

Suborbital Strike!

The Use of Commercial Suborbital Spacecraft for Strike Missions

Capt Daniel J. House, USAF

Dr. John Tiller

Dr. John Rushing

Disclaimer: The views and opinions expressed or implied in the Journal are those of the authors and should not be construed as carrying the official sanction of the Department of Defense, Air Force, Air Education and Training Command, Air University, or other agencies or departments of the US government. This article may be reproduced in whole or in part without permission. If it is reproduced, the *Air and Space Power Journal* requests a courtesy line.



In combat, aircraft survivability can be distilled to five key components: altitude, airspeed, battle damage absorption, emissions control, and connectivity. Since the 1980s, the US Air Force has concentrated solely on decreasing emissions and increasing connectivity to improve aircraft survivability. At the same time, the maximum airspeed and maximum altitude of the service's aircraft have actually decreased, presenting an adversary with targets that must operate well inside the threat's engagement zone.

This article reviews a concept for the use of commercial suborbital spacecraft for military purposes, allowing the Air Force once again to enhance survivability via

altitude and airspeed. By utilizing commercial technology, suborbital spacecraft will be able to reach the battlefield faster than aircraft generated by the traditional procurement process, just as the Liberty program rapidly fielded effective combat aircraft.¹ Higher altitude and airspeeds will give legacy ordnance greater capabilities and permit the use of kinetic-only weapons such as hypervelocity rod bundles.² Finally, suborbital spacecraft will reset the clock for anti-aircraft defense by flying and striking from outside the weapon engagement zone (WEZ) of current systems, thus negating most anti-access, area-denial (A2AD) strategies. This action will force potential adversaries to spread out their limited research and procurement dollars into new weapon systems, either reducing the number of current systems they can support or leaving glaring, fatal holes in their defense posture.

Aircraft Survivability

Every aircraft, whether manned or remotely piloted, is launched on its mission with the assumption that it will survive at least to the point where it can successfully attack the enemy and, kamikazes notwithstanding, with the assumption that it will return to base for use on later missions. Traditionally, aircraft survivability has included four capabilities. The first capability is altitude—the ability to overfly adversaries' defenses—first demonstrated with high-altitude bombing by German zeppelins over London in World War I. The zeppelins flew too high for both anti-aircraft artillery (AAA) and British fighter aircraft to reach.³ From that time until the mid-1960s, aircraft attained higher altitudes to avoid the enemy's WEZ. The top two American platforms for altitude were the U-2, having a maximum altitude of above 70,000 feet, and the SR-71, above 85,000 feet. With the exception of the XB-70, which had a planned altitude of 77,000 feet, every Air Force aircraft since then has been designed for a maximum altitude of 50,000 to 60,000 feet.⁴ Compare the SA-2, the oldest Russian surface-to-air missile (SAM) still operationally used, which had a maximum altitude of 72,000 feet and a range of 16 nautical miles (nm) with its original missile iteration, and the SA-20, which has a maximum altitude of 82,000 feet and range of more than 100 nm. Evidently, SAM designers have been concentrating on extending range over increasing altitude.⁵

The second capability is airspeed—the ability either to outrun the adversary's interceptors or to fly by too fast for his defenses to respond and engage. Once again, the SR-71 boasted the maximum developed airspeed with its Mach 3+ capability, and the XB-70 was designed for Mach 3.1. The Russians tried to defend against these threats by developing both high-speed interceptors (the MiG-25 and MiG-31) and a more capable air-to-air missile (the AA-9 Amos) although they never successfully shot down the fast-moving SR-71.⁶

The third capability is battle damage absorption—how well the platform can take a hit and keep flying. Both the A-10 Warthog and Su-25 Frogfoot were designed for close air support, operating in areas of heavy AAA. Multiple times they have returned safely to base despite being hit by missiles and AAA.⁷ Although these aircraft are specially designed to withstand battle damage, the newest ones entering the fleet are not as robust.

The fourth capability, emissions control, involves control of both internally generated emissions (e.g., onboard radars, radios, data links, heat, and sound) and either the absorption or controlled deflection of off-board-generated emissions, such as enemy radars. Since the successful deployment of the F-117 in Operation Desert Storm, the Air Force has concentrated on emissions control as its primary means of improving aircraft survivability, specifically in relation to enemy radar emissions. The issue with this course of action is the fact that people are forgetting their basic physics. It is impossible to create an aircraft that has no emissions. Eventually the enemy will create a sensor sensitive enough to pick up said emissions, separate them from the environmental noise, and target the friendly aircraft. Second, even if one manages to decrease emissions in one part of the spectrum, one is either unable to lower them in another part or in some cases make them even worse. A good example is the controversial F-35. Even though it has low-observable capability in the S-band radar frequency range, it is less capable in the VHF and L-band, which provide a potential window for targeting.⁸ Another issue concerns an aircraft's infrared emissions. Aircraft invariably heat up when they travel at high speeds through the air. One could easily imagine an opponent enhancing or replacing his integrated air defense system (IADS) radars with infrared search and track sensors on every SAM system.⁹ The point here is that the easiest way to upgrade an anti-aircraft missile, radar, or interceptor is to upgrade and replace the sensors. Sensor technology is constantly improving, and with globalization, possible enemies are quickly catching up in this field. After the development of a sensor technology that can counter stealth by focusing on other emissions, it will spread to our adversaries nearly overnight, significantly minimizing the benefits of stealth.

