁶ Google and Fidelity Investments announced that they were investing a billion dollars in the SpaceX initiative, with Google investing 90% of

the total.²⁷ The principal challenge facing SpaceX's undertaking is guaranteeing the spectrum frequency for operating the system in an area of space that is fairly crowded. OneWeb has already guaranteed ownership of part of the spectrum.²⁸

In 2015, OneWeb announced that Airbus had been awarded the contract to produce the satellites. They are to be launched at the beginning of 2018;²⁹ the ArianeSpace company was chosen to launch the system.³⁰ In response, operators of communication satellites in geostationary orbits expressed concern about interference and disturbances as a result of the planned system and its

²⁵ Peter B. de Selding, Virgin, Qualcomm Invest in OneWeb Satellite Internet Venture, Space News, January 15, 2015. <http://spacenews.com/virgin-qualcomm-invest-in-global-satellite-internet-plan/#sthash.TiXA0ft6.dpuf> Accessed on January 16, 2015.

²⁶ Melody Petersen, Elon Musk and Richard Branson invest in satellite-Internet ventures, LA Times, January 16, 2015. <http://www.latimes.com/business/la-fi-satellite-entrepreneurs-20150117-story.html> Accessed on January 19, 2015.

²⁷ The Associated Press, SpaceX Gets \$1B US Investment from Google, Fidelity, CBC News, January 21, 2015. <http://www.cbc.ca/news/business/spacex-gets-1b-us-investment-from-google-fidelity-1.2921335> Accessed on January 29, 2015

²⁸ Tereza Pultarova, Musk Thinks There is Room for Another Mega Space Network, E & T, January 20, 2015 <http://eandt.theiet.org/news/2015/jan/musk-satellite-network.cfm> Accessed on January 29, 2015

²⁹ France's President + CEOs Celebrate As OneWeb Selects Airbus Defense + Space To Connect The World w/ Microsatellites, Satnews Daily June 15,

2015.

<http://www.satnews.com/story.php?number=1735784868> Accessed on June 19, 2015. Staff Writers, Airbus DS to Build OneWeb Satellite Constellation, Space Daily, June 16, 2015. http://www.spacedaily.com/reports/Airbus_Defence_and_Space_Selected_to_Partner_in_Production_of_OneWeb_Satellite_Constellation_999.html Accessed on June 19, 2015.

³⁰ Peter B. de Selding, Launch Options were Key to Arianespace's OneWeb Win, Space News, June 26, 2015. <http://spacenews.com/launch-options-were-key-to-arianespaces-oneweb-win/#sthash.ogIyvEJm.dpuf> Accessed on June 29, 2015. Jeff Foust, OneWeb Contract A Milestone For Virgin Galactic's Smallsat Launch Effort, Space News, June 25, 2015. <http://spacenews.com/oneweb-contract-a-milestone-for-virgin-galactics-smallsat-launch-effort/#sthash.RouNgYyP.dpuf> Accessed on June 29, 2015. Virgin Galactic Press Release, Virgin Galactic Signs Contract with OneWeb to Perform 39 Satellite Launches, SpaceRef, June 25, 2015. <http://spaceref.com/news/viewpr.html?pid=46183> Accessed on June 29, 2015.

operation. Their concerns focus on the possibility of unplanned damage to continental antennas located on the equator, which are positioned to receive the signals from their satellites; and on the ITU's inability to deal with a problem like that, should it arise. OneWeb announced that its satellites are programmed to reduce their broadcast strength whenever they pass over the equator.³¹ Other complaints about the initiative address the expectation that space debris would increase, which would increase the danger to all space operations. In response, OneWeb announced that it would work to prevent the production of space debris, and promised that its satellites will leave their orbits quickly, i.e. some five years after the end of their usefulness, and not 25 years, which is the standard today.³²

A look at the future shows that predictions of trends in the space market in the coming

years are cautious. In telecommunication, there's worry, especially amongst institutional investors, that the global communication satellite market may suffer from over-supply, due to the introduction of High Through-Put Satellites [HTS]. The price of shares in companies that operate large satellites plummeted this year, and that trend is likely to continue, as the HTS are introduced for a broad range of uses.³³ At the same time, demand for HTS is forecast to increase, primarily for use by cellular applications.³⁴

A similar concern about a decrease in prices and increase in competition exists concerning observation satellites. A number of new companies that provide observation satellites have entered the market, with improved abilities to capture high resolution images. In addition, several countries have decided to launch their own observation satellites, and

³¹ Peter B. de Selding, OneWeb Fails (At Least for Now) To Soothe Satellite Interference, Space News, September 18, 2015. <http://spacenews.com/oneweb-fails-at-least-for-now-to-soothe-satellite-interference-fears/#sthash.HbZpAO8I.dpuf> Accessed on September 19, 2015.

³² Peter B. de Selding, OneWeb Pledges Vigilance on Orbital Debris Issue, Space News, October 15, 2015. <http://spacenews.com/oneweb-pledges-vigilance-on-orbital-debris-issue/> Accessed on October 19, 2015.

³³ Peter B. de Selding, Investors Grow Bearish on Fixed Satellite Services, Space News, September 14, 2015. <http://spacenews.com/investors-grow-bearish-on-fixed-satellite-services/>

[on-fixed-satellite-services/](http://spacenews.com/on-fixed-satellite-services/) Accessed on September 19, 2015.

³⁴ While FSS Faces Challenges, New NSR Report Finds HTS Is Essential, SatNews, July 14, 2015. <http://webcache.googleusercontent.com/search?q=cache:uyziZBwdU40J:www.satnews.com/story.php%3Fnumber%3D738095275+&cd=1&hl=iw&ct=clnk&gl=il> Accessed on July 19, 2015. Global Satellite Capacity Supply & Demand, 12th Edition, Northern Sky Research, <http://www.nsr.com/research-reports/broadcast-digital-media/global-satellite-capacity-supply-and-demand-12th-edition/> Accessed on July 19, 2015.

so demand has waned. For example, in the past, China was a large market, acquiring imaging satellites from the West. However, in recent years, China developed its own capabilities in this field, and significantly decreased its purchase of foreign imaging satellites. Nevertheless, the prediction is that companies providing satellites with very high resolution (30 cm., or 12 inches) will continue to enjoy high demand.³⁵

Cooperation vs. Self-Reliance

2015 saw a continuation of the growing closeness between Russia and China in space activities. That association reinforces China's status, especially in light of the many cooperative ventures that China has woven with the space agencies of other leading countries. Russia and China have established a dialogue on various subjects, among them

navigation,³⁶ the establishment of a joint station on the moon³⁷ and even synchronization of hardware platforms and other technologies. China is also interested in setting up joint production of engines, although Russia is more interested in commercial ventures and selling engines,³⁸ particularly of the RD-180 type.³⁹

China also appears to be forging ties with space agencies in Europe. In January, the ESA announced that a European astronaut would participate on China's space station. This decision reflects one made by the ESA's government ministers concerning the Agency's three long-term strategic partners: China will join the U.S. and Russia in partnering with the ESA.⁴⁰ Upon retiring from his position, the Director General of the European Space Agency, Jean-Jacques

³⁵ Peter B. de Selding, Established Imagery Providers Face Changing Competitive Landscape, Space News, September 24, 2015.

<http://spacenews.com/established-imagery-providers-face-changing-competitive-landscape/#sthash.1l0y2xaB.dpuf> Accessed on September 29, 2015.

³⁶ Staff Writers, Russia, China Agree on Joint Exploitation of Glonass Navigation Systems, Space Daily, May 14, 2015. http://www.gpsdaily.com/reports/Russia_China_Agree_on_Joint_Exploitation_of_Glonass_Navigation_Systems_999.html Accessed on May 15, 2015.

³⁷ Staff Writers, Russia Invites China to Join in Creating Lunar Station, Moon Daily, April 29, 2015. http://www.moondaily.com/reports/Russia_Invites_China_to_Join_in_Creating_Lunar_Station_999.html Accessed on May 3, 2015.

³⁸ Staff Writers, Russia to Launch Large-Scale Space Projects With China, Space Daily, July 5, 2015. http://www.spacedaily.com/reports/Russia_to_Launch_Large_Scale_Space_Projects_With_China_999.html Accessed on July 8, 2015.

³⁹ Mike Gruss, Amid RD-180 Debate, Russia Aims To Sell Engines to China, Space News, July 16, 2015. <http://spacenews.com/russias-interest-in-selling-rocket-engines-to-china-could-add-fuel-to-rd-180-debate/#sthash.WgQ61oYn.dpuf> Accessed on July 18, 2015.

⁴⁰ Peter B. de Selding, ESA Hikes Budget, Takes Steps To Send Astronaut to Chinese Space Station, Space News, January 16, 2015. <http://spacenews.com/esa-hikes-budget-takes-steps-to-send-astronaut-to-chinese-space-station/#sthash.qD1A34vS.dpuf> Accessed on January 18, 2015.

