Point Paper

on

The IFPA Capitol Hill Roundtable

Space-based Sensors: Missile Defense and More

The Dirksen Senate Office Building
Washington, D.C.
July 14, 2015

Sponsored by
The Institute for Foreign Policy Analysis, Inc.

In association with
The Independent Working Group on Missile Defense

Organized by
The Institute for Foreign Policy Analysis, Inc.

September 2015

IFPA
The Institute for Foreign Policy Analysis

Foreword

The Institute for Foreign Policy Analysis, Inc.

The Institute for Foreign Policy Analysis, Inc. (IFPA), now in its thirty-ninth year, develops innovative strategies for new security challenges. IFPA conducts studies and produces reports, briefings, and publications. IFPA also organizes workshops, roundtables, seminars, and international conferences in Washington, D.C., elsewhere in the United States, and overseas that address a wide variety of national and international security issues. IFPA's products and services help government policymakers, military and industry leaders, and the broader public policy communities make informed decisions in a complex and dynamic global environment. In addition to its core staff in Cambridge, Massachusetts, and Washington, D.C., the Institute maintains a global network of research advisors and consultants.

The Independent Working Group

The Independent Working Group (IWG) on Missile Defense was formed in 2002. Its goals are: (1) to identify the evolving threats to the United States, its overseas forces, allies, and coalition partners from the proliferation of ballistic missiles; (2) to examine missile defense requirements in the twenty-first century security setting; (3) to assess current missile defense programs in light of technological opportunities in the post-ABM Treaty world; and (4) to set forth general and specific recommendations for a robust, layered missile defense for the United States to meet these proliferation challenges. The mission of the IWG is to educate policymakers, legislators, the media, and the American people on missile defense issues. Its goal is also to make missile defense as fully as possible a part of homeland security. In other words, the work of the IWG spans both national and domestic security forming an indispensable part of U.S. national security strategy.

Dr. Robert L. Pfaltzgraff, Jr., President of IFPA, is also Chairman of the IWG. IFPA acts as the IWG secretariat, organizing conferences, briefings, and producing major reports, articles and white papers.

The Capitol Hill Roundtable/Conference Series on Missile Defense

The Roundtable on *Space-based Sensors: Missile Defense and More* described in this Point Paper is the latest in a series of IFPA/IWG meetings and educational briefings on missile defense held on Capitol Hill. Recent Capitol Hill Roundtable/Conferences included: The *Aegis Sea-based Missile Defense: Present Status and Future Requirements*, June 26, 2014; *Defending the Homeland - The Role of Missile Defense*, June 25, 2013; Grand *Strategy and the Strategic Triad*, April 20, 2012; and *New START, Nuclear Modernization, and Missile Defense*, July 20, 2010. Information about these meetings and other IFPA and IWG publications and events can be accessed on IFPA's website at www.ifpa.org.

Point Paper Abstract

- The U.S. ballistic missile defense (BMD) program is critically dependent on space assets for:
    - Early warning and missile attack;
    - Discrimination, positioning, and battle management;
        - Unlike terrestrial radars, space sensors have the capability to see beyond the horizon and provide tracking and discrimination of threat missiles during their midcourse flight in space.
    - Hit/Kill Assessment;
        - Space sensors are better able to conduct hit/kill assessment because interception of ballistic missiles normally occurs during the midcourse phase in space over oceans where terrestrial radars have difficulty providing coverage.
    - Cueing and tracking data;
        - U.S. ballistic missile tests utilizing data provided by the Space Tracking and Surveillance System-Demonstrator (STSS-D) satellites have significantly improved the range of Navy BMD interceptors and can do the same for ground-based interceptors.
- The optimal mix to fill current BMD sensor gaps is a more robust space sensor layer fully integrated with terrestrial radars.
- Space sensors such as the STSS-D can also perform other missions including space domain awareness and intelligence collection, allowing multi-mission data sharing to serve numerous national security stakeholders, such as the Missile Defense Agency, Air Force Space Command, the combatant commands, and intelligence community, resulting in operational efficiencies and cost savings.
- The broader national security community relies heavily on space systems for many other critical missions. However, all these systems face several threats that need to be countered, including:

    - Nuclear detonations in space that would generate electromagnetic pulse (EMP), interdiction by direct-ascent anti-satellite weapons, and laser attacks; and
    - Electronic warfare and cyber attacks.
- The United States is undertaking a space security initiative to counter these and other threats and to develop space control capabilities. This effort will include:
    - Passive and active protection measures to help preserve U.S. freedom of action in space.
    - The overall program will be funded at $1 billion or more annually over the next five years.
- The United States national security space community is also exploring ways to partner with industry to take better advantage of the capabilities offered by the commercial space sector and non-traditional suppliers and to determine how it can best leverage those capabilities and create incentives to ensure their maturity and commercial viability. Logical steps forward might include:
    - Incorporating commercial best practices to improve the Defense Department's acquisition process, augment deployment schedules, lower costs, and increase innovation;
    - Expanding the use of commercially developed dual-use technologies; and,
    - Effectively exploiting the new Defense Innovation Unit Experimental (DIUx) project which will partner DOD with the commercial industrial sector to develop dual-use technologies with the goal of maintaining the technological superiority of the United States.

*****

The Capitol Hill Roundtable on *Space-based Sensors: Missile Defense and More*

I. Purpose, Scope, and Overview of the Roundtable

On July 14, 2015, the Institute for Foreign Policy Analysis (IFPA) convened its latest Capitol Hill Roundtable in association with the Independent Working Group (IWG) on Missile Defense in Washington, D.C. Held at the Dirksen Senate Office Building, participants included House and Senate staff members, U.S. government civilian and military officials, industry representatives, and subject matter experts. A video tape of the Roundtable discussion in its entirety can be viewed on IFPA's website at http://www.ifpa.org/confrncNworkshp/confrncNworkshpPages/iwgJuly2015.php.

The roundtable focus was how space-based sensors can fill missile defense surveillance and discrimination shortfalls and help ground- and sea-based interceptors meet the growing ballistic missile threat more effectively. The important contributions of space-based sensors to other critical national security missions – such as space domain awareness, monitoring treaty compliance, and tracking the activities of potential proliferators – were also explored. The roundtable also addressed the threats confronting U.S. space systems, methods to reduce those threats, Congressional perspectives on space, and the role the commercial space sector can play to support the national security space community.

The following expert panelists provided presentations on these and related topics:

- Richard Ritter, Program Executive, C4ISR, Missile Defense Agency;
- Dr. John B. Sheldon, Executive Director, The George C. Marshall Institute;
- Dr. Peter L. Hays, Intelligence Policy Analyst, Leidos;
- Sam Fletcher, Military and Veterans Policy Director, Office of Congressman Doug Lamborn; and,
- Dr. Robert L. Pfaltzgraff, Jr., IFPA President and Shelby Cullom Davis Professor of International Security Studies at The Fletcher School, Tufts University, who served as the moderator.

This Point Paper summarizes the roundtable presentations and discussion organized by major themes and topics addressed.

II. The Space Sensor Layer and Ballistic Missile Defense

- Space-based sensors can help fill critical gaps in the sensing capabilities needed for the missile defense mission. More specifically, a missile defense space layer is essential for maintaining track custody of target launches through booster burnout, through threat deployment of countermeasures, and through intercept and re-entry. This precision track custody is critical to enabling discrimination, full intercept battlespace utilization, and hit/kill assessment. In addition to the missile defense value, the space layer could also provide inherent capability for technical intelligence, space domain assessment (SDA), and battle space awareness.
- The Missile Defense Agency (MDA) has undertaken demonstrations with the two Space Tracking and Surveillance System-Demonstrator, or STSS-D, satellites, currently in low earth orbit to understand how the space layer can best contribute to ballistic missile defense and other U.S. military/national security operations and missions. These demonstrations have helped determine which specific space assets and capabilities should be developed/acquired in the future.
- For example, the 2013 launch-on-remote (LoR) test involving U.S. Navy *Aegis* BMD ships and the two STSS-D satellites increased the intercept battle space of the Standard Missile (SM)-3 missile by approximately 400 percent. Engage-on-remote (EoR) utilizing these space-based assets would increase the battle space even more significantly. Developing LoR and EoR capabilities is a priority because most U.S. weapon systems, such as the SM-3 family of interceptors, have greater kinematic reach (i.e., range) than the sensors organic to them (e.g., the *Aegis* Spy-1 radar for the SM-3s) would allow. This is an example of the increased interceptor battle space that a missile defense space layer would enable.
- As demonstrated in the 2013 test, plugging space-based sensors into the engagement process extends significantly achievable ranges within the defended area. Space sensors provide a quicker threat-missile track to the defender, resulting in increased battle space