The fifth point of aircraft survivability—connectivity—has become of key importance only in the past 25 years. Connectivity has to do with the aircraft's ability to relay data in the form of location, orders, or target information. Connectivity began with light guns and flares to pass simple commands such as take off and land before it progressed to radios for relaying orders and increasing situational awareness and to “identification, friend or foe” for fast, accurate identity checks. At these junctures, it was still possible for the aircraft to fight effectively, even when connections failed because of jamming or equipment problems. In recent years, however, it has led to data links passing situational awareness first and now targeting data—and even to the successful development of remotely piloted vehicles. Manned combat aircraft can still recover to their home base, and most remotely piloted vehicles have lost-link procedures to return to base as well, but both are rendered combat ineffective as soon as their links are severed, putting them at much greater risk of destruction. The reliance on links has come to the point that in comparisons of the F-35 and Su-30, the F-35 can be effectively employed only if it has garnered off-board sensor situational awareness. That is, for the F-35 to win, it needs the presence of an Airborne Warning and Control System (AWACS) aircraft. If the AWACS is jammed or shot down, then the F-35 would not be able to compete against the more capable fighter.¹⁰ In 1992 during an air show in Moscow, Russia announced that its Kh-31 (AS-17) antiradiation missile had been modified specifically to target AWACS with a range of nearly 100 miles.¹¹ One can compensate for this vulnerability by pulling back the AWACS and other high-value airborne assets but with a subsequent cost in sensor range and capability.

Such loss would decrease the effectiveness of every allied platform because of the networked connectivity inherent in today's airpower, making friendly aircraft quite susceptible to attack. Figure 1 compares the survivability of the F-22, F-35, SR-71, and U-2.

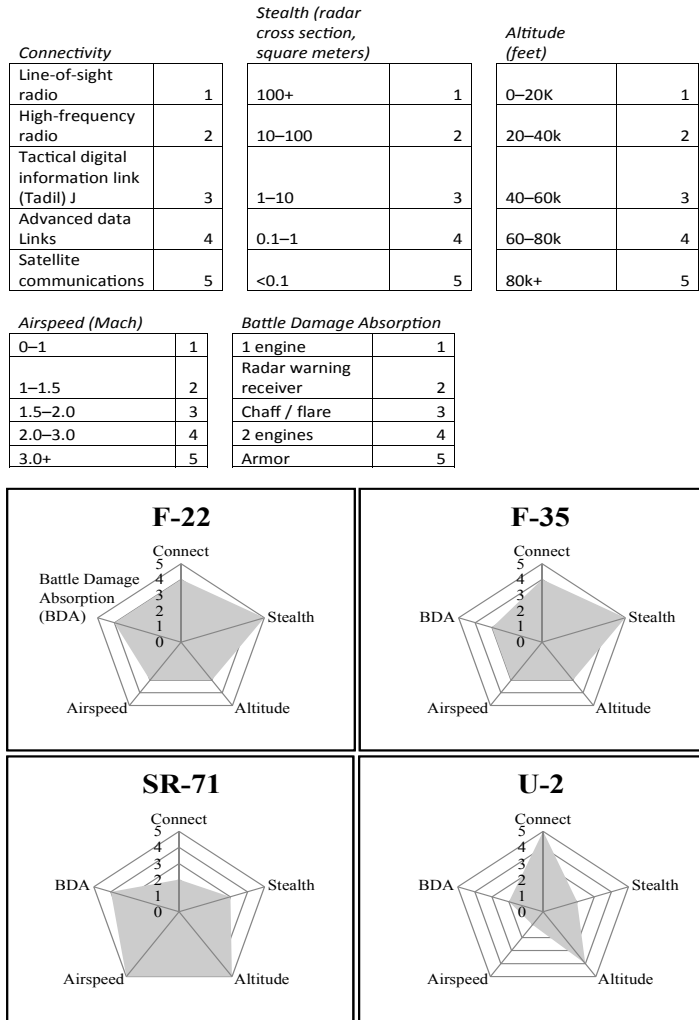


Figure 1. Survivability comparison of the F-22, F-35, SR-71, and U-2. (For the radar cross-section numbers, see Wing Cdr Chris Mills, "Air Combat: Russia's PAK-FA versus the F-22 and F-35," Air Power Australia, 30 March 2009, <http://www.ausairpower.net/APA-NOTAM-300309-1.html>.)

Enter the Suborbital Spacecraft

As we previously saw, the use of stealth and connectivity as the only means of increasing aircraft survivability has been outmaneuvered by recent Russian and Chinese IADS technological development. Since these systems are sold around the world, any adversary could have the advanced anti-aircraft systems necessary to make any conflict very costly for the Air Force. Given both the advanced capabilities and current timeline required to bring a new airframe to the fleet, the authors of this article recognized the need to return to higher altitudes and airspeeds and to increase the speed of procuring new aircraft.