Dordain, sharply criticized the U.S. for its efforts to exclude China from international space exploration. Dordain stated that the United States cannot continue its attempts to isolate China from space research. Rather, China should be guaranteed a place in the international array of countries working in this field.⁴¹ In October, the head of NASA said that the prohibition on cooperation with China in space activities is temporary and will end, at least in the field of space exploration. In response, the head of China's space agency, Xu Dazhe, said that his country would be happy to cooperate with the United States.⁴²

Russia and the ESA continue to cooperate on the ExoMars mission. In September, it was announced that the ESA is helping Russia to acquire the American components required for the project, because the sanctions that the U.S. imposed on Russia has made it difficult

for the latter to get many components that are necessary for its space mission, even though most of them have already been purchased. The mission's first unmanned probe is due to be launched at the beginning of 2016, and a robotic space vehicle is supposed to be sent to Mars in 2018. Russia plans to use domestically produced components for this mission, to avoid having to rely on foreign components.⁴³

Russia and the ESA are attempting to expand their cooperation on lunar missions, with joint plans for the Luna 27 mission. The mission's purpose is to explore the possibility of an extended stay on the moon, by landing on the moon's southern pole. The mission is slated for launch in another five years.⁴⁴

Russia has also been making efforts to reinforce its relationship with the other BRICS nations, i.e. Brazil, India, China and

⁴¹ Peter B. de Selding, Dordain Says ESA Cannot Go it Alone in Debris Mitigation, Space News, May 21, 2005. <http://spacenews.com/dordain-says-esa-cannot-go-it-alone-in-debris-mitigation/> Accessed on October 2, 2016.

⁴² Peter B. de Selding, China and the Moon Loom Large Yet Distant for Bolden, Woerner, Space News, October 16 2015, <http://spacenews.com/china-and-the-moon-loom-large-yet-distant-for-bolden-woerner/> Accessed on August 2, 2016. Irene Klotz, NASA Chief Says Ban on Chinese Partnerships is Temporary, Reuters, October 12, 2015, <http://www.reuters.com/article/us-space-usa-china->

[idUSKCN0S61SU20151012](http://www.reuters.com/article/us-space-usa-china-idUSKCN0S61SU20151012) , Accessed on August 2, 2016.

⁴³ Staff Writers, Europe Helps Russia get Banned US Electronics for ExoMars Project, TASS September 30, 2015, <http://tass.ru/en/science/824976>, accessed on February 8, 2016. Staff Writers, Russia, Europe Agree on Developing ExoMars Project, TASS, August 26, 2015 , <http://tass.ru/en/non-political/816654>, Accessed on February 8, 2016.

⁴⁴ Pallab Ghosh, Europe and Russia Mission to Assess Moon Settlement, BBC, October 16, 2015, <http://www.bbc.com/news/science-environment-34504067>, Accessed on February 8, 2016.

South Africa. As part of this endeavor, Russia announced its intention to invite the other BRICS countries to take part in the new space station that Russia is planning to establish.⁴⁵ At the BRICS summit in July, the president of Russia said that Russia and Brazil are considering establishing a joint project to identify and follow-up on space debris. That was in addition to the decision to build two ground stations of the Russian navigation system, Glonass, on Brazilian soil. During the summit, Russia and India agreed to strengthen their cooperation with each other, primarily in jointly developing vehicles for the navigation satellite systems of both countries, and better coordination between the systems.⁴⁶

At the same time, a number of spacefaring nations maintain a great deal of self-reliance when it comes to space activities. Up until

2009, China acquired most of its satellite imagery from Europe and the U.S. Since then, China has made efforts to develop independent capability in this field, initially with low resolution, but later with higher-resolution satellites. In 2015, China launched a number of advanced observation satellites, which significantly reduced China's dependence on other countries in this field.⁴⁷

Russia, too, has increased its self-reliance, most obviously in upgrading its navigation satellite system. Russia is working to establish an independent monitoring system, increasingly relying on data from its own remote sensing satellites, and much less on data from foreign satellites.⁴⁸ Russia is also heading toward greater self-reliance in constructing electronic components for its navigation system. Russia has reported that within two years, its domestic industry will

⁴⁵ Staff Writers, BRICS May Engage in New Int'l Orbital Station Project, Space Daily, April 14, 2015, http://webcache.googleusercontent.com/search?q=cache:QzpMKURcVUEJ:www.spacedaily.com/reports/BRICS_May_Engage_in_New_Intl_Orbital_Station_Project_999.html+&cd=1&hl=iw&ct=clnk&gl=il, Accessed on February 8, 2016.

⁴⁶ Staff Writers, Putin: Russia, Brazil to Track Space Junk With GLONASS Navigation System, Sputnik News, July 8, 2015, <http://sputniknews.com/politics/20150708/1024389453.html>, Accessed on February 8, 2016. Staff Writers, Russia, India Cooperate on Space Exploration, Glonass Satellite System, Sputnik News, June 30, 2015, <http://sputniknews.com/science/20150630/1024040956.html>, Accessed on February 8, 2016.

⁴⁷ Peter B. de Selding, China Launches High-resolution Commercial Imaging Satellite, Space News, October 7, 2015, <http://spacenews.com/china-launches-high-resolution-commercial-imaging-satellite/>, Accessed on February 8, 2016. Staff Writers, China Launches A Jilin-1 Foursome, Satnews Daily, October 7, 2015, <http://www.satnews.com/story.php?number=1980596976>, Accessed on February 8, 2016.

⁴⁸ Staff Writers, Russia Reduces Reliance on Foreign Satellite Data, Space Daily, December 30, 2015, http://www.spacedaily.com/reports/Russia_reduces_reliance_on_foreign_satellite_data_999.html, Accessed on February 8, 2016.

be able to produce electronic components for its Glonass navigation system, and thus will no longer have to depend on foreign components.⁴⁹

Space Security and Sustainability

The U.S. continues to reinforce its defensive capabilities, which is manifest in a considerable increase in the budget devoted to space defense. The subject is obviously high on the U.S.'s list of priorities. A number of senior American officials supported this increase, stating that the U.S. is a threatened target, and must act accordingly. As part of these efforts, the U.S. has reinforced its Situational Space Awareness [SSA] system via a series of bilateral agreements to cooperate in sharing data, among other things. In January, it was announced that Germany and the U.S. had signed a

cooperative agreement;⁵⁰ in the spring, the agreement with France was upgraded;⁵¹ and in the summer, the U.S. and Israel signed a similar agreement.⁵² In March, the U.S. participated in a strategic dialogue on the subject of space with India, with the aim of reinforcing the cooperation between the two countries.

It should be noted that the number of countries that see SSA as important, and which invest in it, is increasing; many are developing independent SSA capabilities. For example, Russia began to establish an independent system to monitor and follow up on entities in space, to provide better protection for its properties in space.⁵³ In June, the Russian Ministry of Defense announced an upgrade for its existing system.⁵⁴ As part of these efforts, Russia will

⁴⁹ Staff Writers, Glonass System Can Fully Switch to Domestic Electronics in 2 Years, GPS Daily, October 6, 2015,

http://www.gpsdaily.com/reports/Russias_Glonass_System_Can_Fully_Switch_to_Domestic_Electronics_in_2_Years_999.html, Accessed on February 8, 2016.

⁵⁰ Mike Gruss, U.S. and Germany Sign Space Surveillance Pact, Space News, January 31, 2015, <http://spacenews.com/u-s-and-germany-sign-space-surveillance-pact/>, Accessed on February 8, 2016.

⁵¹ Mike Gruss, U.S., France Expand Space Data-sharing Agreement, Space News, April 16, 2015, <http://spacenews.com/us-france-expand-space-data-sharing-agreement/>, Accessed on February 8, 2016.

⁵² Judy Siegel-Itzkovich, US-Israel Cooperation Agreement Signed to Prevent Satellite Collisions in Space, The Jerusalem Post, August 17, 2015, <http://www.jpost.com/Business-and-Innovation/Health-and-Science/US-Israel->

[cooperation-agreement-signed-to-prevent-satellite-collisions-in-space-412370](http://www.gpsdaily.com/reports/Russias_Glonass_System_Can_Fully_Switch_to_Domestic_Electronics_in_2_Years_999.html), Accessed on February 8, 2016.

⁵³ Staff Writers, Guardians of the Galaxy: Russia Creates International Space Patrol, Space Daily, Apr 12, 2015,

http://www.spacedaily.com/reports/Guardians_of_the_Galaxy_Russia_Creates_International_Space_Patrol_999.html, Accessed on February 8, 2016. Staff Writers, Guardians of the Galaxy: Russia Creates International Space Patrol, Sputnik News, April 1, 2015, <http://sputniknews.com/military/20150401/1020316462.html>. Accessed on February 8, 2016.

⁵⁴ Staff Writers, Russia to Build New Generation Space Surveillance Systems, Space War, June 22, 2015, http://www.spacewar.com/reports/Russia_to_Build

establish 12 new facilities for monitoring from space. The first of these will be established in Siberia, with the project slated for completion in 2018.⁵⁵ Similarly, the European Union has begun to move forward on establishing a space surveillance network, via a consortium composed of five countries: France, Germany, Italy, Spain and the UK. The purpose is to coordinate the optical and radar tracking telescopes that they each have in space. The consortium will set up a Security Committee, which will decide which nations shall have access to the data. The EU has budgeted 70 million euros (approximately 80 million dollars) for the program, which will continue for five years, and will operate apart from the ESA's space surveillance program. The purpose of the program, which was first approved in 2014, is to reduce Europe's dependency on the American space surveillance system, and enhance Europe's autonomy in this field.⁵⁶

[New Generation Space Surveillance Systems 999.html](#), Accessed on February 8, 2016.

