# WILD RIDE:

## LAUNCHING TROOPS THROUGH SPACE FOR RAPID PRECISION GLOBAL INTERVENTION

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## DISCLAIMER

**ABSTRACT**

In 2002 the forward-leaning Marines officially documented a need to transport "small numbers of combat Marines…at sufficient speed to ensure the relevance of global terrestrial force projection at the earliest stages of conflict." They have stated the desire to use space as the transport medium. With certain technological advances, the space domain may provide the solution, perhaps the only solution, for this USMC transportation requirement. Although achieving a viable, responsive troop space transportation option comes with significant challenges, the US Air Force as the lead service for space should invest in capabilities that will both satisfy the stated Marine Corps need and make possible other missions that would benefit from fast, low-cost, reliable space transportation.

The purpose of this paper is to examine technologies supporting worldwide point-to-point space transportation "and the implications of this for the USAF between now and 2025." While this futuristic method of achieving rapid global mobility requires maturation of a wide range of technologies, this paper will focus on launch vehicle technologies where an appropriate Air Force contribution would reap substantial rewards for the United States and the Air Force. After exploring the background related to this problem, the paper delves into launch vehicle technologies and immerses the concept in eight possible future scenarios. In seven of the eight alternative futures, we can see utility in having access to a rapid, point-to-point space transport technology.

The author concluded that the need for rapid, precision global mobility through space is valid. Technologies are maturing rapidly with the potential to deliver manned and unmanned responsive spacelift capabilities sooner than 2025, but they have not been adequately demonstrated in a single system. With the proper investments, disciplined planning, and the

right partnerships, the nation will see the opening of the space superhighway.

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## CHAPTER 1: INTRODUCTION

For most people, the United States Marine Corps (USMC) invokes images of a few proud, skilled warriors engaged in fierce amphibious assaults and ground combat, perhaps even slaying dragons.[1] If the Corps has its way, in future images these same Marines will gear up for spaceflight and ride in launch vehicles on their way to the dragon's lair on the other side of the earth. In 2002 the forward-leaning Marines officially documented a need to transport "small numbers of combat Marines…at sufficient speed to ensure the relevance of global terrestrial force projection at the earliest stages of conflict."[2] They have stated the desire to use space as the transport medium. With advances in materials and nanotechnology to reduce weight, information technology for command and control, biotechnology to keep the warfighters mission ready, and technologies to enable more aircraft-like operability, the space domain may provide the solution, perhaps the only solution, for this USMC transportation requirement. Although achieving a viable, responsive troop space transportation option comes with significant challenges, the US Air Force as the lead service for space should invest in capabilities that will both satisfy the stated Marine Corps need and make possible other missions that would benefit from fast, low-cost, reliable space transportation.

The purpose of this paper is to examine technologies supporting worldwide point-to-point space transportation "and the implications of this for the USAF between now and 2025."[3] While this futuristic method of achieving rapid global mobility requires maturation of a wide range of technologies, this paper will focus on launch vehicle technologies where an appropriate Air Force contribution would reap substantial rewards for the United States and the Air Force. After exploring the background related to this problem, the paper will delve into launch vehicle technologies, immerse the concept in eight possible future scenarios, and make recommendations for USAF investment.

## CHAPTER 2: PROBLEM ("WHY NEEDED? WHO'S RESPONSIBLE?")

> *The scope of the intervention necessary to contain or neutralize a contingency grows exponentially as the time between the decision to take action and the physical intervention increases. Earliest intervention results in minimal force application, with consequent minimal visibility at the lowest national cost.*[4]

### Why Needed?

One could easily argue that the stated USMC space mobility requirement begs the question, "Why do the Marines and the nation need the ability to send troops through space?" The world is changing. Enemies in The Long War on Terror and of the nation's future are not limited by borders. In his provocative work, *The Clash of Civilizations?*, Samuel Huntington hypothesized that in the coming years "the dominating source of conflict will be cultural…the principal conflicts of global politics will occur between nations and groups of different civilizations."[5] He goes on to say that while conflicts between states will still exist "the fault lines between civilizations will be the battle lines of the future."[6] With the increase in globalization, one cannot necessarily draw these "fault lines" on a map—they defy borders and span the globe.

