

Statement Before the  
House Armed Services Subcommittee on Strategic Forces  
and  
House Homeland Security Subcommittee on Emergency  
Preparedness, Response and Communications

***“Threats to Space Assets and Implications  
for Homeland Security”***

Testimony by:

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Chairman Rogers, Chairman Donavon, Ranking Member Cooper, Ranking Member Payne and distinguished members of the Committees, thank you for your invitation to appear today to discuss threats to our space assets and the implications of those threats to our homeland security. While on active duty and since I have retired from the Air Force, I have attempted to alert decision-makers to the current and growing threats to national security space systems. I believe the vast majority of Americans are not conscious of these threats, and are therefore blissfully unaware of the impacts on our way of life should conflict extend to space. I commend your committees for taking up this subject.

*Space products and services are found throughout the economy and society. Although the connection to space may not always be readily apparent, it is now rare for most of us to pass an entire day untouched by space in at least one way.*  
*The Space Report, 2016*  
*Space Foundation*

For most of our citizens, space is synonymous with NASA. Manned spaceflight missions on the Space Shuttle, life aboard the International Space Station, and robotic explorations of our solar system capture imaginations and promote our technical prowess. Dreams of humans going to Mars and beyond motivate private investment and attract young talent to NASA and to entrepreneurial companies involved in space.

Much less publicized, and therefore much less known, is the host of satellites that provide services essential to modern life in the United States and across the planet. In fact, according to the latest edition of *The Space Report*, published annually by the Space Foundation, the global space industry is a \$325 billion business. Satellite-provided services have become analogous to electricity—a utility we take for granted. Most of us don't need to—nor want to—know where or how our power is produced. But we expect our local power company to continuously provide the power we need to heat and cool our houses, and to run our myriad electrical devices. When a power outage occurs, we are outraged and quickly call the power company demanding to know when service will be restored. Space services are now a utility as well. Few Americans understand that fact.

*The list of human activities that are dependent on space systems contains most of the major functions that are vital to modern society, including trade and commerce; banking and financial transactions (from operations of major financial markets to minor retail purchases); personal, corporate, and government communications; agriculture and food production and distribution; power and water systems; transportation; news gathering and distribution; weather assessment and prediction; health care and entertainment. Were the world to suddenly be “without space,” these would all seriously degrade or shut down entirely.*

*National Security Space Defense and Protection Report*  
*National Academy of Sciences, 2016*

Both military and law enforcement personnel depend daily on satellite services. In fact, it would be difficult for them to execute their missions without space assets because they have become so accustomed to it. The best way to think about this level of dependence is to consider space services as foundational capability. Back to the utility metaphor—we just expect it to be there and thus we take it for granted.

In contrast, potential adversaries are well aware of our dependence on satellites. Continuous combat operations since OPERATION DESERT STORM in 1991 have provided an unparalleled learning laboratory for them. Not surprisingly, nations are now actively testing methods to deny us continued use of space services during conflict. They have developed a full quiver of these methods, ranging from satellite signal jamming to outright destruction of satellites via a kill vehicle, such as that successfully tested by China in 2007. The pace of these counterspace efforts appears to be accelerating, and the impact of the use of counterspace capabilities likely would be felt by all sectors of the space community.

*In the view of many, space has been, until recently, a “sanctuary” from intentional attack, but that sanctuary status has now eroded or vanished.*

*National Security Space Defense and Protection Report  
National Academy of Sciences, 2016*

*Threats to our use of military, civil, and commercial space systems will increase in the next few years as Russia and China progress in developing counterspace weapon systems to deny, degrade, or disrupt US space systems. Foreign military leaders understand the unique advantages that space-based systems provide to the United States.*

*Russia and China continue to pursue weapons systems capable of destroying satellites on orbit, placing US satellites at greater risk in the next few years. China has probably made progress on the antisatellite missile system that it tested in July 2014. The Russian Duma officially recommended in 2013 that Russia resume research and development of an airborne antisatellite missile to “be able to intercept absolutely everything that flies from space.”*

*Worldwide Threat Assessment, US Intelligence Community  
Senate Armed Services Committee, Feb 9, 2016  
James R. Clapper, Director of National Intelligence*

Following are a few key examples of our dependence on space systems, accompanied by descriptions of how current and developing threats could interrupt, and potentially preclude, our access to satellite services.