In 2012 Captain House, one of the authors, wrote his thesis on using a commercial suborbital spacecraft in a strike capacity.¹² To be considered suborbital, a vehicle must pass the Karman Line, which is set at 100 kilometers (km), requiring a vertical velocity of 1 km/second without sufficient forward velocity to enter orbit (7 km/second). Inside this zone, the vehicle will enter a ballistic trajectory that will take it into space but not keep it in orbit.¹³ The authors reviewed four commercial vehicles, selecting Virgin Galactic's SpaceShip Two for analysis because it had the greatest payload capacity and was furthest along in development. Modifying the spacecraft, hereafter referred to as the Militarized SpaceShip 2 (MSS2), for a strike role allowed it to carry 2,000 pounds of ordnance—the equivalent bomb load of an F-22 in air-to-ground loadout—and a range of 700 nm.¹⁴

Using the desktop computer simulation “Modern Air Power” software by John Tiller, the authors analyzed the MSS2 against both a legacy IADS employed in Iraq and Libya and a modern IADS with newer systems, such as the SA-12 and SA-20. These same scenarios were run for a standard strike package, a cruise missile strike, and a stealth bomber strike for comparison against two target sets—one in a shallow strike (i.e., 50 miles of the forward edge of the battle area [FEBA]) and a deep strike (i.e., 200 miles inside the FEBA). The analysis showed that although the four MSS2s could not match the payload weight of a B-2, they were just as capable of penetrating a modern IADS. The standard strike package and the cruise missile strikes were both decimated in these environments.

The authors further refined these analyses and tested the modern IADS scenario on a Linux cluster computer. Dr. Tiller and Dr. Rushing, coauthors of this article, ran each of the four strike scenarios 10,000 times and aggregated the results. The air interdiction combat air patrol was modified to be more aggressive against friendly aircraft, and the cruise missiles were rippled fire—rapidly fired to overwhelm the enemy IADS instead of single shots to minimize exposure to individual cruise missiles. These actions increased the score of the cruise missiles compared to that of the B-2, but the scores of the standard strike package, B-2 strike, and cruise missiles were still well below the MSS2's. Figure 2 shows the aggregate results of the simulations, the horizontal line representing the scenario outcome score and the vertical line, the number of results for that outcome. Results to the right are better for the friendly side and worse for the enemy. The aggregate score is based on damage to target and Red and Blue losses that were recorded for each run.

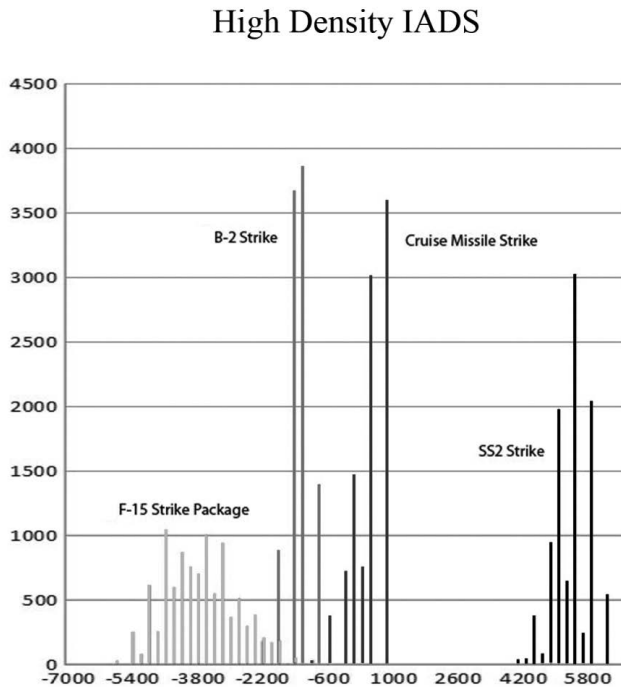


Figure 2. Comparison of four strike capabilities

In the summer of 2013, the suborbital concept was evaluated in the Air Force Research Laboratory's Advanced Concepts Exercise (ACE) 13, which used the MSS3, based on press releases' hints about the capabilities of the future SpaceShip Three (SS3). At that time, SS3 was still believed to be a long-range suborbital spacecraft for point-to-point service although it is possible that it will prove capable of orbit if unveiled. For the ACE 13 test, MSS3 had a payload of 2,500 pounds and a range of 5,500 nm. The results are classified, but the test did show that MSS3 could carry out deep strikes beyond current capabilities and proved immune to present and upcoming IADS systems.

Why So Effective?

The MSS2 concept is effective not simply because it flies outside the range of an enemy IADS. Rather, the spacecraft breaks the kill chain in multiple locations. The kill chain—the steps in dynamic targeting more commonly known as find, fix, track, target, engage, and assess—is the engagement cycle necessary to go from initially acquiring a target to successfully neutralizing it.¹⁵ Earlier, the article noted that stealth is now the primary means of enhancing aircraft survivability. Stealth works by breaking the kill chain at the first step, making it very difficult to find the aircraft. If a B-2 is flying over an enemy nation in broad daylight and an enemy air-

craft spots it, the pilot will be more than capable of fixing, tracking, targeting, and engaging the bomber. The pilot may be limited to either heat seekers or guns, but he or she will still be able to employ the kill chain successfully and take out the B-2.

All that a potential adversary must do to repair this break in the kill chain is invest in and develop sensors capable of detecting stealth aircraft, either by improving the sensor sufficiently to pick up the minuscule returns or using other sensing methods such as sounds, lasers, or heat to search the environment. Once the means of finding the aircraft is sufficiently developed, the enemy can employ either standard air defense fighters to take out our stealth aircraft or upgrade his SAMs with antistealth capability.