and an earlier engagement, and they allow flexible firing doctrines and interceptor shoot-look-shoot opportunities, all of which lead to the greater likelihood of a successful intercept. Moreover, extending an interceptor's engagement space may reduce the inventories required for *Aegis* Standard Missiles and ground-based interceptors, thereby reducing inventory costs. One roundtable participant stated that the myth that timely and accurate fire control data could not be supplied by space systems was "put to rest" by this LoR test.

- Space sensors can perform a number of additional important missions, supporting a range of stakeholders. Space sensor data, for example, is increasingly shared among multiple national security agencies and military commands. As one participant noted, a sensor is a sensor, and the data it generates may be relevant to several users, including Air Force Space Command, the combatant commands, MDA, the National Geospatial-Intelligence Agency (NGA), and other intelligence agencies. Relevant information could include early warning, ballistic missile tracking and discrimination data, SDA, and tactical intelligence. Moreover, the sensor enterprise approach encourages heightened cooperation among these various stakeholders. For example, the MDA's STSS demonstrator satellites have tracked a number of space objects reentering the earth's atmosphere, and this data is of considerable value to the Air Force Space Command for its SDA mission. It is similar as well to what MDA would require in tracking a threat reentry vehicle (RV) during an intercept engagement.
- The Joint Overhead Persistent Infrared (OPIR) Ground (JOG) System, to be fielded next year, will facilitate improved cooperation among stakeholders across multiple mission areas. Any future space layer's data should be shared into the JOG for integration with other OPIR sensor data. Sharing data from space assets for diverse missions will make the development and acquisition of such systems more affordable because the data will serve many users and hence fewer space platforms will be required. With this objective in mind, MDA is working closely with Air Force Space Command and NGA to ensure that both missile defense and other mission areas are all considered in the front-end design when follow-on space systems – such as a possible missile defense midcourse

surveillance, tracking, and discrimination system and the Space-Based Infrared System (SBIRS) – are under development.

- An example of the effectiveness of this cooperative approach is the upgrade made to the three Air Force-operated early warning radars located at bases in California, the United Kingdom, and Greenland. All three have been integrated into the Ballistic Missile Defense System (BMDS) to improve critical early warning and object classification data. The upgrades also improved the radars' ability to carry out the SDA mission. As a result, these radars can provide data to multiple users across mission areas simultaneously. The space community is incorporating this model into the use of current space assets and the acquisition of future ones.
- The location of the sensor is the most important driver in missile defense operations. Fielded U.S. radars typically provide information only on the terminal trajectory of a ballistic missile threat. The space-based Defense Support Program (DSP) and SBIRS satellites, on the other hand, deliver early warning, boost-phase missile data. However, the midcourse flight phase of a threat missile would still be left largely uncovered. For effective missile defense, a defender must understand what that missile is doing in midcourse, how/when it is deploying its RV(s) and decoys, what maneuvers it is undertaking, and if the RV has actually been intercepted and destroyed (i.e., hit/kill assessment). The most effective way – and really the only way – to harvest this range of data is via additional space-based sensors optimized for that task.
- One of the other more salient missile defense shortcomings is the lack of hit/kill assessment. Particularly for longer-range intercepts, MDA cannot assess with great certainty whether or not an intercept has been successful because the engagement has normally taken place in space during the midcourse phase of a missile/RV's flight and over the ocean where terrestrial radars have difficulty providing coverage. Space-based sensors are a better approach for surveilling/assessing the status of an RV in the midcourse flight. Consequently, MDA has developed a concept to place a hit assessment device called a radiometer on a satellite that would provide a much improved damage assessment capability (more below).

