The X-37B: Backdoor weaponization of space?

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Abstract

After spending 674 days in space, the military space plane known as the X-37B returned to Earth in October 2014. But no one really knows what its purpose was, or what it had been doing all that time, leading to all kinds of guessing in the popular press. Photos show something that looks like a baby space shuttle, and television newscasts suggested it could be a space bomber or a satellite meant to spy on other satellites. Using publicly accessible documents, the author attempts to piece together the plane's likely mission, and writes that the X-37B illustrates the United States' continuing interest in militarizing space and, possibly, weaponizing it in the future. He argues that such an approach inadvertently harms the security of the United States' own space assets.

On October 17, 2014, the US Air Force cryptically announced the return of its crewless X-37B Orbital Test Vehicle-3 after nearly two years in space. Headlines uniformly described this remotely piloted spacecraft as "mysterious", which led to speculations about what it did during all that time in the heavens. To add to the mystery, when the Air Force did its habitual livestreaming of the launch of the shuttle-like spacecraft, whoever was in charge had made it a point to turn off the video just before the main engine cutoff, so the craft's initial orbit would be unknown. (Amateur trackers did eventually find it, however.)

If such actions were intended to quiet interest in this "baby space shuttle", they had the opposite effect. If anything, the lack of information about the craft and its orbit whetted appetites and added to the thrill, especially after the X-37B was discovered to have made changes in its orbit during its first mission, and the amount of time it stayed up in space kept getting longer and longer. Analysts speculated that the potential applications could range from targeted intelligence-gathering to space weaponry. Most guesses were within the realm of possibility; some were less credible. But it seems clear that the X-37B is indeed being used to help develop critical technologies that lead down the path to the eventual weaponization of space. The X-37B is a story about hypersonic propulsion, reusable spacecraft, and super thermal materials that can withstand unimaginably high temperatures. Much of the data about the spacecraft has been hidden via classification, but some is in the public domain and available via open-source materials, allowing for an overall picture to be pieced together and viewed without threatening the security of any vital individual components or harming national security.

The ostensible purpose of the X-37B program is to develop a reusable launch system like the earlier space shuttle but smaller and cheaper, one that can quickly respond to evolving military needs in space. Yet another purpose, arguably more important for the military but often overlooked, is that it provides a much-needed platform for testing space weapons technologies that the previous shuttle program could not readily provide. Hence the secrecy. While not alone, the X-37B is an integral part of the Air Force's efforts to militarize space and eventually weaponize it.

1 Subrata Ghoshroy, (2015) *The X-37B: Backdoor weaponization of space? May 1. Available at:* https://thebulletin.org/2015/05/the-x-37b-backdoor-weaponization-of-space/.

Fanning the flames

Through the X-37B program, the Air Force is gathering data on the travel of objects at extremely high speeds and developing cutting-edge space technologies that allow those objects to navigate and be controlled remotely over long distances. It is able to field-test on the very edge of space the latest thermal protection systems, high-temperature structures and seals, and lightweight electromechanical flight systems, which are part of what allows the craft to glide stealth-like to the ground. All of these features are vital for engaging what the military calls "time sensitive" targets in "anti-access/area-denial" environments- or, in plain English, for using high-speed missiles in counter-terrorism operations or for overcoming antimissiles. At such speeds, an enemy may barely have the time to detect an incoming missile on a radar screen before being destroyed.

A hint of the thought process behind the X-37B can be found in a speech given on December 5, 2014 in Washington DC by the leader of the US Air Force Space Command. Gen. John E. Hyten. He said: "We don't ever want to go to war in space, but we need to be prepared to fight a war in that environment "(Ingalsbe, 2014)[2]. His speech continued in this vein, making it seem as if Hyten believes that a space war is inevitable and that the United States has to prepare for it now.

Unfortunately, American political and military leaders seem to be betting that investing heavily in technological superiority will let the United States prevail in a space war-instead of concentrating on leading the world toward a space treaty that would ban all weapons from space.