This development of antistealth technology is not a radical idea. More than 15 years have passed since an F-117 was shot down over Serbia, and even though some questions remain over whether recovered debris from Vega 31 made it into the labs of Russia and China, both countries have recently unveiled stealth aircraft of their own. The limited number of Russian and Chinese stealth aircraft is not too worrisome in a contingency scenario, but the fact that they exist should put fear into stealth drivers' hearts because both countries can now train their radar and SAM operators to pick out stealth platforms while exercising against real stealth aircraft. When the US Navy lost its anti-submarine-warfare experience during the force shaping following the collapse of the USSR, it rebuilt that knowledge base by training against its own submarines.¹⁶ For the first time, enemies can do the same thing in a peacetime environment against stealth and have sufficient time to see which tactics, techniques, and procedures work and which don't, putting them that much further ahead of the learning curve on day one of the battle.

Unlike stealth platforms, suborbital spacecraft break the kill chain in two different locations. First, like stealth vehicles, they hide the aircraft. Stealth platforms do so by hiding from the radar even though they are within its effective envelope. Suborbital spacecraft operate outside the radar's field of view. Modern radars, especially the early warning types, are designed to look at very long ranges horizontally along the surface of the earth and slightly above. There has yet to be a threat to radars in the suborbital realm, so they are not designed to look upwards. For example, the FPS-117 long-range radar has a maximum range of 180 nm, but its maximum elevation is 20 degrees. That is, the maximum altitude the radar can see is 60 nm—and only at the maximum range. The radar's maximum altitude will drop 1 nm for every 3 nm closer to the radar.¹⁷ Without targeting information, the rest of the kill chain cannot be prosecuted.

Although current IADS early warning radars can be pointed upwards, doing so will not provide sufficient warning either to employ antispacecraft weapons or to seek shelter because suborbital spacecraft will be directly overhead upon discovery. Consequently, any ordnance already would have been released and would be only moments away from impact. If a radar is to have sufficient power to see far enough and high enough to acquire a suborbital bomber with sufficient reaction time to engage it successfully, then the country will need to invest in the equivalent of the United States' Ballistic Missile Early Warning System (BMEWS). Doing so will call for radars with capabilities like those of the AN/FPS-115 PAVE PAWS and the AN/FPQ-16 PARCS, both of which are large, immobile systems with massive power

requirements, making them both very expensive to build and operate and easy targets to find and destroy. Since the MSS2 is carried on a mother ship that uses Jet A fuel and theoretically could be refueled in flight, the spacecraft could be launched from any location; therefore, the entire perimeter of a country would be susceptible to a suborbital attack. To cover an entire country's airspace with a BMEWS would also demand a large expenditure of capital to build and maintain the system and would significantly drain that country's military budget, especially for nations like Russia or China that have large landmasses.

The second break in the kill chain is the lack of weapons to engage the suborbital bomber (fig. 3). The current iteration of non-US SAMs does not have sufficient altitude to engage a suborbital spacecraft. Both China and Russia have demonstrated some antisatellite capability, but their weapons are still few in number and designed to take out satellites, systems with no onboard countermeasures such as chaff, or systems unlikely to maneuver because of limited fuel on board and a lack of refueling capability. Since the suborbital spacecraft is in space for only a relatively short time, it can afford to carry decoys such as chaff, assemble a flight with some vehicles carrying jamming pods, or use onboard cold gas systems to maneuver. The only current forces that could engage and destroy a large fleet of suborbital spacecraft are the US Navy's AEGIS radars and RIM-161 Standard Missile 3 and the US Army's AN/TPY-2 radars with Terminal High Altitude Area Defense (THAAD) missiles, both designed for an anti-ballistic-missile role.