⁵⁵ Staff Writers, Siberia Home to New Russian Space Monitoring Complex, Space Daily, July 3, 2015, http://www.spacedaily.com/reports/Siberia_Home_to_New_Russian_Space_Monitoring_Complex_999.html, Accessed on February 8, 2016.

⁵⁶ Peter B. de Selding, A European Space Surveillance Network Inches Forward, Space News, June 17, 2015, <http://spacenews.com/a-european-space-surveillance-network-inches-forward/>, Accessed on February 8, 2016.

China established a center for monitoring space debris, managed by the State Administration of Science, Technology and Industry for National Defense [SASTIND] and the Chinese Academy of Sciences [CAS]. The head of CAS, Yan Jun, said that 30 instances per annum had been documented of space debris coming within 100 meters (328 feet) of Chinese orbiting satellites.⁵⁷ India is developing sophisticated radar to track ten objects simultaneously, from a distance of 1,000 km. [620 miles]. Using it, the Indian Space Agency will be able to track the return of space vehicles to earth's atmosphere, protect its property in space, and monitor space debris.⁵⁸

Today, most security activity in space is conducted by the U.S. military, which provides warnings to foreign governments about possible dangers of satellite collisions. As tracking becomes more important, commercial space companies are

⁵⁷ Zhang Tao (Ed.), China Launches Space Junk Monitoring Center, China Military Online, August 6, 2015, http://english.chinamil.com.cn/news-channels/2015-06/08/content_6530203.htm, Accessed on February 8, 2016.

⁵⁸ Staff Writers, ISRO to Launch First Indigenous Multi-object Tracking Radar in Next 3 Months, Space Daily, May 21, 2015, http://www.spacedaily.com/reports/ISRO_to_launch_first_indigenous_multi_object_tracking_radar_in_next_3_months_999.html, Accessed on February 8, 2016.

increasingly interested in entering this field. Opportunities seem to be offered by the dissatisfaction with the present system, encompassing complaints about the quality of the data, imprecision in warnings and false positives. Lockheed-Martin is a good example of this. The company has already begun to establish private monitoring and tracking stations, to provide data to the government as well as to operators of private satellites. According to commercial sources, the demand for such a service made by the operators of private satellites justifies activities in this area, even without the government as a market.⁵⁹

In recent years, a number of international efforts have been in process, with the purpose of drawing up rules of operation and agreements, so as to ensure sustainability in the space environment. In July 2015, a discussion was held in New York regarding the International Space Code of Conduct. The strategic tensions between the U.S. and Russia, and between the U.S. and China, have affected these processes as well, making

agreement on this issue only a distant possibility. Progress at the multilateral diplomatic level suffers from deceleration and even stagnation, and the future of the code is uncertain. Nevertheless, increasing awareness in various countries of the necessity of taking responsibility and dealing with subjects important to the space environment can be discerned. Some countries have been acting independently to reduce the space debris that they generate, or to monitor the objects floating around in space.

Issues of jamming, disruptions and damage to the continuous operation of space systems have sharpened, and awareness of these problems has increased. Russia reported that it has developed a new electronic system of warfare that can operate from the ground, from the air or from the sea. The system can halt the operations of satellites; and of communications, navigation and location systems; and can neutralize high-precision weaponry.⁶⁰ China announced a breakthrough in developing anti-jamming

⁵⁹ Ilima Loomis, Private Firms Spy a Market in Spotting Space Junk, Nature, September 23, 2015, <http://www.nature.com/news/private-firms-spy-a-market-in-spotting-space-junk-1.18425>, Accessed on February 2, 2016. Warren Ferster, AGI Wins \$8.4 Million Air Force Contract for Orbital Data, Space News, October 1, 2015, [http://spacenews.com/agi-](http://spacenews.com/agi-wins-8-4-million-air-force-contract-for-orbital-data/)

[wins-8-4-million-air-force-contract-for-orbital-data/](http://spacenews.com/agi-wins-8-4-million-air-force-contract-for-orbital-data/), Accessed on February 8, 2016.

⁶⁰ Mark Prigg, Russia Boasts Secret 'Super Weapon' ... Switches Off Foreign Satellites + Enemy Weapons... Claims Yet To Be Proven, Satnews Daily, July 7, 2015, <http://www.satnews.com/story.php?number=1463924365>, Accessed on February 8, 2016.

capability for its satellite navigational system, Beidou.⁶¹

Overview of Space Activities by Country

The United States

At the beginning of the year, a sharp congressional fight occurred in both houses regarding the role of NASA. In general, the Republicans want NASA to focus on space exploration and human spaceflights, and tried to reduce its research activities and earth observation missions. The Democrats are opposed to this and see these demands of NASA as wrong, with negative ramifications for space activity in the U.S.⁶² NASA, for its part, is continuing to develop its new Space Launch System, [SLS]⁶³ and the Orion spacecraft designed for human flights into deep space. However, apparently NASA's first flight of its human space vehicle will be

delayed for more than a year from the original target date of August, 2021.⁶⁴

At the end of March, NASA chose the concept for its planned asteroid mission. NASA chose Option B for its Asteroid Redirect Mission [ARM]. The plan calls for a robotic vehicle to pick up a boulder up to 4 meters (13 feet) across from the surface of an asteroid. This smaller asteroid would then be sent into a retrograde lunar orbit. An Orion spacecraft with two astronauts would then fly to the new, smaller asteroid and collect samples for study on earth. This option was chosen over Option A, wherein a robotic spacecraft would redirect an entire small asteroid into a lunar orbit. Option B was chosen because it provides a much broader range of potential targets and integrates more technology that can be useful in the future. The choice was made despite the fact that Option B is more expensive than Option A.⁶⁵

⁶¹ Staff Writers, China's Beidou Navigation System More Resistant to Jamming, GPS Daily, June 28, 2015,

http://www.gpsdaily.com/reports/Chinas_Beidou_navigation_system_more_resistant_to_jamming_999.html, Accessed on February 8, 2016.

⁶² Jeff Foust, Senators, Bolden Clash over the "Core Mission" of NASA, Space News, March 12, 2015, <http://spacenews.com/senators-bolden-clash-over-the-core-mission-of-nasa/>, Accessed on February 8, 2016.

Jeff Foust, Mikulski Vows To Increase NASA's 2016 Budget, Space News, April 27, 2015, <http://spacenews.com/mikulski-vows-to-increase-nasas-2016-budget/>, Accessed on February 8, 2016.

⁶³ Staff Writers, NASA's Space Launch System Booster Passes Major Ground Test, Space Daily, March 15, 2015,

http://www.spacedaily.com/reports/NASAs_Space_Launch_System_Booster_Passes_Major_Ground_Test_999.html, Accessed on February 8, 2016.

⁶⁴ Jeff Foust, First Crewed Orion Mission May Slip to 2023, Space News, September 16, 2015, <http://spacenews.com/first-crewed-orion-mission-may-slip-to-2023/>, Accessed on February 8, 2016.

⁶⁵ Jeff Foust, NASA Selects Boulder Option for Asteroid Redirect Mission, Space News, March 25, 2015, <http://spacenews.com/nasa-selects-boulder->

Exploration of Mars: In April, NASA announced that, to maintain flexibility, it was delaying decisions on the Mars mission until after the elections.⁶⁶ Nevertheless, despite the fact that the mission to Mars is expected to take place in another 20 years, NASA has begun initial examination of possible landing sites on Mars.⁶⁷

2015 will be remembered as the year in which legislation began to address space mining. In May, a Commercial Space Law was passed in the House of Representatives for the first time, which includes provisions to protect the rights of private companies that will mine asteroids for minerals.⁶⁸ After a great deal of negotiations and compromises to reconcile the House and Senate versions of the bill, it was passed and signed into law by the President. The Law is designed to increase

[option-for-asteroid-redirect-mission/](#), Accessed on February 8, 2016.

⁶⁶ Jeff Foust, NASA Hopes Mars Plans Flexible Enough To Survive Administrations, Space News, April 10, 2015, <http://spacenews.com/nasa-hopes-mars-plans-flexible-enough-to-survive-administrations/>, Accessed on February 8, 2016.

⁶⁷ Jeff Foust, NASA Begins Effort To Find Landing Sites for Human Mars, Space News, October 30, 2015, <http://spacenews.com/nasa-begins-effort-to-find-landing-sites-for-human-mars-missions/>, Accessed on February 8, 2016.

⁶⁸ Jeff Foust, House Approves Commercial Space Bill, Space News, May 21, 2015, <http://spacenews.com/house-approves-commercial-space-bill/>, Accessed on February 8, 2016. Jason Koebler, The US Mulls Breaking an International Treaty So Americans Can Mine Asteroids, MotherBoard, May 14, 2015,

commercial space activity and competition, by renewing approval for and lengthening the time period during which the government can provide tools to commercial companies. These include such things as indemnification for third party damages arising from commercial launches. In addition, the Law lengthens the period of time that the international space station can be used.⁶⁹

Security in Space: An increasing number of reports during the past year pointed to a broad array of threats to the U.S.'s space activities which are cause for concern. The Department of Defense's budget reflects this worry. This is an expression of the strategic importance accorded the ability to control space, and particularly to protect satellites and the space systems.⁷⁰ In addition, although disaggregation had been touted as the best

http://motherboard.vice.com/read/the-us-mulls-breaking-an-international-treaty-so-americans-can-mine-asteroids?utm_source=mbfb, Accessed on February 8, 2016.