This trend is sure to continue, and, as such, we must be prepared to appear anywhere in the world within seconds, minutes, or a few hours versus many hours, days, or more. Conceivably the U.S. military will need to respond quickly to multiple locations around the world simultaneously. Forward presence of military units around the world may be sufficient in some cases; however, we likely will not have the force size or political will to maintain the level of forward presence required to respond to the emerging set of conflicts. Space has the potential to afford us this global flexibility and responsiveness.

United States Special Operations Command expanded upon these thoughts in its 2004 Special Operations Forces Space Enabling Concept (SOFSEC). They foresee that a dangerous, uncertain strategic environment with a dramatically increasing range of threats will continue to pose challenges in the future. The following elements characterize this future strategic environment: “military power will continue to be required to protect…U.S. global interests”; the “battlespace will continue to be global, if not universal”; “the speed and scale of the proliferation of…technology and CBRNE weapons will continue to increase”;[7] “adversaries will have greater access…to sophisticated capabilities”; and “adversaries will continue to adapt as U.S. capabilities evolve.” [8] Tapping into the global reach capabilities that space power offers will allow the US and its Allies to handle the complex contingencies that will continue to litter the international landscape.

In light of the changing world situation, the USMC has predicted that in 25 to 30 years they will need to send a “squad-sized unit of Marines any place on the Earth in less than two hours time.”[9] As stated in their 2002 Universal Needs Statement (UNS) for the Small Unit Space Transport and INsertion (SUSTAIN) capability, “the Marine Corps needs a capability to transport small, mission-tailored units through space from any point on the globe to a contingency at any other point on the globe within minutes.”[10] The Marines like to refer to the concept as getting 13 thinking “*brains*” on the ground at the earliest stage of a crisis rather than 13 sets of “boots.” Based on the UNS, the SUSTAIN capability should have the following characteristics: negligible sensor cross-section, kinetic air defense survivability, flexibility to enter and sustain low earth orbit, transport of up to 13 combat-equipped personnel (not including the transport crew), flexible launch on demand, combined arms weapons suite for self-defense and fire support, multiple personnel insertion options (high altitude, low altitude, ground), unrefueled transport operation for entire mission cycle, vertical and/or short takeoff and landing (V/STOL), avoidance of foreign airspace overflight restrictions, and post-mission extraction ability. Appendix A contains the full text of the UNS as well as the unpublished draft Initial Capabilities Document (ICD).

Marine Colonel J. R. Wassink, head of the Information Operations and Space Integration Branch at the USMC Pentagon headquarters offered anecdotal evidence as to the need for faster response times. Regarding the 04 November 1979 capture of 66 American civilians at the US diplomatic mission in Tehran, Col Wassink pondered, “What could have been done if we could have rapidly reinforced the embassy in Iran? Could we have avoided the [14-month] hostage crisis?” He went on to say that time, distance, and access issues have caused the Marines to reconsider their options for future expeditionary warfare: “We looked at space because you don’t have to worry about overflight. [Also], a prepositioned MEU with a V-22 or C-17 still takes many times longer than two hours to get there.”[11]

Similar to the USMC need, Special Operations Forces (SOF) require “responsive unmanned lift for systems and high loiter vehicles that support persistent and pervasive operational awareness…launched on short notice into space.”[12] Although the stated SOF requirement only asks for responsive, flexible, *unmanned* access to space, many of the requisite technologies are the same. Certainly with SOF’s rare ability to exploit new technology, USSOCOM would also jump at the opportunity to transport a SOF team anywhere in less than two hours.