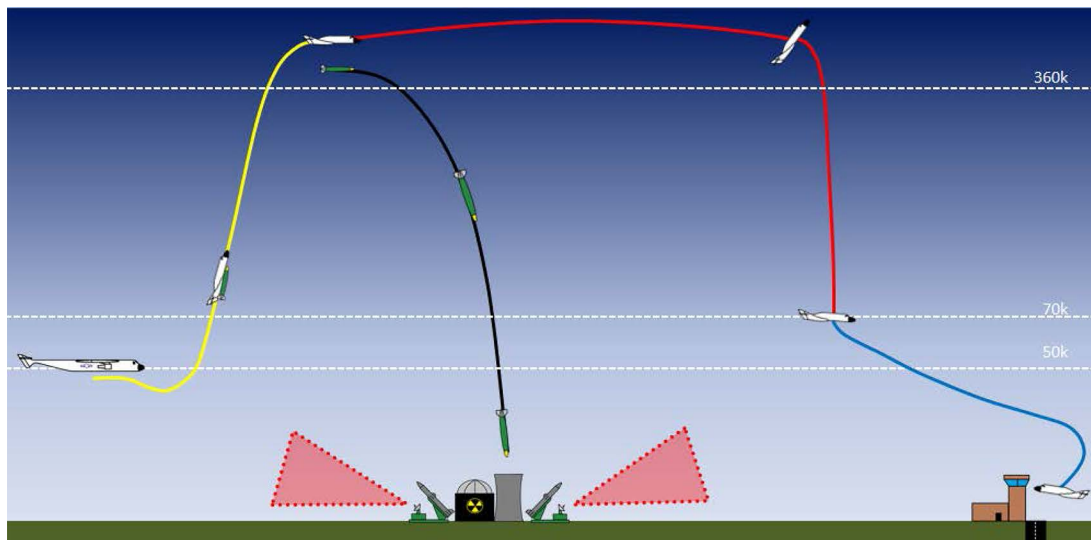


Figure 3. MSS2 overflight profile

There are three other ways to attack the suborbital spacecraft. First, a laser-based system is designed to burn through the skin of the vehicle. The US Airborne Laser was close to coming into production but would have had an issue firing directly overhead. No other major power is near fielding an airborne laser system. A ground-based system could be used but opens itself up to easier destruction. A laser-guided concrete or tungsten bomb, fitted with a sensor tuned to the laser's wavelength, could ride the beam down and destroy the mirror assembly as long as the sensor had sufficient shielding. A second countertactic involves deploying smoke, chaff, or an inflatable Mylar mirror between the laser and the spacecraft. Since there is very little atmosphere and the spacecraft would be cruising at this point, countermeasures once deployed would remain between the spacecraft and the earth. A second attack would take the form of an electromagnetic strike, such as jamming or high-power microwaves, but the long ranges make such an effort extremely difficult to execute without excessive power requirements. By keeping the spacecraft manned, almost all of these threats can be mitigated since the pilot can still operate and attack whereas a remotely piloted vehicle would lose link and refuse to fire. The final method of counterattacking, high-altitude nuclear detonation, entails exploding a nuclear warhead over one's own country, but some radical leaders might resort to such tactics.

This dual breakage in the kill chain from suborbital spacecraft is much more exploitable than the single breakage generated by stealth. Newer and better sensors are being devised every day; recently, gallium nitride semiconductors were authorized under the US arms export policy. When applied to the Patriot radar, these semiconductors allowed it to operate in 360 degrees instead of just a sector, at the same time decreasing cost and maintenance.¹⁸ As long as an opponent uses a set protocol for communication between the sensor head and the flight-control package for a missile—either surface-, sea-, or air-launched—the sensor package can be quickly and quietly swapped out and the Air Force will not know until it loses aircraft to the upgraded weapon. For the suborbital bomber, however, physics becomes our friend.

To counter the suborbital spacecraft, an adversary would need to (1) build a BMEWS that provides total perimeter coverage and (2) completely redesign his missiles to have sufficient energy to reach space. Every joule of energy needed to attain higher altitude, though, will subtract from the energy necessary to operate in the horizontal plane, thus shrinking the weapon's engagement zone. The extreme high altitude from which ordnance would be released would give weapons a glide distance of hundreds of miles; consequently, simple, static point defense of high-value targets would no longer be effective. To counter the suborbital spacecraft threat, the enemy must invest in very large—hence expensive—missiles and a significant number of them to provide complete coverage. We can see in figure 4 that it takes nearly 14 notional SA-30s to offer the coverage against a suborbital spacecraft that a single SA-30 would provide against common airborne targets. This development and deployment of a BMEWS, as well as many interceptor missiles, would prove incredibly costly. Thus, with the development and deployment of a suborbital striker into the US Air Force inventory, an opponent would face the choice of either severely curtailing spending on a traditional IADS to funnel money into antisuborbital weapons or having an IADS that is unable to counterattack. In an A2AD scenario, the first situation results

in a severely weakened traditional IADS for the standard aircraft to break through. The second situation produces a robust traditional IADS, in which case the standard aircraft would stand by until the suborbital spacecraft finishes dismantling the IADS with impunity. Either way, the A2AD IADS scenario is neutralized.

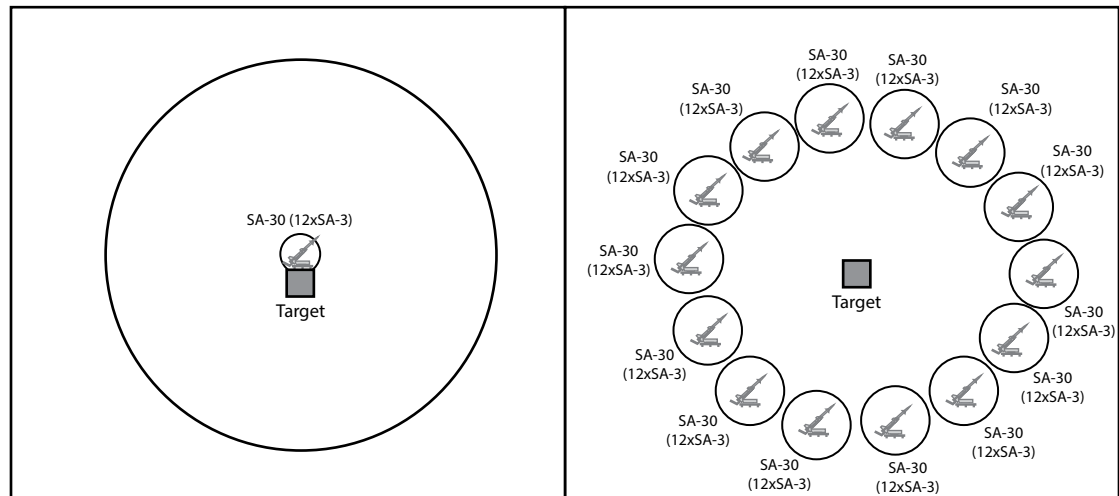


Figure 4. Limitations of airborne versus suborbital SAM requirements

Although the suborbital spacecraft concept does open up a considerable number of new possibilities and almost completely neutralizes current A2AD scenarios, it does have limitations. No single technology is a panacea that can cure all the Air Force's woes. Technology has its own strengths and weaknesses, and limitations must be recognized if it is to be properly employed. A suborbital bomber is not a "Swiss Army knife." The suborbital bomber will fly high and fast, allowing it to be quite effective for missions such as strategic bombing and deep air interdiction for which it needs to cut through the IADS; suppression and destruction of enemy air defenses; and reconnaissance missions that require battle damage assessment, especially if friendly satellites have been neutralized. The spacecraft will not be able to loiter, so it cannot be used for surveillance. Nor can it go low and slow, excluding it from effective use in either a close air support role or combat search and rescue support.