⁶⁹ Jeff Foust, U.S. Senate Passes Compromise Commercial Space Bill, Space News, November 11, 2015, <http://spacenews.com/u-s-senate-passes-compromise-commercial-space-bill/>, Accessed on February 8, 2016.

⁷⁰ Colin Clark, US Commits \$5B In NEW \$\$ To Countering Space Threats; HASC Protects It, Breaking Defense, April 22, 2015, <http://breakingdefense.com/2015/04/us-commits-5b-in-new-to-countering-space-threats-china-russia/> Accessed on February 8, 2016. February 8, 2016 Colin Clark, US Presses Russia, China On ASAT Tests; Space Control Spending Triples, Breaking Defense, April 16, 2015,

way to stay ahead of competing countries in space, the Air Force is now leaning to an even broader approach, known as "space protection".⁷¹

Additionally, even though the U.S. sees China as a threat to its security in space, or perhaps precisely because of that, the U.S. has begun to establish links to China on the subject of protection for civilian space endeavors. The first meeting between the U.S. and China, as part of the official dialogue on space, took place in Beijing in October. Both sides agreed on the importance of the meeting and on the need to strengthen the ties between the two countries vis-à-vis space, and they agreed to hold another meeting in 2016.⁷² Discussions with China have also taken place regarding meteorology. At the end of August, the second meeting

between high-ranking meteorologists from the U.S.'s NOAA and their Chinese counterparts took place. Agreement was reached regarding the importance of continuing cooperation between the two countries during the discussions. They also discussed possible cooperative projects.⁷³

The trend toward commercialization and privatization of space activities in the U.S. continues and in fact, is expanding. The U.S. Air Force has taken a number of steps to transfer services to the private sector, including integrating private satellite operators into military space operations and including them in the Defense Department's Joint Space Operations Center (JSpOC).⁷⁴ The purpose of these processes is to reduce costs, streamline activities and enable the Air Force to focus its activities on space missions

http://breakingdefense.com/2015/04/space-control-spending-triples/?utm_source=Breaking+Defense&utm_campaign=f5420eb54a-RSS_EMAIL_CAMPAIGN&utm_medium=email&utm_term=0_4368933672-f5420eb54a-408021789, Accessed on February 8, 2016.

⁷¹ Mike Gruss, Disaggregation Giving Way to Broader Space Protection Strategy, Space News, <http://spacenews.com/disaggregation-giving-way-to-broader-space-protection-strategy/>, Accessed on February 8, 2016.

⁷² Staff Writers, The First Meeting of the U.S.-China Space Dialogue, Space Daily, October 01, 2015, http://www.spacedaily.com/reports/The_First_Meeting_of_the_U_S_China_Space_Dialogue_999.html, Accessed on February 8, 2016.

⁷³ Staff Writers, The Second China-US High-level Meeting on Satellite Matters was Held, Terra Daily, September 2, 2015, http://www.terradaily.com/reports/The_second_China_US_high_level_meeting_on_satellite_matters_was_held_999.html, Accessed on February 8, 2016.

⁷⁴ Mike Gruss, U.S. Air Force Initiative To Put Commercial Seats in JSpOC, Space News, March 18, 2015, <http://spacenews.com/u-s-air-force-initiative-to-put-commercial-seats-in-jspoc/>, Accessed on February 8, 2016. Aaron Mehta, Commercial Space Eyes Greater Share, Defense News, April 13, 2015, <http://www.defensenews.com/story/defense/air-space/space/2015/04/13/commercial-space-greater-share/25356941/>, Accessed on February 8, 2016. Spacenews, Vol. 26, No. 2 (June 15, 2015), p. 8.

that are more purely defense in nature. One of the most interesting examples in this context is that the Air Force is examining the possibility of transferring responsibility for preventing collisions in space from the JSpOC to civilian entities.⁷⁵ In another instance, with the purpose of improving its capabilities, the National Geospatial-Intelligence Agency [NGA] announced that it was looking into the use of new imaging products available on the commercial market.⁷⁶

The engine issue, which began as a result of the tension between Russia and the U.S. over the Crimean and Ukrainian crises, became an internal American issue pitting the industry and the Air Force in a dispute with Congress. The company, United Launch Alliance [ULA], which has a virtual monopoly on the

national security market, has asked Congress to increase the number of Russian rockets that it is allowed to acquire, which was restricted by an act of Congress. ULA claims that the ban makes it difficult to develop its new launcher,⁷⁷ and the American Air Force is supporting the company in its efforts.⁷⁸ At the end of the year, ULA announced that it was pulling out of the Department of Defense competition to launch the GPS-III satellites. That announcement came after ULA issued repeated warnings, to the effect that it would be unable to continue developing the new engines without continued access to the Russian RD-180 engines it currently uses.⁷⁹ This step, and the company's lobbying efforts, with pressure from the Air Force, led

⁷⁵ Mike Gruss, Strategic Command Envisions Civil Space Traffic Management, Space News, June 16, 2015, <http://spacenews.com/strategic-command-envisions-civil-space-traffic-management/>, Accessed on February 8, 2016. Sydney J. Freedberg Jr., STRATCOM Must Be Warfighters, Not FAA In Space: Lt. Gen. Kowalski, Breaking Defense, June 16, 2015, <http://breakingdefense.com/2015/06/stratcom-must-be-warfighters-not-faa-in-space-lt-gen-kowalski/>, Accessed on February 8, 2016.

⁷⁶ Gruss, Mike, "New NGA Strategy Aims to Exploit Commercial Satellite Imagery Boom", Space News, Vol. 26, Issue 38 (October 26, 2015): Page 1, <http://bt.e-ditionsbyfry.com/publication/?i=277974> Accessed October 28, 2015.

⁷⁷ Warren Ferster, ULA Execs Say RD-180 Engine Ban Blocks Path to Next-gen, Space News, May 22, 2015, <http://spacenews.com/ula-execs-say-rd-180-engine-ban-blocks-path-to-next-gen-rocket/>,

<http://spacenews.com/ula-execs-say-rd-180-engine-ban-blocks-path-to-next-gen-rocket/>,

Accessed on February 8, 2106.

⁷⁸ Staff Writers, US Space Command Warns on Overly Fast Russian Rocket Engine Phase Out, Space Daily, July 1, 2015,

http://www.spacedaily.com/reports/US_Space_Command_Warns_Not_to_Phase_Out_Russian_Rocket_Engine_Too_Quickly_999.html, Accessed on February 8, 2016. Mike Gruss, Air Force Says ULA Will Need 18-22 RD-180s To Compete with SpaceX, Space News, July 27, 2015, <http://spacenews.com/air-force-says-ula-will-need-18-22-rd-180s-to-compete-with-spacex/>, Accessed on February 8, 2016.

⁷⁹ Lara Seligman, ULA Pulls Out of DoD's Space Launch Competition, Defense News, November 18, 2015, <http://www.defensenews.com/story/defense/air-space/2015/11/18/ula-pulls-out-dods-space-launch-competition-2/75980998/>, Accessed on February 8, 2016.

the Senate to allow the ULA to acquire 20 more Russian rockets.⁸⁰

Russia

Space activity in Russia continues to experience difficulties and failures, due to technological failures and economic problems stemming from the financial crisis in Russia. A number of launch failures occurred this year. The first took place in April, when a supply ship for the International Space Station spun out of control.⁸¹ A month later, a launch failure destroyed a Mexican communications satellite.⁸² At the end of the year, a partial failure occurred in the launch of Russian satellites, when the Soyuz 2.1v, launched from the Plesetsk Cosmodrome, failed to

separate completely. One of the payloads was lost, while the other reached its destination orbit.⁸³

After the first two failures mentioned above, the Russian government strongly criticized the space sector.⁸⁴ As a result, a number of reforms were instituted in the Russian space industry. Among others, they included re-organization of the Roscosmos space agency into a corporation that will include as subsidiaries all of the Russian manufacturers related to space, and increase the salaries of employees in the space industry.⁸⁵ Russia has begun implementing these reforms by merging the Russian space agency and the Russian commercial corporation, United Rocket and Space Corporation [URSC]. The

⁸⁰ Andrea Shalal, ULA Orders 20 More RD-180 Rocket Engines, Space News, December 23, 2015, <http://spacenews.com/ula-orders-20-more-rd-180-rocket-engines/>, Accessed on February 8, 2016.

⁸¹William Harwood, Russia Scrambles to Restore Cargo Ship Communications, CBS News, April 28, 2015, <http://www.cbsnews.com/news/russians-scramble-to-restore-progress-cargo-ship-communications/>, Accessed on February 8, 2016. Jeff Foust, Progress Failure Puts Burden on Upcoming Resupply Missions, Space News, May 1, 2015, <http://spacenews.com/progress-failure-puts-burden-on-upcoming-resupply-missions/>, Accessed on February 8, 2016. Jeff Foust, Progress Docking Called Off, Space News, April 29, 2015, <http://spacenews.com/progress-docking-called-off/>, Accessed on February 8, 2016.