From an Air Force perspective, the preponderance of effort related to flexible, rapid space access comes from the Operationally Responsive Space (ORS) program. According to the Mission Needs Statement (MNS), one of the four ORS required key capabilities is “recoverable, rapid-response transport to, through, and from space,” and any ORS systems must be responsive, maneuverable, operable, economical, survivable, interoperable, and flexible.[13] The SUSTAIN concept falls well within this mission space. Additionally, Maj Bob Lancaster, an Air Force Security Forces officer who worked the Security Forces Transformation project, immediately recognized Air Force applications that stem from the USMC concept. He postulated that "if [the USMC and SOF] mission is base seizure, and they get there in under two hours, the follow-on forces (Security Forces, etc.) will need to get there quickly as well."[14] Career logistician Maj Andy Hunt of HQ USAF/A9 also acknowledged utility in the concept for Air Force rapid resupply missions stating that "from a logistics standpoint it would be fantastic."[15]

The obvious implication of responsive space launch is the fast, flexible, precise global delivery of "stuff" (i.e., people, equipment, weapons, or other assets). An important side benefit of this precise global delivery is the global range that it affords, thus avoiding much of the costs, force protection, sustainment, and foreign access requirements of forward bases.[16] Furthermore, one can easily envision other benefits of this type of capability: point-to-point high-value cargo delivery, long range strike and precision global strike (PGS), or, if extended to orbital applications, responsive satellite replenishment, satellite repair, or astronaut recovery. Col Wassink would like to see in the DoD an "increased recognition of emerging types of missions (i.e., take PGS a step further to be not just Global Strike but 'Global Intervention'—expand the mission set to more than just kinetic but to global influence."[17] The author dubbed this concept "rapid precision global intervention," or the ability to take the full range of capabilities quickly and accurately anywhere in the world to achieve the desired effects. The reader will see this concept throughout this paper.

**Who's Responsible?**

> *The US Air Force provides the Nation a unique capability to project national influence anywhere in the world on very short notice. Air and space forces, through their inherent speed, range, and flexibility, can respond to national requirements by delivering precise military power to create effects where and when needed.*[18]

—Air Force Doctrine Document (AFDD) 1

Strategic thinkers in the Department of Defense and elsewhere recognize the advantages of revolutionizing the space launch business; however, the current launch paradigm needs a major shift to achieve the desired responsiveness. "Rapid" and "responsive" are often the adjectives of choice for spacelift discussions when uttered from the mouths of space visionaries, warriors dreaming of a better way to get to the fight, or future planners trying to create a new reality. In today's world, however, "rapid, responsive space launch" only exists if one dramatically redefines "rapid" and "responsive." Fortunately, the future holds the promise of transforming today's slow, unresponsive spacelift into a realistic capability for moving people and cargo anywhere in the world in a very short time. The distinctive capabilities of the Air Force make it uniquely suited to help make good on this promise and suggest that the AF should take the DoD lead on advancing our rapid force projection options using space as a medium.

While rapid response is not the sole purview of the Air Force, the Air Force does bear the major burden to lead these global types of activities. Per Air Force Basic Doctrine (AFDD 1) the USAF's distinctive capabilities "stem from two sources: functions that are best accomplished only by air and space forces and functions that achieve the most benefit to the Nation when performed by air and space forces."[19] Three of the USAF distinctive capabilities—rapid global mobility, precision engagement, and global attack—highlight what air, space, and cyberspace power bring to this fight. Capitalizing on these distinctive capabilities in "command of the commons,"[20] the Air Force could realize the concept of near instantaneous intervention anywhere. The following excerpts from AFDD 1 define the three aforementioned distinctive capabilities, providing context for discussing the Air Force's role in delivering rapid space launch options for combatant commanders.

> Rapid Global Mobility refers to the timely movement, positioning, and sustainment of military forces and capabilities through air and space, across the range of military operations…It is the particular competence of air and space forces to most rapidly provide what is needed, where it is needed…in minimum time to directly achieve strategic objectives.[21]
>
> Global Attack: The ability of the Air Force to attack rapidly and persistently with a wide range of munitions anywhere on the globe at any time is unique…the responsiveness of air and space forces can be instantaneous…Our Service is able to rapidly project power over global distances and maintain a virtually indefinite "presence" over an adversary…The ability to continuously observe an adversary's actions from space and then, when provoked, to swiftly respond with a wide variety of capabilities provides the true essence of deterrence."[22]
>
> Precision Engagement: Increasingly, air and space power is providing the "scalpel" of joint Service operations…The Air Force is…the Service with the greatest capacity to apply the technology and techniques of precision engagement anywhere on the face of the Earth in a matter of hours. In addition to the traditional application of force, precision engagement includes nonlethal as well as lethal force...Precision engagement represents a global capability not only to win wars, but also the ability to drive crises to peace.[23]