Rapid Development

We have shown that a suborbital spacecraft not only is a viable weapon platform but also is necessary in the coming age to counteract the increasing A2AD capabilities of potential adversaries. However, we have not discussed how to procure said spacecraft. Since this concept opens up a new field of airpower, it needs to be treated as a

Skunk Works–style project so that new ideas can quickly be tested, evaluated, and either implemented or killed as necessary. The program should be run much like the one for the MC-12 Liberty, using quick-reaction capabilities to modify a commercial aircraft into a viable weapon system. The MC-12W program went from establishing requirements to flying operational missions in 14 months.¹⁹ The commercial suborbital spacecraft nearest completion that meets the necessary mission specifications is Virgin Galactic's SpaceShip Two. Even though its initial test bed, the VSS *Enterprise*, crashed on 31 October 2014, taking the life of one test pilot and injuring a second, Virgin Galactic nevertheless is moving ahead with production.²⁰ As of this writing, the second SpaceShip Two has been built and is finishing the ground-test phase prior to flight testing.²¹ Given the present rate of production, it is possible to procure and have ready for testing an MSS2 by the end of 2018.

This early adaption would provide three additional advantages. The first is that tactics, techniques, and procedures could be developed from a clean slate. No other country would have this capability, and we could test and employ it to our maximum benefit since enemies would not know what to expect. The second is an economic boost in the US space-development sector that would keep it more firmly implanted in the United States, not only providing stable jobs but also keeping the advanced technology and corporate knowledge for its development and manufacture in this country. The third is that the launcher for MSS2, WhiteKnight Two, can also be used for launching satellites, thereby increasing the Air Force's capability of rapid space response.

In addition, to save both development costs and prevent future countermeasures, the authors recommend that MSS2 be manned. First, remotely piloted communication systems are not designed for use in suborbital spacecraft but for communicating with an air-breathing platform below them via satellite or talking to a satellite directly overhead via a ground station. A remotely piloted suborbital spacecraft will need a new communication method for its higher data rates—one that can fill the gap between aircraft and satellite. The second reason that MSS2 should be manned is that remotely piloted aircraft have an inherent risk that the link can be tampered with or cut. Any country that has sufficient technological capability to create an advanced IADS can carry out computer and network attacks over radio frequencies. Reportedly, in 2007 Israel used a computer network and an electronic operation to take down the Syrian IADS, assuming control as administrators and turning sensors off target.²² Remotely piloted vehicles are susceptible to the same types of attacks, the simplest of which is jamming the Global Positioning System so it cannot confirm its location and refuses to release its ordnance. The more advanced attacks can take over as the operator of the remotely piloted aircraft directs it to turn, land, or even theoretically release its ordnance on friendly forces. Jamming a manned spacecraft may prevent the pilot from deciding to release weapons, but we do not have to fear inadvertently dropping bombs on friendly forces.

The final aspect of development that needs to be discussed is the weapons that MSS2 will carry. Extremely high altitude will allow a weapon to generate a substantial amount of kinetic energy without the need to resort to explosives. By channeling that energy, we can create weapons that do not need explosive charges, thus generating two benefits. The first is that they are inert at ground level. A tungsten rod

travelling at zero miles per hour is able to injure somebody only if he or she trips over it. Therefore, one can use cluster munitions without the political backlash they generate from unexploded munitions left behind. In a war zone, if an ammunition ship or ammo bunker filled with these weapons is hit, there will be no subsequent detonations that lead to further damage to the ship convoy or base. Second, without the need for explosives, the weapon itself can be made smaller, allowing the vehicle to carry more of them. Utilizing the DeMarre equation for the penetration of kinetic energy weapons, the authors were able to determine that a 5 centimeter by 25 centimeter tungsten penetrator should be able to pierce the top armor of a Russian T-72 tank. The shrinking of guidance systems has led to the development of laser-guided bullets. With either infrared or television guidance, a single cluster bomb of tungsten penetrators should be able to take out an entire airfield or every ship in a harbor.

The weapon bay itself, though, will be designed to hold conventional munitions. Such bays should accommodate the weapon, not the reverse. Designing a weapon to reflect the limits of the aircraft always hurts the weapon. The Air Force recognized this fact first with the development of the AIM-4 Falcon, originally designed to fit into the weapons bay of the F-102.²³ The constraints placed on the missile by doing so rendered it almost useless. It proved ineffective in Vietnam and was eventually retired from the Air Force in favor of the AIM-9, designed by the Navy without restraints at the same time as the AIM-4 and still in use today. Like the F-117's, the weapons bay will be designed around the weapons, allowing the MSS2 to employ conventional munitions while suborbital munitions are in development, along with a much faster initial operational capability. We can compare the survivability capabilities of the MSS2 to those of the SR-71 and see their near overlap, except for the fact that the MSS2 will be capable of employing munitions (fig. 5).