⁸² Staff Writers, Russia Loses Mexican Satellite After Rocket Failure, Space Daily, May 16, 2015, http://www.spacedaily.com/reports/Russia_loses_Mexican_satellite_after_rocket_failure_999.html, Accessed on February 8, 2016.

For the official wording on the reason for the failure, see: Peter B. de Selding, Russian Statement on Proton Failure Leaves Questions, Space News, May 30, 2015, <http://spacenews.com/russian-statement-on-proton-failure-leaves-questions/>, Accessed on February 8, 2016.

⁸³ Marcia S. Smith, Another Launch Failure for Russia, Space Policy Online.com, December 7, 2015, <http://www.spacepolicyonline.com/news/another-launch-failure-for-russia>, Accessed on February 8, 2016.

⁸⁴ Staff Writers, Failure is Not an Option for Russian Space Industry, Space Daily, May 21, 2015, http://www.spacedaily.com/reports/Failure_Is_Not_An_Option_For-Russian_Space_Industry_999.html, Accessed on February 8, 2016.

⁸⁵ Staff Writers, Russian Deputy PM Attacks Space Industry with Reform Bill, Space Daily, May 20, 2015, http://www.spacedaily.com/reports/Russian_deputy_PM_attacks_space_industry_with_reform_bill_999.html, Accessed on February 8, 2016.

resulting corporation will oversee all Russian space development and production.⁸⁶ Under this new structure, a number of holding companies will be formed. Each branch of the space industry will have its own holding company, with the companies involved in that branch organized under it. Thus, development of launchers, satellite construction, engine manufacturers, in-orbit operations, guidance systems, scientific research, etc. will each have a holding company of its own.⁸⁷ The Russian parliament approved a series of laws enabling these changes in July.⁸⁸ At the end of December, the Russian president signed the

order to dismantle the Russian space agency so that it could be re-organized as described above.⁸⁹

At the same time, Russia is drawing up its plans for future space exploration, with the moon as its principal objective.⁹⁰ To achieve this objective, Russia is promoting technological projects and cooperation with other space agencies, among them that of China,⁹¹ the ESA and others. In addition to its target of a human moon landing, Russia continues to advance its ExoMars program to Mars, which is being implemented in

⁸⁶ Staff Writers, Russia to Create World's First Rocket Engine Manufacturing Holding, Space Daily, May 1, 2015,

http://www.spacedaily.com/reports/Russia_to_Create_Worlds_First_Rocket_Engine_Manufacturing_Holding_999.html, Accessed on February 8, 2016.

⁸⁷ Peter B. de Selding, Latest Proton Failure Leaves Customers, Insurers in a Bind, Space News, May 29, 2015, <http://spacenews.com/proton-failure-leaves-customers-insurers-in-a-bind-2/>, Accessed on February 8, 2015.

Staff Writers, Recent Proton Loss to Push Up Launch Costs, Warns Manufacturer, Space Daily, May 27, 2015,

http://www.spacedaily.com/reports/Recent_Proton_loss_to_push_up_launch_costs_warns_Manufacturer_999.html, Accessed on February 8, 2016.

⁸⁸ Staff Writers, Russia's Lower House Passes Law on Roscosmos Space Corporation, Space Daily, July 7, 2015,

http://webcache.googleusercontent.com/search?q=cac he:WTgeQTYzhkYJ:www.spacedaily.com/reports/Russias_Lower_House_Passes_Law_on_Roscosmos_Space_Corporation_999.html+&cd=1&hl=iw&ct=clnk&gl=il, Accessed on February 2, 2016. Staff Writers, Export Revenue to help Russian space industry cut expenditures, Space Daily, July 10, 2015, <http://webcache.googleusercontent.com/search?q=cac>

http://www.spacedaily.com/reports/Export_Revenue_to_Help_Russian_Space_Industry_Cut_Expenditures_999.html+&cd=1&hl=iw&ct=clnk&gl=il, Accessed on February 8, 2016. Staff Writers, Russia Starts Implementation of Fundamental Space Industry Reform, Space Daily, July 16, 2015, http://webcache.googleusercontent.com/search?q=cac he:hcQgGLdzNxYJ:www.spacedaily.com/reports/Russia_Starts_Implementation_of_Fundamental_Space_Industry_Reform_999.html+&cd=1&hl=iw&ct=clnk&gl=il, Accessed on February 8, 2016.

⁸⁹ Brooks Hays, The Last and First Day for Roscosmos, Space Daily, December 31, 2015, http://www.spacedaily.com/reports/Today_is_the_last_day_for_Roscosmos_999.html, Accessed on February 8, 2016.

⁹⁰ Staff Writers, Russia Plans to Start Moon Exploration Jointly With Partners, Moon Daily, March 15, 2015, http://www.moondaily.com/reports/Russia_Plans_to_Start_Moon_Exploration_Jointly_With_Partners_999.html, Accessed on February 8, 2016.

⁹¹ Staff Writers, Russia Invites China to Join in Creating Lunar Station, Moon Daily, Apr. 29, 2015, http://www.moondaily.com/reports/Russia_Invites_China_to_Join_in_Creating_Lunar_Station_999.html, Accessed on February 8, 2016.

cooperation with the European Union.⁹² In addition to this program, Russia announced that it expects to participate in every future human space flight to Mars.⁹³

Due to the decrease in the value of the Russian ruble, the cost of Russian space activity increased by 30%.⁹⁴ As a result, Russia's space programs for the next decade were cut back by 15 billion dollars. Nevertheless, Russia sees its space programs as an important factor in its international status. Thus, it wants to continue its plans for space exploration and research, and for human flights to the moon and even beyond that.⁹⁵ At the end of the year, Deputy Prime Minister for Defense Rogozin, in speaking on

the subject, reiterated Russia's pledge to continue working toward its space goals.⁹⁶

In 2014, Russia noted that its commercial space activities were weak, and focused on reinforcing them. Thus, by June 2015, Russia's space agency announced the establishment of an imaging center and the initial launch of a fleet of observation satellites, so as to strengthen Russia's standing in the commercial imaging market.⁹⁷

Further to what was written above in the overview of space security and sustainability, Russia could point to an achievement in November, when it successfully tested its new anti-satellite rocket.⁹⁸ In military space

⁹² Staff Writers, Russia-EU Mars Research Program to Be Completed, Mars Daily, January 13, 2015, http://www.marsdaily.com/reports/Russia_EU_Mars_Research_Program_to_Be_Completed_999.html, Accessed on February 8, 2016.

⁹³ Staff Writers, Roscosmos: Manned Flight to Mars Will Be Impossible Without Russia's Help, Mars News, Mar. 15, 2015, http://www.marsdaily.com/reports/Roscosmos_Manned_Flight_to_Mars_Will_Be_Impossible_Without_Russias_Help_999.html, Accessed on February 8, 2016.

⁹⁴ Staff Writers, Russian Space Program Costs Soar 30% Over Sanctions, Sputnik News, May 21, 2015, <http://sputniknews.com/russia/20150521/1022401349.html>, Accessed on February 8, 2016.

⁹⁵ Staff Writers, Russia to Continue Development of Nuclear Engine for Deep Space Flights, Space Daily, Apr. 29, 2015, http://www.spacedaily.com/reports/Russia_to_Continue_Development_of_Nuclear_Engine_for_Deep_Space_Flights_999.html, Accessed on February 8, 2016.

⁹⁶ Staff Writers, Death Rumors of Russian Lunar Program 'Greatly Exaggerated' – Deputy PM, Moon Daily, December 31, 2015,

http://www.moondaily.com/reports/Death_rumors_of_Russian_lunar_program_greatly_exaggerated_Deputy_PM_999.html, Accessed on February 8, 2016. Staff Writers, Russia Postpones Plans on Extensive Moon Exploration Until 2025, Moon Daily, December 30, 2015, http://www.moondaily.com/reports/Russia_Postpones_Plans_on_Extensive_Moon_Exploration_Until_2025_999.html, Accessed on February 8, 2016.

⁹⁷ Staff Writers, Roscosmos to Launch More Satellites, Set up Imaging Center, Space Daily, June 22, 2015, http://www.spacedaily.com/reports/Roscosmos_to_Launch_More_Satellites_Set_up_Imaging_Center_999.html, Accessed on February 8, 2016.

⁹⁸ Staff Writers, Russia Flies Strategic Space Warfare Missile, Space War, December 3, 2015, http://www.spacewar.com/reports/Russia_flies_strategic_space_warfare_missile_999.html, Accessed on February 8, 2016.

activities, Russia's army merged its Air Force; anti-air, anti-missile defenses; and space forces under a single command structure. The commander of the Air Force will head the new Aerospace Force, which will be responsible for all of Russia's military activities in space. The purpose of the re-organization was to better coordinate and streamline development and implementation of air and space forces; and to place increasing focus on aerospace.⁹⁹

During the year, the conflict between Russia and Canada over territorial claims to the Arctic "heated up". In August, Russia submitted its renewed claims for Arctic territory to the UN Commission on the Limits of the Continental Shelf.¹⁰⁰ That same month, Russia announced that it was going to establish a system to monitor environmental conditions in the Arctic Circle. The system

⁹⁹ Staff Writers, Guarding Space: Russia Creates a New Branch of the Armed Forces, Space War, August 4, 2015, http://www.spacewar.com/reports/Guarding_Space_Russia_Creates_a_New_Branch_of_the_Armed_Forces_999.html, Accessed on February 8, 2016. Matthew Bodner, Russia Merges AF With Missile Defense, Space Commands, Defense News, August 8, 2015, <http://www.defensenews.com/story/defense/air-space/air-force/2015/08/08/russia-merges-af-missile-defense-space-commands/31221349/>, Accessed on February 8, 2016.