- Space sensors also afford essential operational flexibility. A roundtable participant stated that it is difficult to know with certainty on what trajectory an adversary will launch a ballistic missile. U.S. monitoring of potential adversary ballistic missile tests has revealed that they occasionally fire missiles along unexpected trajectories. Unfortunately, the locations of terrestrial radars cannot be easily shifted to capture unanticipated launch trajectories. Space sensors, on the other hand, provide sufficient flexibility to track unexpected threat trajectories as well as launches from unanticipated launch sites. A related benefit is that, unlike the global deployment of U.S. terrestrial radars, the fielding of space sensors does not involve cumbersome and time-consuming host-nation negotiations/agreements for basing rights and approved operations.
- For the missile defense mission, the optimal solution is a mix of both space and terrestrial sensor systems. The terrestrial radars employed in the BMDS are very good at detecting and tracking targets in their field of view due to their accurate ranging capabilities. Nonetheless, while terrestrial-based radars perform these tasks effectively, they are normally scanning only one area; if it is the wrong area, then the radar is not going to see the threat ballistic missile. Unlike terrestrial radars, space sensors provide the ability to see over the horizon and can pass that information to a radar, queuing it to scan a broad area or to narrow its focus, increasing in either case its range and sensitivity. Space-sensor queuing would be especially useful in "heavy raids," i.e., an attack by several threat missiles.
- MDA is currently performing space sensor-to-radar queuing in part to test its utility against the "heavy raid" threat. Ideally, space and terrestrial sensors would work in a coordinated fashion to maximize the sensor resources available to handle the threat raid. The integration of space-based sensors and ground-based radar, therefore, offers the greatest operational payback. There is, of course, growing concern over evolving threats to U.S. space assets (described in detail below). However, as one roundtable participant noted, the United States also fields terrestrial radars in seventeen time zones, several of which include extremely hostile areas. To illustrate, one radar site is a short distance from the Gaza Strip and others are deployed elsewhere in the conflict-ridden Middle East. So,

while there is a threat to U.S. space systems, it must be balanced against the fact that terrestrial radars confront multiple threats as well and possibly more serious ones.

III. U.S. Space Systems and National Security

- As noted earlier, the broader U.S. national security community well beyond MDA is also critically dependent on space. The overwhelming majority of U.S. military operations rely on a variety of space systems orbiting at diverse altitudes. These include satellites to provide: force enhancement, such as military communications; navigation aids from Global Positioning System (GPS) satellites; threat warning and attack assessment; environmental monitoring; the collection of geospatial and classified information, together with surveillance and reconnaissance, to support air, sea, and land force operations; and overall space control, including space surveillance, battle management, and command and control to ensure access to and the use of space by U.S. military forces.
- At present, the United States remains well ahead of other nations in the exploitation of space systems for the enhancement of terrestrial military operations. However, the margin of military advantage the United States derives from its space capabilities will be increasingly difficult to sustain as the number of space-faring nations grows and as access to satellite systems and services rapidly expands. This trend will no doubt accelerate as space-relevant commercial capabilities and dual use technologies – driven by market forces rather than government programs – proliferate.
- Given these and other vulnerabilities associated with greater reliance on space assets, the benefits afforded by space systems are often underappreciated. Going forward, such benefits need to be highlighted, including the fact that space assets allow the United States to field a smaller, yet more lethal force structure than it would otherwise be able to support.

IV. U.S. Space Systems: Structure, Vulnerabilities, and Threats

- U.S. space systems consist of several segments: the space-based segment (the satellites), the launch segment (that includes launch vehicles), the ground-based segment (telemetry and tracking stations), a user segment (e.g., an *Aegis* BMD destroyer or a *Patriot* interceptor battery), the up/down communication link segments, and the supply segment (the manufacturers of the satellites and their components).