In addition to the distinctive capabilities of the Air Force, in June 2003 the Secretary of Defense appointed the Secretary of the Air Force as the DoD Executive Agent for Space with the mission to "develop, coordinate, and integrate plans and programs for space systems and the acquisition of DoD…operational space force capabilities to ensure the United States has the space power to achieve its national security objectives." In this context, space power is defined as "the total strength of a *nation's* capabilities to conduct and influence activities to, in, through, and from the space medium to achieve its objectives."[24] One should note that the mission covers the "nation's" space capabilities and not solely those of the DoD or the Air Force. Specific duties of the DoD Executive Agent for Space include integrating the DOD Component needs into the

National Security Space Plan (NSSP), developing courses of action that improve space programs, and encouraging commercial competition and prototypes that increase capabilities at lower costs and with shorter acquisition cycles.[25]

With the SECAF's dual roles in space, first as head of the Air Force component with its distinctive capabilities that are global and expeditionary in nature and second as DoD Executive Agent for Space, the Air Force should have a dog in the fight when it comes to exploring and satisfying service and joint space needs. While the Air Force has stepped up in its new role as DoD space champion, the service is conspicuously absent in the discussion of manned space operations, and it only scratches the surface of the responsive spacelift requirements. To the USAF's credit, resources are tight, the nation is at war, and the NSSP does indeed list as a desired future state to achieve flexible, responsive space launch;[26] the Air Force just does not yet have a good plan for the DoD to get there.

# CHAPTER 3: TECHNOLOGY EXPLORATION ("CAN WE?")

*Without risk and without failure, we cannot initiate and realize the very breakthroughs we so desperately need to open the space frontier.*[27]
—Peter H. Diamandis, MD
Chairman/CEO, X PRIZE Foundation
Chairman/CEO, Zero Gravity Corporation
Founder, International Space University

## Assumptions

The statement of two assumptions will help narrow the scope of the evaluation of responsive space launch technologies. Although these assumptions seem to be in the territory of science fiction, they are not beyond the realm of possibility, but not by 2025.

1. We will not see other technological breakthroughs (i.e., advanced robotic warriors, super soldiers, or "proxy bots"[28]) by 2025 that will eliminate the need to send thinking humans in harm's way as first responders to achieve the desired effect.
2. Teleportation, or movement from one place to another without traveling through space (the three-dimensional type not the outer type), will not be a reality anytime in the next 20 years.

## Technologies Required

Like most advanced capabilities, space transportation requires a host of technologies, people, and processes to work together as a system of systems. Good people and processes are extremely important; without them, any new capability is sure to fail. While this section addresses people and process issues, it does not attempt to explore people and processes in depth. This section will instead focus primarily on technologies, principally those involved in the launch vehicle itself. Furthermore, with respect to the specific technologies presented here, it is the synergistic relationship between the various technologies, not necessarily the individual technologies themselves, that will provide the breakthroughs necessary to open space up to a greater expanse of operations.

Many different materiel design concepts could provide the capabilities necessary to deliver the desired SUSTAIN capabilities. Trade studies must occur to optimize the system designs. The most likely answer to the problem will be a family of operationally responsive spacelift vehicles, some suborbital, some orbit-capable, with a range of lift capacities. The most efficient family will not only meet the needs of SUSTAIN but will also satisfy the range of ORS requirements and ideally the requirements of civil and commercial space at the same time. While these decisions require much more analysis by a larger team of experts, the following technologies are common to virtually any of the design options: propulsion, thermal protection, structures, materials, avionics, power systems, and operability.

**Sources of Technology and Related Concepts**

Several concepts within military, commercial, and civil space have addressed or are addressing certain aspects of the problem of making responsive space transportation a reality. The following paragraphs describe some of the key projects and their respective potential contributions to this mission and to the technology areas mentioned in the previous section, especially in the areas of propulsion and operability. These explanations will be intentionally brief. Readers should check the provided references for additional information on each project.