¹⁰⁰ Atle Staalesen, Russia Submits Claim for North Pole, Barents Observer, August 4, 2015, <http://barentsobserver.com/en/arctic/2015/08/russia-a-submits-claim-north-pole-04-08> Accessed on August 7, 2015.

would integrate civilian and military elements, and completion is planned for 2025. The cost is some six billion rubles (93 million dollars). The system would involve a range of sensors and data collection elements, including radar, satellite systems and remote-controlled devices like drones, on land, under water, in the sky and in space.¹⁰¹

China

In general, China's international status vis-à-vis space has strengthened. China has reinforced its ties to various countries in Europe and with the ESA. Despite the American prohibition, China may be allowed to dock one of its space vehicles at the International Space Station.¹⁰²

Concerning launchings, China announced that it had successfully completed all of the required tests on its upgraded Long March-5

¹⁰¹ Staff Writers, Russia to Create Multimillion Dollar Arctic Monitoring System by 2025, Space Daily, August 10, 2015, http://www.spacedaily.com/reports/Russia_to_Create_Multimillion_Dollar_Arctic_Monitoring_System_by_2025_999.html, Accessed on February 8, 2016.

¹⁰² Jonathan O'Callaghan, Is China About to Join the International Space Station? Historic Talks With the US are Taking Place, Claims Russian Cosmonaut, The Daily Mail, May 29, 2015, <http://www.dailymail.co.uk/sciencetech/article-3102679/Is-China-join-International-Space-Station-Historic-talks-taking-place-claims-Russian-cosmonaut.html>, Accessed on February 8, 2016.

engine, and it will be ready for its first launch in 2016.¹⁰³ Development of the launch engine is part of the Chinese lunar program; plans call for the program to be completed in 2017, with the launch of a mission to the moon.¹⁰⁴ China has continued to develop its second space laboratory, Tiangong 2, as part of its planned human space flights and scientific research programs. In fact, China announced that in 2016, it plans to launch Tiangong 2.¹⁰⁵

In the field of space security, China passed a new national security law, which defines cyberspace and outer space as part of China's national interests, in addition to the deep ocean and the polar regions. The Law also stipulates that the Chinese government is to protect the sovereignty of these areas.¹⁰⁶ A report issued annually in the U.S. regarding China's capabilities stated that China continues to upgrade its capabilities. That includes China's ability to disrupt the U.S.'s

space systems in wartime. For example, China can launch anti-satellite missiles from the ground; it is capable of using satellite-based weapons to disrupt other satellites; it can launch ground missiles against ground support facilities, thereby disrupting control of satellites; it can use cyber -attacks to jam U.S. control of its satellites or take control of them itself; and can even use nuclear weapons to damage satellites. The report also stated that China had already tested these systems, to determine their readiness and reliability. It was also reported that, apparently, China was behind the cyber-attack on the American space system in September, 2014.¹⁰⁷

¹⁰³ Andrew Jones, China's Largest Ever Rocket Cleared for 2016 Launch after Completing Tests, GB Times, August 18, 2015, <http://gbtimes.com/china/chinas-largest-ever-rocket-cleared-2016-launch-after-completing-tests>, Accessed on February 8, 2016.

¹⁰⁴ Staff Writers, China Completes Second Test on New Carrier Rocket's Power System, Space Daily, March 24, 2015, http://www.spacedaily.com/reports/China_completes_second_test_on_new_carrier_rockets_power_system_999.html, Accessed on February 8, 2016.

¹⁰⁵ Morris Jones, China's Space Laboratory Still Cloaked, Space Daily, March 10, 2015,

http://www.spacedaily.com/reports/Chinas_Space_Laboratory_Still_Cloaked_999.html, Accessed on February 8, 2016.

¹⁰⁶ Neil Connor, China Targets Web Control with New National Security Law, Space War, July 1, 2015, http://www.spacewar.com/reports/China_targets_web_control_with_new_national_security_law_999.html, Accessed on February 8, 2016.

¹⁰⁷ Staff Writers, New Details Emerge About China's Military Space Program, Space War, October 20, 2015, http://www.spacewar.com/reports/New_Details_Emerge_About_Chinas_Military_Space_Program_999.html, Accessed on February 8, 2016.

India

India continues to reinforce its array of launchers, primarily the GSLV engine, which can be used to send astronauts into space.¹⁰⁸

In July, India decided to increase to ten the number of launchers it produces annually. The Indian government is attempting to strengthen its domestic space industry, among other ways by encouraging Airbus to build large telecommunications satellites there.¹⁰⁹ India and the U.S. drew closer regarding space security, when they conducted bilateral strategic talks on the issue in March.¹¹⁰ In light of India's success in its research mission to Mars, India is advancing plans for an exploratory mission to Venus.¹¹¹

Japan

At the beginning of the year, Japan increased its space budget to 2.75 billion dollars, an increase of 18.5% over the previous year.

This sizeable outlay is intended to support Japan's new space policies, which places security as its top priority. Among the activities that benefit from the greater funding are projects to develop a satellite surveillance system and a satellite navigation system. The new budget reflects the Japanese government's comprehensive security doctrine, as manifest in its first official National Security Strategy of December, 2013, and its understanding that its space policies are an integral aspect of this strategy and should support its overall security strategy. Japan's security strategy became even more cohesive in May of 2014, when in strategic talks with the U.S., the two countries agreed to cooperate on security and surveillance in space. Among other things, Japan is investing in programs for gathering military intelligence in space and monitoring the seas around Japan.¹¹² Japan is also increasing its presence in the world of space

¹⁰⁸ "India Test Fires New Engine for GSLV," *Spacenews*, Volume 26, Number 17, May 4, 2015, p. 9, Tomasz Nowakowski, ISRO successfully tests its GSLV Mk III cryogenic engine, *Spaceflight Insider*, March 16, 2015, <http://www.spaceflightinsider.com/organizations/isro/isro-successfully-tests-its-gslv-mk-iii-cryogenic-engine/>, Accessed on February 8, 2016.

¹⁰⁹ Peter B. de Selding, For Airbus, Modi Visit Opens Door To Building Larger Satellites in India, *Space News*, Apr. 13, 2015, <http://spacenews.com/for-airbus-modi-visit-opens-door-to-building-larger-satellites-in-india/>, Accessed on February 8, 2016.

¹¹⁰ Frank A. Rose, US-India Space Security Cooperation: A Partnership for the 21st Century, *Space War*, March 13, 2015,

http://www.spacewar.com/reports/US_India_Space_Security_Cooperation_A_Partnership_for_the_21st_Century_999.html, Accessed on February 8, 2016.

¹¹¹ Staff Writers, After Mars, Indian Space Agency Aims at Venus, *Space Daily*, May 25, 2015, http://www.spacedaily.com/reports/After_Mars_India_n_Space_Agency_Aims_at_Venus_999.html, Accessed on February 8, 2016.

¹¹² Paul Kallender-Umezu, Japan Boosts Space Spending In Support of Security Focus, *Space News*, February. 2, 2015, <http://spacenews.com/japan-boosts->

exploration and is planning a moon landing in 2018; its estimated cost will be some 126 million dollars. The lunar mission is designed to serve as a springboard to a future mission to Mars.¹¹³

The European Space Agency

For the European Space Agency, 2015 was characterized by internal changes. At the beginning of the year, a new DG was chosen, Johann-Dietrick Woerner, from the German Aerospace Center, DLR. Upon announcement of his appointment, Woerner said that he plans to make a lot of organizational changes in the ESA and in its administration.¹¹⁴ The ultimate goal of the reforms he intends to implement is the establishment of a kind of "United Space in Europe through ESA".¹¹⁵ These changes began to be seen by the end of 2015.¹¹⁶

The 2015 budget for the ESA grew by 8%, to 4.5 billion Euro, thanks in part to a million Euro contract from the EU executive commission for the ESA to serve as the technical manager of the EU's satellite navigation system, Galileo. The Galileo system significantly increased in size during 2015. By the end of the year, a dozen Galileo satellites were in space, enabling operation of the system by 2016.¹¹⁷ Among the principal ESA investments in the coming years will be development of the heavy launcher Ariane-6; and a focus on observation satellites, in which 8% of its budget will be invested. The ESA's investment in science will account for 11.5% of its budget. By contrast with all of the ESA's other programs, the scientific one is funded by required contributions from the member countries, rather than volunteer contributions.¹¹⁸ The budget also reflects the European aim of relying more on its own

[space-spending-in-support-of-security-focus/](#),

Accessed on February 8, 2016.

¹¹³ Staff Writers, Japan Planning Moon Mission: Space Agency, Moon Daily, April 20, 2015, http://webcache.googleusercontent.com/search?q=cache:He6irPezmNOJ:www.moondaily.com/reports/Japan_planning_moon_mission_space_agency_999.html+&cd=1&hl=iw&ct=clnk&gl=il, Accessed on February 8, 2016.