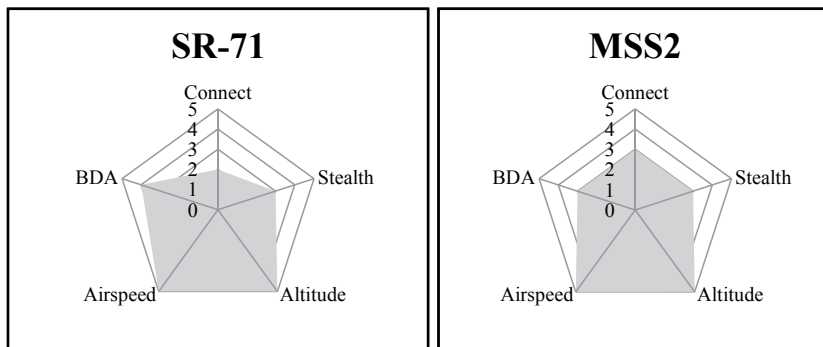


Figure 5. Survivability comparison of the SR-71 and MSS2

Conclusion

In the 1930s, the United States Army Air Corps, along with the rest of the world, was infatuated with long-range bombers. The Air Corps Tactical School pushed the doctrine of strategic bombardment. The statement “the bomber will always get through” was quickly taken up despite the warnings of fighter advocates such as Claire Chennault.²⁴ This stance directly affected aircraft development in peacetime, allowing creation of the B-17 but no other effective airframes. The United States entered World War II with a heavy bomber but no developed doctrine besides massed air raids or advanced aircraft for any other roles, and the Army Air Corps suffered severely for it.

We are quickly entering the 1930s mind-set again in today’s Air Force, but now the rallying cry is “the stealth aircraft will always get through!” To develop weapons that provide the greatest capability and most efficient use of resources, the Air Force needs to examine aircraft survivability from its five key components and apply each one to its individual mission.

The most effective method for breaking apart an A2AD IADS environment involves procuring a vehicle that can attack from outside the scope of the enemy’s IADS. The weak points here are altitude and airspeed. The current iteration of SAMs and fighters cannot touch a suborbital spacecraft. Although opening and developing a new line of air vehicles and training personnel to operate them may be expensive, the cost does not begin to compare with what adversaries would need to spend to counteract them.

A suborbital spacecraft, procured rapidly from commercial designs along the lines of the MC-12 program, will supply the necessary capabilities to keep the Air Force viable well into the 2030s to 2040s. It will regain freedom of maneuver within the A2AD environment and allow the creation of weapons that rely only on kinetic energy and that remain inert directly after use. Such a vehicle will keep technologically advanced jobs and manufacturing in the United States while forcing potential adversaries to spread their budget more thinly over multiple defensive systems. The future is forever changing. Only by thinking outside the norm and being willing to test new ideas will we have any hope of keeping up. 🌟

Notes

1. “MC-12W Liberty Intelligence, Surveillance and Reconnaissance (ISR) Aircraft, United States of America,” [airforce-technology.com](http://www.airforce-technology.com/projects/mc-liberty/), 15 March 2015, <http://www.airforce-technology.com/projects/mc-liberty/>.

2. Headquarters USAF/XPXC, *The U.S. Air Force Transformation Flight Plan* (Washington, DC: Headquarters USAF/XPXC, November 2003), 66, http://www.au.af.mil/au/awc/awcgate/af/af_trans_flight_plan_nov03.pdf.

3. Wilbur Cross, *Zeppelins of World War I* (New York: Paragon House, 1991), 153.

4. “Lockheed SR-71A,” National Museum of the Air Force, 29 May 2015, <http://www.nationalmuseum.af.mil/Visit/MuseumExhibits/FactSheets/Display/tabid/509/Article/198054/lockheed-sr-71a.aspx>; “U-2S/TU-2S,” US Air Force, 23 September 2015, <http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104560/u-2stu-2s.aspx>; and “North American XB-70 Valkyrie,” National Museum of the Air Force, 3 November 2015, <http://www.nationalmuseum.af.mil/Visit/MuseumExhibits/FactSheets/Display/tabid/509/Article/195767/north-american-xb-70-valkyrie.aspx>.