Ironically, the United States could have the most to lose in a Cold War-style space race, because it has the most skin in the space game. The United States has the overwhelming majority of satellites in orbit-for commercial, telecommunications, environmental, research, and military uses. According to the Union of Concerned Scientists'[3] database, there are 1,235 operating satellites in orbit; of this number, the United States has 512 satellites, Russia has 135, and China 116, with the other 472 spread among many countries. The number of America's military satellites alone-159-is larger than either Russia's or China's total number of satellites.

Even a minor space battle could result in the near-Earth heavens being littered with debris, rendering them uninhabitable for all satellites. As was graphically illustrated in the fictional Hollywood movie Gravity last year, the presence of even a relatively small amount of space junk can wreak serious havoc. Yet a portion of the X-37B's mission appears aimed at testing technologies that-while potentially useful for satellite repair- could also be the foundation for a space warfare capability.

A convoluted history

The X-37B has its origins in a more benign project, the X-37, a joint program between NASA and the Defense Department. Given that the secret spacecraft's overall design doesn't appear to deviate much from the days of the more open X-37 program, one can imagine that at least part of the mission now is the same as it was then: doing experiments to develop technologies for a reusable spacecraft that could shuttle cargo and astronauts to low-Earth orbit.

Space enthusiasts have long dreamed of getting into orbit without using an expendable rocket, and hence reaching space cheaper, faster, and more reliably. The unmanned X-37B[4] seems to

2 *Ingalsbe, T. (2014) Gen. Hyten: Future of AF is air, space, cyberspace integration. Air Force News Service, December 9. Available at:* http://www.af.mil/News/ArticleDisplay/tabid/223/Article/555722/gen-hyten-future-of-af-is-air-space-cyberspaceintegration.aspx.

3 *Union of Concerned Scientists (2014) Satellite database. Available at:* http://www.ucsusa.org/nuclear_weapons_and_global_security/solutions/space-weapons/ucs-satellite-database.html.

4 *Martinez M (2014) Unmanned X-37B space plane lands, its exact*

promise much of that: Although it is launched vertically from a launchpad, when this remotely operated vehicle returns to the ground it lands horizontally on an airstrip, like an airplane. Therefore, the vehicle can be thought of as a hybrid of spacecraft and aircraft. It can withstand the vacuum of space and maneuver there, yet it has wings that give the X-37B aerodynamic lift once it reenters the Earth's atmosphere-allowing it to descend and land, gliding back home just like the space shuttle. The wings also help it to brake.

With its use of a rocket to get off the ground, the X-37B is still a long way from the ultimate ideal of a true space plane, which would take off from the ground horizontally and use aerodynamic lift to get into space without the need for an expendable rocket or other external assist. But true believers expect that such experimenting will ultimately lead to this goal-which would theoretically be a less costly, more reliable, and more controllable way of regularly getting humans into space. The space shuttle, with its rocket-assisted launch, got us partway there, and the unmanned X-37B could conceivably be viewed as a logical extension of this approach in some ways.

But the technological hurdles to cheaper space access are high, as the recent test of the US private-sector rocket system SpaceX showed (Kramer, 2015)[5]. It failed to land its first-stage rocket in one piece, something essential to reuse. There is one other major challenge for a reusable spacecraft: It must fly at least five times faster than the speed of sound, or somewhere in the range of 3,800 miles per hour, a speed known as "hypersonic". By comparison, a typical passenger jet aircraft has a maximum cruising speed of 550mph, or about 0.8 Mach. A high-end fighter jet like the F-16 Eagle or the Russian MiG can fly at Mach 2 or higher- which is supersonic.

A spacecraft typically experiences speeds that are much greater than the fastest fighter jet. The usual reentry speed of the space shuttle was about 17,500mph, or roughly Mach 25, which NASA calls "high-hypersonic". At these hypersonic speeds, friction heats the spacecraft body to such extremely high temperatures that only specialty metals and alloys can withstand them (NASA, 2015)[6]. This "reentry problem" was solved early in the space program by using spacecraft that only needed to survive one-time use. The solution is much more complex for a vehicle that must be turned around quickly and sent back up into space again.