¹¹⁴ Peter B. de Selding, How ESA's Next Director-General Got the Job, Space News, December 23, 2016, <http://spacenews.com/dlrs-woerner-to-head-esa/>, Accessed on February 8, 2016.

¹¹⁵ Peter B. de Selding, Tough Sledding for Proposed ESA Reorganization, Space News, July 27, 2015, <http://spacenews.com/tough-sledding-for-proposed-esa-reorganization/>, Accessed on February 8, 2016.

¹¹⁶ Peter B. de Selding, ESA Reorganization Groups Directorates Together, Space News, November 23, 2015, <http://spacenews.com/esa-reorganization-groups-directorates-together/>. Accessed on February 11, 2016.

¹¹⁷ ESA, Launching Galileo, Galileo's Dozen: 12 Satellites Now in Orbit, December 17, 2015, http://www.esa.int/Our_Activities/Navigation/The_future_-_Galileo/Launching_Galileo/Galileo_s_dozen_12_satellites_now_in_orbit, Accessed on February 12, 2016.

¹¹⁸ Peter B. de Selding, ESA Hikes Budget, Takes Steps To Send Astronaut to Chinese Space, Space News, January 16, 2015, <http://spacenews.com/esa-hikes-budget-takes-steps-to-send-astronaut-to-chinese-space-station/>, Accessed on 11.2.2016.

countries to produce the necessary components, thereby reducing its dependency on the U.S.¹¹⁹ In general, space activities in Europe continue to suffer from the tension between the Agency and the European Commission in their interwoven relationship of powers, particularly concerning management of space activities in Europe.¹²⁰ In the field of scientific research, the new DG has indicated that the moon will be the principal objective of the ESA. His vision is to establish a permanent station on the moon, similar to the International Space Station in composition and cooperation with other players.¹²¹

In the technological-industrial sphere, the Agency focused primarily on igniting development of the new Ariane-6 launcher. At the beginning of April, ESA and the principal contractor on the project, Airbus, reached a tentative agreement about funding

for developing the project.¹²² In July, ESA approved the development and construction budget of 4.2 billion Euro (4.6 billion dollars) for the new launcher. Predictions are that the new launcher will be ready in five years. At the same time, funding for continued development of the small-satellite launcher, the Vega, was approved, as was the budget for the associated new launch base. The latter is being constructed in French Guiana, at a cost of 370 million Euro.¹²³

France

The French Space Agency announced that the government research program will support French industry to develop all-electric-propulsion satellites, and budgeted 25 million Euro (30 million dollars) for the first stage of development. This step was taken in light of the prediction that by 2020, half of the commercial telecommunications satellites in the world will be all-electric.¹²⁴

¹¹⁹ Peter B. de Selding, European Satellites Still Heavily Dependent on U.S. Parts, Space News, January 29, 2015, <http://spacenews.com/european-satellite-still-heavily-dependent-on-u-s-parts/>, Accessed on February 11, 2016.

¹²⁰ Peter B. de Selding, Data-relay Project Exemplifies Uneasy Relationship Between European Commission and ESA, Space News, January 30, 2015, <http://spacenews.com/data-relay-project-exemplifies-uneasy-relationship-between-european-commission-and-esa/>, Accessed on February 11, 2016.

¹²¹ Katherine Derla, Moon Village Is International Space Station Successor, Stepping Stone To Mars: ESA Head, Tech Times, January 16, 2016, <http://www.techtimes.com/articles/124968/20160116>

[/moon-village-is-international-space-station-successor-stepping-stone-to-mars-esa-head.htm](http://moon-village-is-international-space-station-successor-stepping-stone-to-mars-esa-head.htm), Accessed on February 11, 2016.

¹²² Peter B. de Selding, Full Industry Control of Ariane 6 Non-negotiable, Exec Says, Space News, April 9, 2015, <http://spacenews.com/full-industry-control-of-ariane-6-nonnegotiable-exec-says/>, Accessed on February 11, 2016.

¹²³ Peter B. de Selding, ESA Approval Paves Way for Ariane 6, Vega – Contracts, Space News, July 17, 2015, <http://spacenews.com/esa-approval-paves-way-for-ariane-6-vega-contracts/>, Accessed on February 11, 2016.

¹²⁴ Peter B. de Selding, CNES Gives All-Electric Satellite Research a \$30 Million Jolt with More To

This step is one in a series that the French government is taking to invest in new technology, which would place French industry on the cutting edge worldwide. The focus of the initiative is on developing large satellite systems at low orbits to provide internet services; observation satellites at high resolution; and telecommunication satellites with high output in a broad geostationary orbit. The French government has selected these three areas for heavy investment, because France's competitive advantage is being threatened by American companies.¹²⁵ In June, the government gave its approval for the Arianespace consortium to be wholly controlled by Airbus Safran Launchers, after the French Space Agency sells its share of Arianspace.¹²⁶ Despite the sale, the French government will retain the right to oversee the Arianespace company.¹²⁷

Come, Space News, March 9, 2015, <http://spacenews.com/cnes-gives-all-electric-satellite-research-a-30-million-jolt-with-more-to-come/>,

Accessed on February 11, 2016.

¹²⁵ Peter B. de Selding, France Unveils Commercial Space Investment Initiative, Space News, September 11, 2015, <http://spacenews.com/france-unveils-commercial-space-investment-initiative/>, Accessed on February 11, 2016.

¹²⁶ Peter B. de Selding, French Divestment Will Put Arianespace in Airbus Safran's Hands, Space News, June 10, 2015, <http://spacenews.com/french-divestment-will-put-arianespace-in-airbus-safrans-hands/>, Accessed on February 11, 2016.

¹²⁷ Peter B. de Selding, France Giving up Arianespace Ownership, but not Oversight, Space News, June 19, 2015, <http://spacenews.com/france-giving-up-arianespace-ownership-but-not-oversight/>, Accessed on February 11, 2016. Staff Writers, Arianespace

United Kingdom

The U.K. is advancing on its new space program, continuing its efforts to establish a commercial spaceport.¹²⁸ In the sphere of regulation, the British government has followed the lead of other countries and agreed to set a liability cap for satellite operators. In the event of failures or accidents, the U.K. Outer Space Act sets their maximum liability at 60 million Euros (66 million dollars).¹²⁹ This is being done in an effort to encourage the growth of the commercial space sector in the British Isles. Towards the end of 2015, the U.K. announced an update to its space policy: by 2030, its objective is to have a 10% share of the world space market.¹³⁰

Restructure Signals Major Changes in Company Governance, Space Daily, June 17, 2015, http://www.spacedaily.com/reports/Arianespace_restructure_signals_major_changes_in_company_governance_999.html, Accessed on February 11, 2016.

¹²⁸ Jeff Foust, British Government Narrows List of Potential Spaceport Sites, Space news, March 3, 2015, <http://spacenews.com/british-government-narrows-list-of-potential-spaceport-sites/>, Accessed on February 11, 2016.

¹²⁹ Peter B. de Selding, U.K. Agrees to Liability Cap for Satellite Operators, Space News, July 27, 2015, <http://spacenews.com/u-k-agrees-to-liability-cap-for-satellite-operators/>, Accessed on February 11, 2016.

¹³⁰ U.K. Space Agency Status Report, U.K. Releases National Space Policy, SpaceRef, December 14, 2015, <http://spaceref.com/europe/uk-releases-national-space-policy.html>, Accessed on February 11, 2016.

Canada

For the first time since the 1980s, the subject of space became an issue in the national elections which took place in October, 2015. All three candidates for Prime Minister emphasized their commitment to invest in space.¹³¹ As a result of the conflict between Canada and Russia over the Arctic, Canada drew closer to Ukraine. Canada informed Ukraine that it would make available to the latter the data and images that Canada receives from its sophisticated observation satellites, primarily the Radarsat-2.¹³² The MDA corporation warned that Canada is losing its competitive advantage in the field of space robotics, due to the government's decision to pass up opportunities to cooperate in development with Europe and other

countries during the last year and a half. Therefore, the company is setting forth on a series of acquisitions of American and other foreign companies, so as to better position itself to work in the American market.¹³³

Israel

In 2015, Israel was voted in as a regular member of the UN Committee on the Peaceful Uses of Outer Space [COPUOS].¹³⁴ Israel also hosted the prestigious annual International Space Conference. During the Conference, the Israel Space Agency signed a number of agreements to cooperate with other space agencies, including NASA;¹³⁵ CNES, France's space agency;¹³⁶ and ASI, Italy's space agency.¹³⁷

¹³¹ Chantal Da Silva, Canada's Space Policy Enters Orbit of Election Campaign, CBC News, October 11, 2015, <http://www.cbc.ca/news/politics/canada-election-2015-space-policy-election-1.3261004>,

Accessed on February 11, 2016.

¹³² Staff Writers, Canada Grants Kiev Access to Sophisticated Satellite Imagery, Space War, April 12, 2015,

[http://webcache.googleusercontent.com/search?q=cache:kGyK49xufG4J:www.spacewar.com/reports/Canada Grants Kiev Access to Sophisticated Satellite Imagery 999.html+&cd=1&hl=iw&ct=clnk&gl=il](http://webcache.googleusercontent.com/search?q=cache:kGyK49xufG4J:www.spacewar.com/reports/Canada+Grants+Kiev+Access+to+Sophisticated+Satellite+Imagery+999.html+&cd=1&hl=iw&ct=clnk&gl=il),

Accessed on February 11, 2016.