- Global Positioning System satellites enable precise navigation and timing services across the world. High speed communications networks, first responder location abilities, cellular phone capability, high efficiency farming, transportation vehicle tracking, and many other applications depend on the signals radiating from GPS satellites. Military operations are heavily reliant on GPS for precision warfare. Unfortunately, GPS jamming capability has

proliferated to the extent that relatively low power jammers are now available for sale online. Several nations have developed much higher power jammers, thereby increasing the size of the jammed area and making the jamming effects more difficult to overcome. Widespread and well-conceived jamming during conflict would impact both civilian and military users of GPS.

- Communications satellites in low earth orbits as well as higher altitude orbits provide “over-the-horizon” services at the speed of light. Television, radio, voice, video, financial transaction data, and many other signals are received and relayed continually by satellites. Some of the most important communications networks for national security are dependent on jam-resistant communications satellites. Like GPS jammers, however, proliferation of communications satellite jammers complicates combat mission planning and execution. Also troubling is the development of both low- and high-altitude anti-satellite weapons by China and Russia. Interference or destruction of even one communications satellite likely would open a geographic hole in a constellation, preventing normal communications in that region. This fact holds true for both commercial and government satellites. Until recently, the higher orbits of most of these satellites were thought to be unreachable by potential adversaries’ anti-satellite weapons. But continued development and testing by these nations has demonstrated that no orbit can be regarded as safe from attack.

- Missile warning satellites operate at higher orbital altitudes and use infrared sensors to detect heat sources on the surface of the earth and above it. The plume exiting a rocket engine is very hot, which is detected by satellites and transmitted to ground stations. The intensity and length of a rocket engine’s burn, as well as the trajectory of the rocket, allows the ground stations to determine the range and type of the rocket. This also enables classification of the rocket type: missile or space booster. Using all this information about the rocket, an assessment can be made on whether an attack is in progress—on the United States’ territory, on our allies’ territories or on our deployed forces. That data also is used to cue early warning radars and missile defenses. Early warning enabled by these satellites provides the President, allied leadership and operational commanders the maximum time possible to prepare for, and respond to, an attack. Without these satellites, warning times would be limited to the much shorter timelines achievable with the coverage of missile warning radars alone. Clearly, maximizing response decision time is critical and missile warning satellites are the key.

- Imaging satellites provide vital data for earth observation. Optical and radar imaging satellites orbit at lower altitudes and transmit images used for earth resources data collection, disaster relief, intelligence collection, map making, treaty monitoring and many other services. A picture is truly worth a thousand words for a military commander and for a treaty monitor. On the other end of the spectrum, satellite images provide broad coverage to aid disaster response officials, which is particularly important in remote regions. Because of the ability of imaging satellites to collect images over denied territory, they become prime targets for denial and destruction by potential adversaries in times of conflict. Ground-based lasers can be used to temporarily or permanently blind an optical satellite. Radar satellites can be jammed from the ground or from space. And both radar and optical satellites in low orbits are vulnerable to

ground-based anti-satellite weapons on a very short timeline: launch to kill in as little as 10 minutes.

- Weather satellites operate at both low and high orbits to collect information on terrestrial weather and solar activity. Sensors on the satellites allow analysis of cloud formations, surface winds, wave heights and other important meteorological data. These data have a direct impact on our national security because they provide advanced warning of storms, thereby preserving human life. Hurricane warnings, for example, enabled evacuations and preparations that have saved many lives in storms such as Katrina and Sandy. Daily forecasts seen on TV and other news sources also depend on satellite data to feed the weather models which produce the forecasts. Solar weather sensors provide important data on high energy particles ejected from the sun. These particles can impact satellite performance, terrestrial communications links, and astronaut and aircrew health. Forecasting of solar storms alerts satellite operators to possible electronic malfunctions, and it allows NASA to implement special protection measures for astronauts in orbit. Weather satellites are vulnerable to the same threats discussed above. In addition, potential reductions in the funding for the next generation of weather satellite programs could create major shortfalls in our ability to provide the warnings and the daily forecasts we now take for granted.