But whatever has been learned from the shuttle-like X-37B mission about the process of handling hypersonic speeds, extreme temperatures, and reentry technologies for peaceful space uses, can easily be applied to less benign flying objects, such as hypersonic missiles. It is one of the many areas of the X-37B project, which could leave a backdoor to militarization of space.

Even in the days of the more open X-37 program, certain sensitive design parameters were classified. And after NASA was forced to drop its end of the project because of budget pressures, the spacecraft became more of a "black" program under the X-37B name. The project was first transferred to the Defense Advanced Research Projects Agency (DARPA) and then to the Air Force's Rapid Capabilities Office. Where the craft's development ultimately wound up says much about the nature and urgency of its mission, because the latter office is tasked with expediting the process of developing and putting into the field select combat support and weapon systems. And to do so rapidly, as the name suggests (US Air Force, 2009)[7].

mission a mystery. CNN, October 20. Available at: http://www.cnn.com/2014/10/18/us/air-force-space-plane-x37b/index.html.

5 *Kramer M (2015) See SpaceX's rocket landing crash up close with these photos & video. Space.com, January 16. Available at:* http://www.space.com/28295-spacex-rocket-landing-crash-photos-video.html.

6 *NASA (2015) Speed regimes: Hypersonic re-entry. Available at:* http://www.grc.nasa.gov/WWW/BGH/hihyper.html.

7 *US Air Force (2009) Rapid Capabilities Office. Fact sheet,*

From a purely technical standpoint, there appears to be not much difference in the basic engineering design between the X-37 and the X-37B. Here are some comparisons, all drawn from publicly available unclassified documents: the earlier X-37 was 27.5 feet long, whereas the X-37B is 29 feet 3 inches. The wingspans are respectively 15 feet and 14 feet 9 inches. The X-37 weighed slightly less (10,000 pounds) compared with the X-37B (11,000 pounds). The dimensions of the cylindrical experimental bay-7 feet long by 4 feet in diameter, or roughly the size of a pickup truck-are the same for both vehicles. Both craft were designed for a minimum on-orbit duration of approximately nine months, which the X-37B has already exceeded by a large margin (Boeing, 2015[8]; NASA, 2003[9]).

As for what the X-37B can do, the Air Force openly announced a list of technologies being tested. It includes advanced guidance, navigation, and control; thermal protection systems; high temperature structures and seals; lightweight electromechanical flight systems; and autonomous orbital flight, reentry, and landing. Officials also said that they anticipate that multiple missions will be required to satisfy all the test program objectives, with the exact number of missions yet to be determined (Badger, 2012)[10].

Little is publicly known about the X- 37B's latest mission, or indeed any of its activities. The US Air Force launched the robotic plane on December 11, 2012 atop a United Launch Alliance Atlas 5 rocket from its Cape Canaveral base in Florida. The robotic craft returned to Earth on October 17, 2014, gliding to a stop on Runway 12 at Vandenberg Air Base in California. What it did during its 674 days in orbit is unknown, but it was aloft far longer than the 270 days planned.

There is no doubt that the military wants to continue to keep some parts of the mission secret, especially those that involve making a rendezvous with another craft, the ability to do in-orbit maneuvers to spy on other satellites, and the release or retrieval of micro satellites. These capabilities have already been demonstrated by the space shuttle, but not in a military setting. The handlers of the X-37B are likely doing them in secret to make sure the craft can do them reliably.

What we do know is that the X-37B's payload bay is likely too small to carry large telescopes to conduct reconnaissance. And the National Reconnaissance Office (NRO) already has plenty of other assets to do that. (This little-known US government agency is responsible for designing, building, launching, and maintaining America's spy satellites, which it has done for "customers" such as the CIA for over 50 years (National Reconnaissance Office, 2012)[11]. But according to Jonathan McDowell, an astrophysicist at the Harvard-Smithsonian Astrophysical Observatory, the NRO may be involved with the X-37B in another way, most likely in testing new sensors in space. He thinks that this testing could be one of the reasons the last mission with X-37B was extended significantly- a particular sensor might have worked better than expected, he theorizes, and the people operating it wanted to collect as much test data as possible.