- Each of these segments is vulnerable to various kinds of attacks as both space and counterspace capabilities continue to proliferate globally. Potential and existing adversaries view U.S. space systems as legitimate targets. China, Russia, Iran, and North Korea, in particular, possess counterspace assets and capabilities that could place U.S. space systems at risk.
- The launch, ground, and user segments are vulnerable to land, sea, air, and cyberspace attacks. The up/down links can be struck using electronic warfare (EW) techniques, such as jamming, spoofing, and cyber attacks. Literally thousands of cyber and EW attack options are available to U.S. adversaries, many of which now offer more sophisticated attack options over greater ranges. The space segment of satellite systems is also subject to various attacks by direct-ascent anti-satellite weapons (ASATs), electromagnetic pulse (EMP), and lasers (more below). An adversary could also sabotage satellite components during their manufacture and installation within the supply chain segment.
- Kinetic energy weapons can be deployed terrestrially or in space. The former Soviet Union tested a co-orbital ASAT system at least 20 times. The Soviet ASAT would chase the target satellite until it caught up over the course of several orbits and then detonate an explosive charge destroying the target. In 1985, the United States tested a miniature homing vehicle (MHV) ASAT launched from an F-15 aircraft which intercepted and destroyed a U.S. satellite at an altitude of approximately 250 miles**.** One of the residual consequences of kinetic energy ASAT attacks is the creation of debris in space that may take years, if not decades, to be destroyed by coming out of orbit. For example, it was almost 17 years before the debris resulting from the 1985 U.S. ASAT test was fully eliminated by conflagration reentering the earth's atmosphere.
- China tested a direct-ascent ASAT system in 2007 destroying one of its satellites orbiting at roughly twice the altitude of the satellite destroyed in 1985 by the U.S. MHV.[1] This test added 25% to the debris total in low earth orbit. In May 2013, China tested an ASAT

[1] "China's Anti-Satellite Test: Worrisome Debris Cloud Circles Earth," by Leonard Davis, *Space.com.*, February 2, 2007. See http://www.space.com/3415-china-anti-satellite-test-worrisome-debris-cloud-circles-earth.html.

launched into a much higher altitude, reportedly almost reaching geostationary orbit. Although no satellite was targeted for destruction, this test was of great concern to the Pentagon because it demonstrated that China was developing a capability to target some of the most critical satellites in the U.S. space inventory orbiting in higher orbits (e.g., early warning, communication, and certain intelligence assets).[2]

- The United States has also demonstrated an ASAT capability more recently. In February 2008, an SM-3 designed for ballistic missile defense was fired from a U.S. *Aegis* Navy ship destroying a decaying U.S. satellite.[3] The debris created by this engagement was destroyed during reentry into the atmosphere within a few months.
- The space segment is also vulnerable to the effects of nuclear detonations in space which would generate electromagnetic pulse.[4] EMP attacks are of considerable concern because they trap high energy radiation in the earth's magnetic field. Satellites orbiting in low earth orbit will inevitably pass through that field and, unless specifically hardened against this threat, the satellite's electronics will eventually be destroyed.[5] An EMP attack could be a particularly attractive option for a terrorist group like the Islamic State or al-Qaeda. Several U.S. government (USG) studies have also concluded that a single or a small number of nuclear weapons detonated in this way would be one of the best ways for such a group to produce a devastating and lasting impact.
- One of the most difficult challenges is collecting data on Russian and Chinese counterspace lasers and determining if a laser incident/activity has actually occurred. This is important because several actors apart from the Russians and Chinese also use lasers today to determine the precise location of satellites, many of which are outfitted with laser reflectors to aid in their detection. However, the United States obviously does not want