**High Ops Tempo – Energetic Access to Globe & Launch Experiment (HOT EAGLE)**

HOT EAGLE was Air Force Research Laboratory's (AFRL) paper study completed in 2006 for the Defense Advanced Research Projects Agency (DARPA) to examine the feasibility of SUSTAIN. Although DARPA did not decide to fund HOT EAGLE after this seedling effort, much of the work continued in AFRL's FAST project (see below). FAST has a broader scope; it is not focused on SUSTAIN but on the bigger picture of responsive space access. Nonetheless, the approach and technologies are similar.[29]

**Fully-Reusable Access to Space Technology (FAST)**

FAST is a joint project of AFRL and Air Force Space Command with the intent of demonstrating technologies to enable existing and new Air Force operational space missions such as spacelift; Intelligence, Surveillance, and Reconnaissance (ISR); space control; and global mobility. Key goals of this program include reducing space launch costs and increasing reliability by an order of magnitude, "aircraft-like operability" (15-minute call-up time, four-hour turnaround, four or more times higher flight rates than existing launch systems, operations and maintenance crew size of six or less), and scalability to support a full range of payload requirements. Although FAST is primarily concerned with launch to orbit, its technologies are intrinsic to point-to-point global transportation as well. Planned experiments include the following: airframe and structural health management experiment, propulsion experiment, subsystem experiment, leading edge demo, and flight operations experiment. The FAST program approach is to demonstrate these fully-reusable access-to-space technologies in a series of small and affordable ground and flight experiments leading up to an integrated experimental X-Vehicle in 2010 to 2015 and prototype Y-Vehicle in 2015 to 2020. As of Fall 2006, the AFRL program office had the resources and personnel in place to execute the ground demos.[30]

**Affordable, REsponsive Spacelift (ARES)**

ARES is an Air Force Space Command and AFRL program intended to "create a transformational spacelift capability, embodying affordability, responsiveness, simplicity of operations, and reliability for a wide range of payload classes."[31] ARES is actually a family of vehicles to provide affordable, responsive spacelift for all of the DoD's satellites. The concept is a hybrid launch vehicle with expendable upper stages and a fly-back booster, 24- to 48-hour turnaround time, and costs expected to be lower than current expendable or conceptual fully-reusables. Flight demonstrations are scheduled to begin in 2010. The ARES budget is approximately $4M per year.

**Falcon Family of Launch Vehicles**

The Falcon family is "designed to provide breakthrough advances in reliability, cost, flight environment and time to launch" for transporting satellites to low earth orbit.[32] Reliability is the principal driver. Falcon 1 is a two stage, rocket-powered launch vehicle. It is designed for cost efficient and reliable transport of small (1500 lb) satellites to low Earth orbit. Two test launches have occurred in 2006 and 2007; both had failures prior to reaching orbit but gathered valuable test data. Falcon 9 is a heavy lift vehicle. The developer, SpaceX, won a contract from NASA to demonstrate three flights of Falcon 9 beginning in 2009.[33]

**X-41 Common Aero Vehicle (CAV)**

The Air Force CAV is a maneuvering reentry vehicle capable of carrying a variety of payloads (primarily munitions) down from orbit or suborbital reentry and either impacting a target or dispensing munitions at a desired location. CAVs are expected to have 2000-3000 nautical miles of cross-range for maneuvering. "CAV needs to be deployed at very high velocities to be effective, and Mach numbers less than 20 for suborbital deliveries produce relatively short ranges and cross-ranges." This limitation would have implications for a suborbital manned vehicle if CAV-like technologies were used. DARPA's FALCON (Force Application and Launch from CONUS) program (not to be confused with the Falcon family of launch vehicles) is scheduled to provide a reasonable penetrator capability from a traditional launch vehicle in the 2008 timeframe. FALCON has no funding for any on-orbit CAV effort.[34]

### X-43 Hyper-X

In 2004 NASA made aviation history with two flights of a scramjet-powered, hypersonic airplane (or greater than five times the speed of sound). This was the first hypersonic flight of a vehicle with air-breathing engines. Compared to rocket-powered vehicles, scramjets (supersonic combustion ramjets) promise more aircraft-like operability for increased affordability, flexibility, and safety for flights within the atmosphere and into orbit. Unlike rockets, because scramjets do not have to carry their own oxidizer, the vehicles can be smaller and lighter - or carry more payload than an equivalent sized rocket. Ultimate applications include hypersonic missiles, hypersonic airplanes, the first stage of multistage reusable launch vehicles, and single-stage-to-orbit reusable launch vehicles. The eight-year, $30M per year program was a high-risk, high-payoff research effort.[35]