Admittedly, however, little hard information on this aspect of the mission has been made public, and so there is no way to make definitive

August 28. Available at: https://www.af.mil/About-Us/Fact-Sheets/Display/Article/2424302/rapid-capabilities-office/.

8 *Boeing (2015) X-37B Orbital Test Vehicle overview. Available at:* https://spaceflight101.com/spacecraft/x-37b-otv/.

9 *NASA (2003) X-37 demonstrator to test future launch technologies in orbit and reentry environments. May. Available at:* http://www.nasa.gov/centers/marshall/pdf/100427main_x37-facts.pdf.

10 *Badger E (2012) Air Force launches 3rd X-37B Orbital Test Vehicle. Air Force News Service, December 11. Available at:* http://www.af.mil/News/Article-Display/tabid/223/Article/109994/air-forcelaunches-3rd-x-37b-orbital-test-vehicle.aspx.

11 *National Reconnaissance Office (2012) About the NRO. Available at:* http://www.nro.gov/about/index.html.

statements. But the Air Force has shown that it is aggressively developing technologies for hypersonic travel to space, and that the X-37B is the lynchpin of those efforts. The Air Force is not at all shy about its interest in developing hypersonic technologies for space. For example, in discussing the Air Force budget for the fiscal year 2015, the Under Secretary of the Air Force Eric Fanning said that it had spent over $100 billion from 2000 to 2015 in "cutting edge space technologies."

It's all about being hyper

So what exactly are the technologies the Air Force would like to develop? In his testimony before the House Armed Services Committee on March 26, 2014, the deputy assistant secretary for Science, Technology, and Engineering, David E. Walker, laid out some priorities. At the top of his list of what he called "game-changing technologies" was hypersonics (House Armed Services Committee, 2014)[12].

Walker said that getting objects to travel at super-high speed provides options for engaging "time-sensitive" targets in "anti-access/area-denial" environments. These are code words for counterterrorism operations, as well as for dealing with the growing Chinese anti-ship missile capabilities that could pose a threat to the US Pacific naval fleet.

Walker also said that the Air Force is interested in developing a hypersonic cruise missile called the High-Speed Strike Weapon (HSSW). For it to mature, several crucial technologies must be developed. Among them are materials that can withstand high temperatures; guidance, navigation, and control systems that work at hypersonic speeds; and thermal protection and heat management- the very same technologies being developed under the guise of the X-37B.

Hypersonic technology will be applicable to the so-called "tactical boost-glide" system for prompt long-range strike that the United States has begun testing. In that system, a booster rocket accelerates to speeds of Mach 5 or above and then launches a vehicle that glides over a long distance unpowered, reentering the atmosphere at hypersonic speeds. The United States wants to develop a missile system at the higher realms of the hypersonic that can strike anywhere on Earth in less than 90 minutes; a boost-glide vehicle is one possible method for doing so.

The advantages of such a system are many: Conventional bombs are dropped from aircraft moving, at best, between 700 miles per hour and 800 mph. Boost-glide systems, on the other hand, could cover long distances at speeds of up to 7,000mph to surprise the adversary after a quick reentry. It is a highly destabilizing system: an adversary will have little notice, and minimal chance of establishing radar contact. And since boost-glide is a large part of what the X-37B does, it is a fair bet that there is some technology transfer going on.

Piggybacking research

In addition to the direct testing of boost-glide systems, the X-37B offers the Air Force a platform to test a whole gamut of hypersonic technologies. In a sense, the plane serves as an integrated test bed for all sorts of weapons that travel at hypersonic speeds-such as DARPA's X-51 Waverider[13], a program in which an air-breathing missile known as the "scramjet"reportedly reached a speed of 5.1 Mach, which is the low end of the hypersonic world for several seconds. At such extreme airspeeds, the missile could reach any target in the

12 *House Armed Services Committee (2014) Presentation to the Subcommittee on Intelligence, Emerging Threats and Capabilities. March 26. Available at*: https://www.darpa.mil/attachments/DrPrabhakar-26-Mar-14.pdf.