Many other types of satellites, their uses and their vulnerabilities to existing and developing threats could be addressed, but I believe the point is made: space is critical for our economic vitality, for efficiency of modern life and for our national security. It logically follows, then, that protecting our space assets is no longer merely desired—it is essential.

Thus far, I have focused on satellite vulnerabilities. Our space capabilities also are reliant on ground stations and cyber connectivity. The ground stations scattered around the world monitor satellite health, receive mission data from the satellites, and send operating commands to the satellites. Without the ground stations, the satellites would not be capable of accomplishing their intended purpose. The possibility of physical attacks on these stations is a concern. While steps are taken to ensure security to the maximum extent practicable, the stations still are potential avenues of attack on space systems. Equally concerning in this information age is the possibility of cyber attack. Cyber security upgrades have been made at every ground station; however, we should not conclude that cyber attacks are no longer possible. With cyber activity occurring at the speed of light, damage can be done very quickly. And attributing the activity to a particular actor is often difficult and time-consuming.

The increasing number of objects in orbit also presents a threat to our satellites. Active satellites, non-operational satellites, spent rocket stages and other space debris occupy the same orbital regimes. The problem is particularly acute in lower orbits. While the sheer volume of space is immense and the probability of collisions is low, when two objects meet at orbital velocities, the results are catastrophic. A 2009 collision between an active Iridium communications satellite and a non-operational Russian satellite is Exhibit A of the situation. Every collision causes a large increase in debris, which exacerbates the overall space traffic problem. The Chinese anti-satellite test in 2007 resulted in thousands of pieces of debris—

pieces that still represent a navigation hazard today. As the number of objects in orbit increase, and as intentional and unintentional collisions occur, the collision probabilities increase to potentially unacceptable levels. Currently in the planning stages are large constellations of small satellites for imaging and broadband services. These, too, will add to the complex task of space traffic management in the coming years.

*We have consistently underestimated both the rate of increase in our own space-related capabilities, our reliance on them, and the rate at which potential threats have progressed with the ability to counter them.*

*Admiral James O. Ellis, Jr., USN (Ret)*

*Former Commander, U.S. Strategic Command*

*Testimony to the House Armed Services Subcommittee on Strategic Forces*

The environment of space has fundamentally shifted from the ethereal sanctuary of the past to the increasingly crowded and contested environment of today. Broad agreement on this fact, however, has not produced architectural change decisions to reduce our vulnerabilities. A recent analysis by the Cost Assessment and Program Evaluation (CAPE) team in the Office of the Secretary of Defense found that space research and development is at a 30 year low. Worse, some 15-40% of that amount is used to fund management services and technical assistance functions, not actual program-related research and development. The space industrial base is eroding due to this low level of investment. Further compounding the historically low investments, the engineering staff in the satellite industry has declined by 28% in last decade. At a time when the space industry's engineering talent and innovation should be put to work, decisions to initiate new programs that are responsive to the threats have not been made. Understandably, industry is unwilling to invest internal R&D funds until the government makes those decisions. Because satellites have limited lifetimes, the lack of a decision to make needed changes to our architectures due to the changed space environment is a de facto decision to continue the status quo with no additional meaningful protection for critical space assets.

The last administration began initial steps toward space protection. The relatively new Joint Interagency Combined Space Operations Center has the potential to be a catalyst for how operations in a contested environment must evolve. Experimentation and eventually realistic operational exercises will produce revelations about operating in this new era of space. Developing new concepts of operations and new tactics in the face of extant and postulated threats is essential. The time-honored adage of "train like you're going to fight" applies in space as well. But exercises alone won't be enough if the systems in space are not built with protection and mission resilience as key performance requirements—there simply will be no levers to pull to defend. To this point, the CAPE analysis found that of the \$6B added for space protection in the 2016 President's Budget, approximately 80% is currently allocated to non-satellite programs.