---

[2] "Through a glass, darkly: Chinese, American, and Russian anti-satellite testing in space," by Brian Weeden, *The Space Review*, March 17, 2014. See http://www.thespacereview.com/article/2473/1.
[3] One-Time Mission: Operation Burnt Frost." See http://www.mda.mil/system/aegis_one_time_mission.html.
[4] See "How to Protect a Vulnerable America from EMP Threat," *Investor's Business Daily*, by Henry F. Cooper and Robert L. Pfaltzgraff, Jr. at http://news.investors.com/ibd-editorials-perspective/100314-720276-countering-an-emp-attack-on-america.htm?p=2 and *Countering the EMP Threat: The Role of Missile Defense*, White Paper by Henry Cooper and Robert L. Pfaltzgraff, Jr., July 2010 at http://www.ifpa.org/pdf/IWGWhitePaper.pdf.
[5] The effects of EMP were demonstrated in July 1962 during a U.S. test called Starfish Prime when a 1.4 megaton nuclear warhead was detonated 250 miles above Johnson Island in the South Pacific. Over the course of a few months, the EMP field destroyed all seven satellites in low earth orbit at the time.

other nations firing lasers at its national security satellites. With this concern in mind, a roundtable participant observed that the difference between the amount of laser energy needed to locate a satellite and that required to destroy or degrade it might not be that significant. Today's laser systems generate megawatts of energy that could be deposited on a satellite, a level which would likely destroy or severely degrade unprotected satellites, particularly those in lower orbits.

- Several of the threats noted above, especially sabotage, electronic jamming, spoofing, and cyber attacks, are perhaps even more dangerous because they are more likely to be utilized than an attack by direct-ascent ASATs which would cross an escalation threshold requiring a speedy U.S. military response. Additionally, cyber attacks, jamming, and sabotage, would be far more difficult to detect, let alone to assign responsibility with any certainty. Without attribution, retaliation-based deterrence becomes impossible. Thus, the spectrum of potential cyber/EW attacks creates a particular challenge for deterrence. Nevertheless, it would not be easy conduct successful cyber attacks against military space systems which operate on secure, virtual private networks.

V. Addressing U.S. Space Vulnerabilities

- As reliance on space assets for U.S. national security, including ballistic missile defense, expands, it is important to reduce their vulnerabilities. Indeed, minimizing the vulnerability of U.S. space systems has become a priority for the White House and the Pentagon. There has been an 18-month White House effort to develop an action plan on space, generally referred to as the space security initiative, which is slated to conclude shortly.[6] This effort represents a fundamental change in how the USG views space security and required space capabilities. Statements by Deputy Defense Secretary Robert Work in April 2015 at the 31st Space Foundation Symposium, and more recently at the Geospatial Intelligence Symposium on June 23, 2015,[7] emphasized the major shift that is taking place in U.S. thinking about space. The United States will allocate additional

[6] In addition, the U.S. military conducted several "Day without Space" studies that underscored U.S. dependence on a variety of space capabilities and highlighted their vulnerabilities.
[7] Speech by Deputy Secretary of Defense Robert O. Work at the Geospatial Intelligence Symposium 2015, June 23, 2015. See http://www.defense.gov/News/Speeches/Speech-View/Article/606685/geoint-symposium-2015.

funding of at least $1 billion per year over the next five years to develop capabilities to improve the defense and resiliency of space-related systems.

- There are two prongs to the space security initiative focused on both passive and active protection measures for all segments of U.S. space systems. The first is to create extremely robust, capable, resilient space capabilities that can operate through a variety of threats. The second prong is implementation of space control. Space control is the ability to ensure U.S. freedom of action in space at times and locations of our choosing without interference by an enemy. In many ways, space control is no different strategically than land, sea, or air control. Participants stated that the United States should develop space control capability as transparently as possible to help ensure broad public support for the initiative.[8]
- Passive measures to support this security initiative include hardening satellites against jamming, protecting sensors by covering them if they are being hit by lasers, and making satellites slightly more maneuverable against direct-ascent ASATs. Another approach, particularly advocated by Air Force Space Command, is disaggregation, which entails dispersing or disaggregating the payloads on our large and expensive satellites onto a greater number of smaller satellites in various orbits. This would complicate enemy attack plans because an adversary would have to identify and then strike a greater number of satellites to achieve success. Furthermore, a greater number of U.S. satellites would provide useful redundancy, allowing the overall inventory to degrade more gracefully if attacked and put out of commission.
- Active protection measures would include the development of small satellite "bodyguards" for the more valuable U.S. assets, such as early warning satellites. Increased cooperation with our allies in areas of satellite communications and earth observation capabilities is another approach. Roundtable participants also suggested improved integration of space-based systems with ground-based systems, such as radars, airborne systems, and unmanned aerial systems, all of which also provide intelligence on missile