13 *US Air Force (2011) X-51A Waverider. Fact sheet, March 2. Available at*: http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104467/x-51a-waverider.aspx.

world in an hour or less, a tremendous boon to strategists. This demonstration, if true, showed for the first time that a hypersonic missile was indeed feasible-and it could be a missile that did not need to carry the enormous weight of liquid oxygen needed for combustion.

So, even if the X-37B does not have scramjets, it is developing reentry technologies at hypersonic speeds. And obviously, combining the air-breathing supersonic propulsion system of the Waverider with what has been learned about reentry technology developed from the X-37B could help to develop an extremely fast boost-glide missile for prompt global strikes.

Hypersonic propulsion and flight involve working out many problems at once: extreme airspeeds, temperatures, pressures, and stresses, along with compact airframes and low weight. Solving them all requires the latest new materials and advances in high-performance computing-but the key item is actual flight data from real-world tests. Such data are essential to verify results obtained from computer simulations, but it is very difficult to create such hypersonic test conditions in a laboratory. In this regard, the X-37B provides much-needed flight data which were not easily available from the space shuttle because crewed missions did not allow for a lot of risky experiments.

Highlighting the importance of hypersonics, Lt. Col. Timothy R. Jorris of the Air Force presented a paper at the American Institute of Aeronautics and Astronautics Flight Testing Conference in June 2014; in it he gave an overview of all the different activities in hypersonics, space transit, and space launch from the X-37B program, High Speed Strike Weapon (HSSW) research, the X-51 A, and other programs (Jorris, 2014)[14].

X-37B is breaking new ground

In their book, Coming Home: Reentry and Recovery from Space, NASA scientists Roger D. Launius and Dennis R. Jenkins describe the success of theX-37B missions as "nothing short of spectacular". They say the missions broke new ground in the development of thermal protection systems and "pushed the envelope of knowledge about re-entry". So, even though the space plane itself has nothing such as the scramjet-a technology that takes atmospheric oxygen traveling at supersonic speeds and uses it for combustion, allowing for extremely high speeds- the research from the X-37B is proving essential to developing hypersonic scramjet technology (Launius and Jenkins, 2012)[15].

Nothing beats praise from a competitor, such as China. In an otherwise purely technical article published in Science China, authors from the Science and Technology and Scramjet Laboratory of the National University of Defense Technology praised the good thermal protection and aerodynamic characteristics of the X-37B. Its success will "quicken the development of the hypersonic propulsion technology", they observed (Huang et al., 2012)[16].

Meanwhile, DARPA is moving on to the next stage: exploring technologies for autonomous operations in geostationary orbit 22,500 miles above the Earth, where most communication satellites reside. In a formal Request for Information released on September 3, 2014, DARPA sought industry aid and advice on developing a "robotic servicer" designed for operating at that altitude. DARPA envisions a servicer that could inspect satellites, carry out repair missions, or assist satellites in orbit-change

14 *Jorris TR (2014) Recent and ongoing hypersonic, space transit, and space launch flight tests. Aerospace Research Central. Available at:* http://arc.aiaa.org/doi/abs/10.2514/6.2014-2579.

15 *Launius RD and Jenkins DR (2012) Coming Home: Reentry and Recovery from Space. Washington, DC: NASA. Available at:* http://www.nasa.gov/connect/ebooks/coming_home_detail.html.

16 *Huang, W,Li SB, Liu J et al. (2012) Investigation on high angle of attack characteristics of hypersonic space vehicle. Science China 55(5): 1437"1442. Available at:* http://link.springer.com/article/10.1007%2Fs11431-012-4760-6.

maneuvers (DARPA, 2014)[17].

While benign-sounding on the surface, a robotic servicer that can carry out repairs or assist satellites could easily threaten the geostationary satellites of other nations. (A geostationary satellite moves in the same direction as the Earth at exactly the same speed, thus making it able to hover over a given spot on the ground indefinitely). Such operations would be particularly dangerous, because even an accidental collision could cause a shower of debris that endangers everything else at that altitude-and would effectively last forever.