¹³³ Peter B. de Selding, MDA Corp. Worries Canada Is Losing Its Robot Edge, Space News, May 5, 2015, <http://spacenews.com/mda-worries-canada-is-losing-its-robot-edge/>, Accessed on February 11, 2016.

¹³⁴ United Nations, Fourth Committee Approves Four Draft Texts, Concludes General Debate on Questions Relating to Information, UN, October 29, 2015, <http://www.un.org/press/en/2015/gaspd593.doc.htm>,

Accessed on February 11, 2016.

¹³⁵ Israel Ministry of Science, Technology and Space Press Release, NASA and Israel Space Agency Sign Cooperation Agreement, SpaceRef, October 13, 2015,

<http://spaceref.com/iac2015/nasa-and-israel-space-agency-sign-cooperation-agreement.html>,

Accessed on February 11, 2016. Staff Writers, NASA, Israel Ink Space Cooperation Agreement, Space Daily, October 13, 2015,

[http://webcache.googleusercontent.com/search?q=cache:iBgJz1mKpKAJ:www.spacedaily.com/reports/NA SA Israel ink space cooperation agreement 999.html+&cd=1&hl=iw&ct=clnk&gl=il](http://webcache.googleusercontent.com/search?q=cache:iBgJz1mKpKAJ:www.spacedaily.com/reports/NA+SA+Israel+ink+space+cooperation+agreement+999.html+&cd=1&hl=iw&ct=clnk&gl=il),

Accessed on February 11, 2016.

¹³⁶ Israel Ministry of Science, Technology and Space Press Release, Israel and France Expand Space Cooperation, SpaceRef, October 13, 2015, <http://www.spaceref.com/news/viewpr.html?pid=47038>, Accessed on February 8, 2016.

¹³⁷ Staff Writers, ASI and ISA Strengthen the Cooperation in the Earth Observation Field, Space Ref, October 19, 2015,

Facebook and Eutelsat acquired almost all of the payload on the Amos-6 satellite, to provide internet services to sub-Saharan Africa, at a cost of 95 million dollars. The Amos-6 is under development by the Israel Aerospace Industries [IAI].¹³⁸ In addition, IAI is in advanced stages of developing an electric-powered light weight communication satellite, the Amos-E.¹³⁹

The Middle East

Interest in new markets must be noted, primarily the Middle East and Africa. In April, the Turkish company Turksat began constructing the country's first independent communication satellite. The development budget is 203 million dollars, which was approved by the government in December 2013. Turkey has stated that developing

national independent capability in building its own satellites is of strategic importance to the country, and over time will contribute to the Turkish economy as well. The launch is planned for 2020.¹⁴⁰

The United Arab Emirates continues to progress on its space program, by entering into cooperative agreements with a number of countries, including the U.S and France.¹⁴¹ The Memorandum of Understanding that the UAE signed with CNES, the French space agency includes joint work on the UAE's probe to Mars. A launch for the probe is planned for 2020, so that it would reach Mars in 2021, to mark 50 years of UAE independence.¹⁴² The UAE also signed Memoranda of Understanding with China¹⁴³ Russia, the U.K. and Kazakhstan. In addition,

<http://spaceref.com/news/viewpr.html?pid=47081>, Accessed on February 8, 2016.

¹³⁸ Staff Writers, Eutelsat and Facebook to Partner on Vsat Initiative to Get Africa Online, Terra Daily, October 19, 2015, http://www.africadaily.net/reports/Eutelsat_and_Facebook_to_partner_on_satellite_initiative_to_get_more_Africans_online_999.html, Accessed on February 8, 2016.

¹³⁹ Barbara Opall-Rome, IAI Develops Small, Electric-Powered COMSAT, Defense News, October 12, 2015, <http://www.defensenews.com/story/defense/air-space/2015/10/12/iai-develops-small-electric-powered-comsat/73808432/>, Accessed on February 8, 2016. Staff Writers, IAI is Developing a Light-weight Communications Satellite: the AMOS-E, Israel Defense, October 12, 2015,

<http://www.israeldefense.co.il/en/content/iai-developing-light-weight-communications-satellite-amos-e> Accessed on February 8, 2016

¹⁴⁰ Peter B. de-Selding, Construction of Turksat's 1st Domestic Satellite Now Underway, Space News, Apr. 21, 2015, <http://spacenews.com/construction-of-turksats-1st-domestic-satellite-now-underway/>, Accessed on February 8, 2016

¹⁴¹ Staff Writers, Joint Announcement by the United States of America and the United Arab Emirates Space Agency on Bilateral Space Cooperation, U.S. Department of State, March 20, 2015, <http://www.state.gov/r/pa/prs/ps/2015/03/239649.htm>, Accessed on February 8, 2016.

¹⁴² Peter B. de-Selding, France, UAE Sign Cooperative Space Accord, Space News, April 9, 2015, <http://spacenews.com/france-uae-sign-cooperative-space-accord/>, Accessed on February 8, 2016

¹⁴³ Staff Writers, UAE Signs an Mou with People's Republic of China for Cooperation in Space Science,

the UAE has begun talks with Russia, with the aim of acquiring maritime launch platforms, which would be capable of supporting the launch of Zenith-3SL rockets.¹⁴⁴ The UAE has also established a working group to draw up space policies and regulations.¹⁴⁵

For the first time in three years, Iran launched a satellite, named Fajr (which means Dawn in Persian). The satellite re-entered three weeks later.¹⁴⁶ As a result of the nuclear arms agreement that the major powers signed with Iran in July, and the removal of sanctions on Iran, Russia and Iran signed a cooperative agreement on space activities in August 2015. The agreement calls for joint development of a satellite system to monitor

the earth's surface, atmosphere and oceans. The system is based on the Canopus-B satellite, with the launch of the first satellite in the system slated for 2018.¹⁴⁷

Brazil

It's become obvious that Brazil and Russia are getting closer, after Brazil unilaterally ended the agreement it had with Ukraine to operate the Cyclone-4 launcher from its territory.¹⁴⁸ Since then, Brazil announced that Russia had offered Brazil assistance in developing space centers and Cyclone launchers.¹⁴⁹ In June, Brazil signed a cooperation agreement with NASA,¹⁵⁰ and in September, Russia and Brazil agreed to establish another ground station for the Glonass system on Brazilian land.¹⁵¹

ZAWYA, December 28, 2015, https://www.zawya.com/story/UAE_signs_MoU_with_China_for_cooperation_in_space_science-ZAWYA20151228061816/, Accessed on February 8, 2016

¹⁴⁴ Staff Writers, UAE Moves to Purchase Russian Spacecraft Launch Platform, Space Daily, March 26, 2015, http://www.spacedaily.com/reports/UAE_Moves_to_Purchase_Russian_Spacecraft_Launch_Platform_999.html, Accessed on February 11, 2016

¹⁴⁵ Michael J. Listner, Op-ed | UAE Moving To Become a Player in Outer Space Activities, Space News, May 11, 2015, <http://spacenews.com/op-ed-uae-moving-to-become-a-player-in-outer-space-activities/>, Accessed on February 11, 2016

¹⁴⁶ Gunter's Space Page, Fajr, http://space.skyrocket.de/doc_sdat/fajr.htm Accessed on February 7, 2016.

¹⁴⁷ Staff Writers, Russia to help Iran build own satellite observation systems, RT, August 25, 2015,

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Staff Writers, Russia to Develop Earth Remote-Sensing Satellite System for Iran, August 25, 2015, <http://sputniknews.com/science/20150825/1026180063.html>, Accessed on February 11, 2016

¹⁴⁸ Peter B. de Selding, Brazil Pulling Out of Ukrainian Launcher Project, Space News, April 16, 2015, <http://spacenews.com/brazil-pulling-out-of-ukrainian-launcher-project/>, Accessed on February 11, 2016

¹⁴⁹ Staff Writers, Russia Ready to Help Brazil Develop Space Centers, Rockets, Space Daily, April 30, 2015, http://www.spacedaily.com/reports/Russia_Ready_to_Help_Brazil_Develop_Space_Centers_Rockets_999.html, Accessed on February 11, 2016

¹⁵⁰ NASA Press Release, NASA Signs Scientific and Education Agreements with Brazil, June 30, 2015, <http://www.nasa.gov/press-release/nasa-signs-scientific-and-education-agreements-with-brazil> Accessed on February 13, 2016.

¹⁵¹ Staff Writers, Russia, Brazil Sign Contract for Glonass Ground Measuring Station, Space Daily,

In conclusion, one of the significant processes of 2015 which deserve further attention is the tension between the private and public sectors. Particularly interesting is the growing awareness of the challenge to assure a sustainable space environment, which leads the private sector to put pressure on the public sector in order to advance standardization and regulation concerning a variety of activities in the field of space. This inherent tension between the need to improve and enhance cooperation, and the desire to establish self-reliance and ensure independent access to space, will continue to characterize the activities of governments towards the space environment. In the field of space exploration, a large number of spacefaring nations have marked the moon as their focal point for the coming years. The U.S. is not a part of this trend yet. Nevertheless, the U.S. will not be able to ignore this trend, and will most likely reconsider its plans accordingly.