---

[8] For background on the reasons for instituting this initiative see "The Battle Above," *Sixty Minutes*, April 26, 2015 at http://www.cbsnews.com/news/rare-look-at-space-command-satellite-defense-60-minutes/.

capabilities and ballistic missile early warning and tracking. Integration not only provides greater operational effectiveness and redundancy but also increases the cost of attack for an adversary. The use of diplomacy was also suggested, particularly by setting forth a declaratory policy letting potential adversaries clearly understand what would happen if they attacked a U.S. space system.

- Improved space domain awareness capabilities will be key as well to future space control and defense operations. Knowing that a threat, whether on the ground or in space, may be about to engage U.S. space assets, as well as understanding what countering actions can be taken and how much time is available to act, is an especially critical dimension of SDA.
- Currently, there is a consensus among the White House, DOD, the intelligence community, and Congress on the need for the protection of U.S. space systems, including by means of augmented resiliency and better space control. However, one area that has received insufficient attention is how best to consolidate and organize this consensus and move it forward. While stakeholder cooperation is growing, a participant stated that a unity of effort within the Department of Defense still has not fully taken hold because of the many actors involved. This is even more the case within the intelligence community, given that it has nothing comparable to the Goldwater-Nichols Act which governs DOD and mandates increased cooperation. Hence, the integration between (and among) the two groups, while growing, remains a work in progress.
- Several participants stated that the public also seems to support the space initiative. However, sustaining focus on the initiative will be an ongoing challenge, particularly as the United States enters a presidential election cycle that might divert attention from these and related issues. The United States must balance communicating highly classified data about the threats to U.S. space assets to the public in order to sustain needed support with the legitimate concerns about the security of that data (i.e., intelligence sources and methods). So, while challenges exist from an organizational and management perspective, there is a consensus as well that sustained engagement is necessary to fund and implement the space initiative and to maintain public support.

VI. Congressional Perspectives on Space in the 2016 Defense Budget

- The markup of the House of Representative's version of the 2016 National Defense Authorization Act (NDAA) contains several important provisions regarding space. For example, Congressman Doug Lamborn from Colorado, who is Vice Chairman of the House Subcommittee on Strategic Forces and also co-chairs both the Space Power Caucus and the Missile Defense Caucus**,** believes that the United States should focus even greater efforts on the utilization of space to enhance our national security.
- This goal was reflected in a brief, but important amendment he authored in the 2016 NDAA. It underscores his belief that space is the key to the future of the ballistic missile defense mission. The amendment states that Congress "finds" that MDA has managed a successful space sensor demonstration program called the Space Tracking and Surveillance System (STSS) and that a future missile defense architecture will require improved space-based sensors to enable tracking and discrimination as well as other capabilities. Consequently, it is the sense of Congress that "a robust multi-mission space sensor network will be vital to ensuring a strong missile defense system." A copy of the amendment is in the Appendix.
- In addition, Congressman Lamborn's amendment highlights the importance of MDA's further development of the space-based kill assessment (SKA) project, which is aimed at testing and ultimately fielding a damage assessment space sensor. SKA will demonstrate a sensor capability to verify whether threat missiles have been destroyed by interceptors, and it will help as well to close gaps in the existing U.S. sensor network for the damage assessment mission. A participant added that many on Capitol Hill also believe that apart from augmenting its space sensor constellation for missile defense, the United States must also develop a new exoatmospheric kill vehicle (EKV) for the interceptor component of the U.S. Ground-based Missile Defense (GMD) program.[9] The United States could have the world's best missile defense sensor network, but if it does not have an interceptor capable of interdicting a threatening ballistic missile, such a network would be of little

[9] The U.S. GMD is a limited ballistic missile defense against intermediate- and long-range ballistic missile threats for homeland defense of the United States. There are two GMD interceptor sites, one at Fort Greely, Alaska and one at Vandenberg Air Force Base, California. See http://www.mda.mil/system/gmd.html.

utility. The converse, however, is also true. Although the nation has invested over $30 billion on GMD to date, without a better sensor network, including a space layer, the United States will possess a great gun that might not be able to hit what it needs to hit. A better sensing capability would also reduce the complexity of interceptor operations overall, thereby increasing the cost-effectiveness of whatever interceptor inventory the United States procures as a counter the growing ballistic missile threat.