The United States is the principal driver of space weaponization

Just as important as hypersonic technology itself is the attitude of those who control it. In April 2006, Lt. Gen. Frank G. Klotz, former vice-commander of the US Space Command, extolled the virtues of these new technologies and what he called Operationally Responsive Space, which would allow, for example, the steering of satellites so they can cover battlefield areas for intelligence-gathering. Similarly, the ability to launch small satellites quickly would have the potential to dramatically alter space-based support for those fighting wars; the mini-satellites could be used to compensate for the loss of one's own satellites to the enemy, or to threaten an adversary's space systems with electronic warfare (Klotz, 2006)[18].

And on May 20, 2014 Gen. William L. Shelton, the former commander of the US Space Command, gave a major speech to the 30th National Space Symposium, held in Colorado Springs. Titled "National Security Space: Then, Now, Tomorrow", it covered space history.

from Sputnik to the space shuttle (Shelton, 2014)[19]. Sounding almost nostalgic about the early days of space flight, when "it was just us and the Soviet Union in space", he drew attention to the "dangerous current environment in space". He pointed out that there are now 11 countries with their own launch capabilities, and some of those countries have an openly aggressive agenda.

Gen. Shelton was right about the 1960s, when satellites were mostly used for reconnaissance, and the United States and the USSR had agreed to not target one another's orbiting platforms, euphemistically called "national technical means". The landmark 1972 Anti-Ballistic Missile (ABM) Treaty also indirectly banned space-based sensors and tests, keeping a lid on the overt militarization of space (NTI, 1972)[20].

However, the dynamics of space changed drastically in 1991 during the Persian Gulf War, in which the United States used its space-based assets for the first time directly for warfare-although they were confined mostly to communications and reconnaissance. This trend continued during the NATO bombing of Serbia in 1999, when Global Positioning System satellites guided bombs and cruise missiles to their targets. And even though the United States had a clear superiority in space, the military's emphasis was on not letting up: In the year 2000, Donald Rumsfeld went so far as to warn of an impending "Pearl Harbor in space", before becoming Secretary of Defense under George W. Bush. The following year, the United States unilater-

17 *DARPA (2014) Wanted: Insights to guide creation of robotic satellite-servicing capabilities in geostationary Earth orbit. Request for information, September 3. Available at:* https://www.darpa.mil/news-events/2014-09-03.

18 *Klotz FG (2006) Defining responsive space. Remarks to the Responsive Space Conference, Los Angeles. April 24. Available at:* https://www.afspc.af.mil/About-Us/Leadership-Speeches/Speeches/Display/Article/252920/defining-responsive-space/.

19 *Shelton WL (2014) National security space: Then, now, tomorrow. Remarks to the 30th National Space Symposium, Colorado Springs. May 20. Available at:* http://www.afspc.af.mil/library/speeches/speech.asp?id¼750.

20 *NTI (1972) Treaty on the Limitation of Anti-Ballistic Missile Systems (ABM Treaty). Available at:* https://www.nti.org/learn/treaties-and-regimes/treaty-limitation-anti-ballistic-missile-systems-abm-treaty/

ally withdrew from the ABM Treaty, and the push in the US military for missile defense systems and the militarization of space began in earnest. Both Russia and China were highly critical of US actions.

Preventing an arms race in space

Discussions about how to prevent an arms race in space started long ago; the UN Conference on Disarmament even started negotiations on a treaty, but the United States prevented it from going any further. And at the 2008 Conference on Disarmament in Geneva, China and Russia introduced an actual space arms control treaty, popularly known as the Prevention of an Arms Race in Outer Space treaty (PAROS Treaty, 2012)[21].

The treaty proposal comes in the nick of time. In 1997, the United States conducted a test of a megawatt-class ground-based laser called MIRACL (Mid-Infrared Advanced Chemical Laser)[22], firing it at a dying US satellite in orbit 416 kilometers overhead.