5. Dr. Carlo Kopp, "Almaz S-75 Dvina/Desna/Volkhov," Air Power Australia, 19 February 2015, <http://www.airspacepower.net/APA-S-75-Volkhov.html>; and Kopp, "Almaz-Antey S-300PMU2 Favorit," Air Power Australia, April 2012, <http://www.airspacepower.net/APA-S-300PMU2-Favorit.html>.
6. Dario Leone, "How the MiG-31 Repelled the SR-71 Blackbird from Soviet Skies," Aviationist, 11 December 2013, <http://theaviationist.com/2013/12/11/sr-71-vs-mig-31/>.
7. Francis Crosby, *The Complete Guide to Fighters & Bombers of the World* (London: Hermes House, 2008), 447, 492.
8. Dr. Carlo Kopp, "Assessing Joint Strike Fighter Defence Penetration Capabilities," Air Power Australia, 7 January 2009, <http://www.airspacepower.net/APA-2009-01.html>.
9. Wing Cdr Chris Mills, "Air Combat: Russia's PAK-FA versus the F-22 and F-35," Air Power Australia, 30 March 2009, <http://www.airspacepower.net/APA-NOTAM-300309-1.html>.
10. Dr. Carlo Kopp, "Sukhoi Flankers: The Shifting Balance of Regional Air Power," Air Power Australia, April 2012, <http://www.airspacepower.net/APA-Flanker.html>.
11. Norman Friedman, *The Naval Institute Guide to World Naval Weapon Systems*, 5th ed. (Annapolis, MD: Naval Institute Press, 2006), 533–34.
12. Daniel House, "The Viability of Commercial Sub-orbital Spacecraft for Military Strike Missions" (thesis, American Public University System, Charles Town, WV, 2012).
13. Simon Adebola et al., *Great Expectations: An Assessment of the Potential for Suborbital Transportation*, Masters 2008, Final Report (Strasbourg, France: International Space University, 2008), 6–14, https://isulibrary.isunet.edu/opac/doc_num.php?explnum_id=95.
14. "F-22 Raptor," US Air Force, fact sheet, 23 September 2015, <http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104506/f-22-raptor.aspx>.
15. "Dynamic Targeting and the Tasking Process," in Curtis E. LeMay Center for Doctrine Development and Education, "Annex 3-60, Targeting," 10 January 2014, <https://doctrine.af.mil/download.jsp?filename=3-60-D17-Target-Dynamic-Task.pdf>.
16. CAPT William J. Toti, USN, Retired, "The Hunt for Full-Spectrum ASW," US Naval Institute *Proceedings Magazine* 140, no. 6 (June 2014), <http://www.usni.org/magazines/proceedings/2014-06/hunt-full-spectrum-asw>.
17. "AN/FPS-117 Long-Range Air Surveillance Radars," Lockheed Martin, 2013, <http://www.lockheedmartin.com/content/dam/lockheed/data/ms2/documents/FPS-117-fact-sheet.pdf>.
18. Sydney J. Freedberg Jr., "The Biggest Thing since Silicon: Raytheon's Gallium Nitride Breakthrough," Breaking Defense, 20 February 2015, <http://breakingdefense.com/2015/02/the-biggest-thing-since-silicon-raytheons-gallium-nitride-breakthrough/>.
19. "MC-12W Liberty Intelligence, Surveillance and Reconnaissance (ISR) Aircraft, United States of America," airforce-technology.com, 15 March 2015, <http://www.airforce-technology.com/projects/mc-liberty/>.
20. Tariq Malik, "Virgin Galactic SpaceShipTwo Crash: Full Coverage and Investigation," Space.com, 19 December 2014, <http://www.space.com/27629-virgin-galactic-spaceshiptwo-crash-full-coverage.html>.
21. "FAA-AST Awards Virgin Galactic Operator License for SpaceShip Two," Virgin Galactic, 1 August 2016, <http://www.virgingalactic.com/faa-ast-awards-virgin-galactic-operator-license-for-spaceshiptwo/>.
22. John Costello, "Bridging the Air Gap: The Coming 'Third Offset,'" War on the Rocks, 17 February 2015, <http://warontherocks.com/2015/02/bridging-the-air-gap-the-coming-third-offset/>.
23. Ron Westrun, *Sidewinder: Creative Missile Development at China Lake* (Annapolis, MD: Naval Institute Press, 1999), 28–29.
24. Martha Byrd, *Chennault: Giving Wings to the Tiger* (Tuscaloosa: University of Alabama Press, 1987), 46–53.



Capt Daniel J. House, USAF

Captain House (BA, Texas A&M University; MA, American Military University) is the flight commander of Advanced Capabilities and Targeting Strategies, 55th Intelligence Support Squadron, 55th Wing, Offutt AFB, Nebraska. He is responsible for conducting signal development, big data and advanced analytics, full-spectrum mission integration, emerging technologies capabilities, and tactics, techniques, and procedures for all RC-135V/W, RC-135S, and RC-135U collection airframes. An RC-135V/W Rivet Joint electronic warfare officer instructor with over 1,500 hours, he has flown combat missions in Operation Enduring Freedom, Operation Unified Protector, and Operation Inherent Resolve.



Dr. John Tiller

Dr. Tiller (BA, Hendrix College; MSc, PhD, McMaster University) is president of John Tiller Software and has been a professional war-game designer and developer for over 20 years. During that time, he has published more than 100 war-game releases for Windows PC, Macintosh, Linux, iPad, Android, and Kindle. His war games have received multiple awards, including War Game of the Year on several occasions. For over 10 years, Dr. Tiller has performed in excess of 20 research and development projects for the Air Force and Navy, including organizations such as the Air Force Office of Scientific Research and Squadron Officer College. He is also a private pilot with over 1,000 hours of flight time.



Dr. John Rushing

Dr. Rushing (BS, Rensselaer Polytechnic Institute; MS, PhD, University of Alabama in Huntsville) joined Intel Corporation in 1999 as a senior computer-aided design engineer. In 2002 he returned to the University of Alabama in Huntsville where he is currently a principal research scientist. Dr. Rushing's current research includes artificial intelligence, modeling and simulation, data mining, and parallel algorithms.

Let us know what you think! Leave a comment!

Distribution A: Approved for public release; distribution unlimited.

<http://www.airpower.au.af.mil>