- In addition, the House version of the NDAA would make space a Major Force Program joining the eleven other such programs that already carry that designation within the defense enterprise. This proposal was made because of the importance of space within the defense budget and to ensure that space receives a higher level attention from the senior leadership at the Pentagon.

VII. The National Security Community and Leveraging Commercial Space Capabilities

- One of the most important issues confronting the U.S. government is how to partner with industry to harness its growing commercial space capabilities. The USG needs to understand how it can best leverage those capabilities and create incentives to ensure their maturity and commercial viability. A key issue for the Defense Department and national security community as a whole is finding a way to inject best commercial business practices into the USG development and acquisition process in order to improve innovation, reduce costs, and deploy systems on a timelier basis. This is the primary reason Secretary of Defense Ash Carter initiated the Defense Innovation Unit Experimental (DIUx) project, the goal of which is for DOD to partner with the commercial sector (particularly in Silicon Valley) to develop dual-use technologies and maintain the technological superiority of the United States.[10]
- One roundtable participant observed that two or three years ago commercial companies and non-traditional suppliers were not interested in doing business in the military/defense

[10] "Pentagon, DIUx Officials Discuss DoD, Industry Innovation," by Terri Moon Cronk, *DoD News*, August 5, 2015. See http://www.defense.gov/News-Article-View/Article/612750/pentagon-diux-officials-discuss-dod-industry-innovation.

space sector. That has changed, however. Commercial satellite vendors now see growing opportunities within the DOD market, based in part on their ability to offer cost-effective options for adding certain types of national security/defense payloads on commercial satellites.

- Based on its assessments of the future market for the "Internet of Things", the commercial space sector has developed very affordable, high throughput satellites providing data rates approaching 180 megabytes per second. There is also increasing activity in high resolution earth observation via both electro-optical and synthetic aperture radars. While the capabilities needed for many national security missions, including missile defense, can only really be provided by the government, there is no reason why the commercial sector cannot contribute and support to an even greater extent than it now does missile defense and space-based architectures and wider national security needs.
- MDA, for example, is exploring ways to leverage commercial satellite platforms. Use of commercial space assets may be an especially economical means for conducting a number of missile defense and broader national security applications/missions. By way of illustration, overhead costs for ground maintenance in support of a commercial satellite utilized in part for a defense application, it was suggested by a participant, could be largely absorbed by the much larger commercial space community and infrastructure, instead of solely by the Department of Defense.
- Although DOD and MDA are increasingly exploring the commercial avenue in order to reduce costs, commercial space capabilities and assets are not the answer, it was acknowledged, for all defense applications. The potential cost savings that could result from using commercial products and assets must be balanced against the national security space community's need for guaranteed service and its concerns about possible threats to commercial space systems, including cyber attacks.

*****

Appendix

AMENDMENT TO HR 1735

OFFERED BY MR. LAMBORN OF COLORADO

At the appropriate place in title XVI, insert the following:

SEC. 16___. SENSE OF CONGRESS ON MISSILE DEFENSE SENSORS IN SPACE.

(a) FINDINGS.—Congress finds the following:

(1) The Missile Defense Agency has run a successful space sensor program with the space tracking and surveillance system.

(2) The Missile Defense Agency is now executing a promising and groundbreaking space sensor system called space-based kill assessment.

(3) The future missile defense architecture will require significantly improved sensors in space to provide tracking, discrimination, and more.

(b) SENSE OF CONGRESS.—It is the sense of Congress that a robust multi-mission space sensor network will be vital to ensuring a strong missile defense system.