I attended this test at White Sands Missile Range in New Mexico as a technical observer for the House Armed Services Committee; the object was to see if the laser could blind any sensors on the satellite and possibly destroy its electronic circuits, making the satellite inoperable. While the MIRACL laser itself failed to work, a much smaller substitute laser was put in its place at the last moment, and that smaller laser-a million times less powerful than MIRACL-was able to temporarily blind the satellite's sensors. The conclusion (which the popular press missed) was that even though the larger laser was not behaving properly that day, the test had successfully shown that a reconnaissance satellite high in space was vulnerable to a land-based laser-and a much smaller, less powerful laser than expected, at that.

And in 2008, the US military blew up another satellite called USA-193, which had gone out of control soon after launch. (That satellite was destroyed with a missile at an altitude of 250 kilometers.)

While the United States has been the primary driver in the weaponization of space, other countries have not stood still. China conducted antisatellite tests in 2007 and again in 2013. And Russia tested a new device of its own on November 9, 2014, dubbed the "satellite catcher" (Rincon, 2014)[23].

Under the draft of the PAROS treaty submitted to the United Nations, participating countries would pledge to refrain from placing objects carrying any type of weapon into orbit, from installing weapons on celestial bodies, and from threatening to use force against objects in outer space. They would also agree to practice measures to build confidence in commitments to refrain from weaponizing space.

So far, the United States has been cool to the suggested treaty. The Bush administration's position was that the present space treaties were adequate and a new treaty unnecessary. Although there was much hope that President Obama would do things differently, there has actually been little change so far. While perhaps the United States is not blocking the negotiations, there has been no evidence of any initiative to break the deadlock. That serves the space enthusiasts in the Pentagon and the military contractors just fine, and the Aerospace Industries Association is lobbying hard for more funding for research in hypersonics (Aerospace Industries Association, 2014)[24].

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21 *PAROS Treaty (2012) Prevention of an Arms Race in Outer Space Treaty. Available at:* https://www.nti.org/learn/treaties-and-regimes/proposed-prevention-arms-race-space-paros-treaty/

22 *U.S. Test-Fires ‚MIRACL' at Satellite Reigniting ASAT Weapons Debate, Arms Control Today, October 1997.*

23 *Rincon P (2014) Russia tests `satellite catcher.' BBC News, November 20. Available at:* http://www.bbc.com/news/science-environment-30097643

24 *Aerospace Industries Association (2014) Hypersonic technology and development: Imperatives critical to US national*

But an arms race in space can still be avoided, if the international community can convince the military strategists and political leaders in the space-faring nations-especially the United States-that there would be no winners in a war in space, only losers. Perhaps it is possible to return to Shelton's good old days, by creating a treaty that would respect the integrity of all satellites and pledge not to develop and test military space systems. The Soviet Union and the United States maintained such a regime for more than four decades; the trick now is to extend it beyond the bipolar world of yesteryear. If nothing else, efforts could at least begin with Russia and the United States-the two big dogs in the arena.

The fantastic new space technologies now being developed have the potential to benefit everyone; just as a satellite catcher can be used to harm another country's satellite, it can also repair a defective one. Instead of developing these technologies in secret with an eye to their military use, an open, collaborative program could lead to faster innovation in space, at much lower cost. Such an example already exists in the case of the International Space Station, where collaboration between the United States and Russia continues, even under the rapidly deteriorating relations between the two countries. Perhaps that example of cooperation could be extended to include all the machinery that has been put in space to serve humankind.

security and aerospace superiority. Available at: http://www.aia-aerospace.org/assets/AIA_Hypersonic_White_Paper_032611.pdf.

Notes

1. There are no reliable public data relating specifically to the number of Russian and Chinese military satellites in orbit. The information available deals solely with the total number of these countries' satellites (Union of Concerned Scientists, 2014).

2. Despite the claims for the spectacular success of the X-51's final test (which occurred after two previous failures), the program was canceled. The Air Force didn't explain why, nor did it say exactly how sustained the supersonic combustion was, only stating in an announcement that the "X-51 traveled 230 nautical miles in 6 minutes, reaching a peak speed of 5.1 Mach". Simple arithmetic, however, says that the average speed was only about 3.8 Mach, well below hypersonic speed-which is defined as 5.0 Mach (US Air Force, 2011).

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