*With our newfound appreciation of the importance of space systems, we had better understand the significant threat to modern society that their loss represents and, in considering how best to respond, we appreciate both the urgency of the need and the depth of the challenge. While deterrence, in all its dimensions, must be part of our national strategy, a successful outcome nationally and globally requires all elements of diplomatic, intelligence, military, and economic domains to achieve outcomes desired nationally and acceptable globally.*

*National Security Space Defense and Protection Report  
National Academy of Sciences, 2016*

Warfare in space is in no one's best interest, and the level of the United States' dependence on space means we have the most to lose. As we consider space capability protection options in space, in cyber and on the ground, we must consider whether our actions are stabilizing or destabilizing in the international arena. Every action we contemplate should cause us to ask ourselves if said action dissuades and deters potential adversaries from nefarious activity. Deterrence is successful when an adversary believes we have the strength to impose costs on them or to deny the benefits they seek. Unfortunately, classical deterrence theory fails us when our actions are not observable due to orbital distances, cyber anonymity and/or security classification. We urgently need sponsored and funded study work on what constitutes deterrence in the 21<sup>st</sup> century and what recommended steps would increase our deterrent posture. We need an intellectual framework to think our way through this maze which requires that we deter use of space and cyber weapons, while continuing to deter use of nuclear weapons. The writings of Bernard Brodie and Herman Kahn on nuclear deterrence strategy provide a good model for the intellectual depth needed. That same level of research from academia and think tanks would help navigate negotiations on international agreements governing space activity—agreements which are either outdated or sorely lacking. The potential consequences are too great for us to merely hope for the best.

Some have suggested we just throw in the towel on space. Because space systems are now being threatened, as their logic goes, we can't depend on them when we most need them. I strongly reject that argument. The unique and often ubiquitous services available from space either can't be replicated, or the alternatives are impractical and/or too expensive. We don't stop operating in any other domain when challenged—we find ways to make our systems effective while defeating or mitigating the threats. So, we must determine how we will defend our space systems and make them more mission resilient to interruption, denial and destruction. And the programmatic decisions to produce a protected space architecture are long overdue.

*A key aspect of space is that the speed of advances in access and spaceborne capabilities has significantly outpaced the creation of guiding national-let alone international strategies and policies. The technological advances in space systems and increased reliance on them have created a space-enabled "critical infrastructure" that has not been matched by coherent supporting protection and*

*loss-mitigation strategies, clearly articulated and accepted policies, and robust defensive capabilities.*

*National Security Space Defense and Protection Report  
National Academy of Sciences, 2016*

Many of us remember the tag line for the 1979 movie, *Alien*: “In space, no one can hear you scream.” From my perspective, apparently no one on earth can hear you scream about space vulnerabilities, either. Many have banged the gong hard since 2007, but 10 years of innumerable studies and policy debates have not produced tangible improvements in our space protection posture. Most would find this inaction intolerable if satellites had mothers. They don’t, but America’s sons and daughters, as well as society in general, heavily depend on space services—some in life or death situations. If you know the armed burglar is on the front porch, you don’t wait until he is already inside the house to take action. Yet that is precisely our posture today.

*We are living in a paradox: The achievements of the industrial and information ages are shaping a world to come that is both more dangerous and richer with opportunity than ever before.*

*Global Trends Report  
National Intelligence Council, 2017*

Our heavy reliance on space capabilities for modern living, as well as national security operations, creates vulnerabilities to current and escalating threats. Other nations have chosen to create weapons systems with the clear intent of exploiting those vulnerabilities if and when they choose to do so. I believe our nation is more than capable of adjusting to this new environment and protecting our critical space infrastructure while avoiding unnecessary provocation. I thank the two committees for delving into this subject and I look forward to answering your questions.