### *SpaceShipOne*

SpaceShipOne by private company Scaled Composites won the Ansari X-Prize for the first non-government manned space flight above 100 km. The goal was to demonstrate that non-government space flights can be feasible and low cost in an effort to spawn the space tourism industry. New technologies included the launch aircraft, the three-person spaceship, hybrid rocket propulsion technologies, and a variety of new systems. SpaceShipOne is air-launched from the mother aircraft, separates and climbs to suborbital altitude, then reenters in a high drag configuration for stable flight. It finally lands horizontally on a runway. Other commercial ventures were competing with Scaled Composites prior to their winning the X-Prize. Some of these other companies still have their own vehicle systems attempting to achieve the same goals.[36]

As mentioned before, several other projects are also making steady progress in technologies related to responsive spacelift. NASA, DARPA, the Navy, the Air Force, and their contractors are the chief contributors along with some private companies. The main problem with all of these projects is not with the technology but with the fact that they are more or less separate projects that are only loosely linked. To really drive a revolution in space access in a resource-constrained environment, the nation needs to coordinate its efforts, capitalize on areas of expertise, and share costs.

# CHAPTER 4: ANALYSIS OF THE FUTURE ("SHOULD WE?")

*"The status quo is not an option for the things you care about."*[37]

## Challenges and Counterarguments

Many challenges exist that the US will need to overcome before a SUSTAIN type of capability could come to fruition. Some of these same challenges provide valid counterarguments against the need for launching troops through space. Since these challenges and counterarguments merit individual, extensive attention outside the scope of this paper, this section merely poses some important questions, in recognition that responsive space access is not an easy, risk-free proposition.

What specific situations exist or could exist where transport by air, sea, or ground is not good enough and space transport would be required? Are there other non-materiel solutions that would obviate the need for transporting troops through space? What is the cost/benefit tradeoff? Will the military and commercial wartime and peacetime "market" adequately support this capability? These questions all deal with validating the need for space transportation of troops. Evolutionary improvements in air, land, and sea mobility coupled with improvements in forward basing structure could satisfy some of the USMC needs without traveling though space and developing revolutionary systems. Unfortunately, there are still limitations with each of these such as political overflight restrictions, that prevent them from meeting all of the USMC future expeditionary requirements. The draft ICD in Appendix A does a good preliminary assessment of the alternatives and how they might contribute to an interim solution.

Is there enough room for people, weapons, gear, and extra people/cargo for the return flight? Will the passengers be mission-ready upon landing? Can they rapidly egress in a tactically sound manner? How much training will be required? How often will flights be practiced? These questions address the concept of operations. Although each question has its own unique problems, all of them can be resolved within the design trade space. Of these CONOPS issues, the mission readiness challenge may require the most research. Insufficient data exist to allow proper analysis of the impact on the human organism during these types of suborbital or possibly orbital profiles. Never has a human had to endure the physical rigors of combat immediately following spaceflight, so more work still needs to occur.

What would such a capability force the enemy to do? Can they see you coming? How vulnerable would the system be to shoot-down, worst case with simply small arms fire? Does your landing let them know you are there? How do we ensure other states do not mistake troop launch as a hostile missile launch? Finally, these questions relate to enemy responses and system survivability. These are perhaps the most challenging of the questions posed since the enemy intentions are never certain and the enemy always gets a vote. Designing the vehicles with self-defense and fire support in mind can overcome the survivability issues; however, these capabilities will add weight, which is never the friend of space access. As for the mistaken identity problem, there is historical precedence for geographically separating nuclear and non-nuclear launch sites and flying different launch profiles to prevent just such a catastrophic misunderstanding.

Countless other questions arise—How do you get the people home? Would this capability replace or just augment airborne platforms? What type of ground infrastructure will you need? Is the current ground system viable? Is this system antonymous? If so, what's the fail safe? What are the risks? All of these questions require careful consideration before expending too much of the DoD’s resources.

**Future Forecasts and Technology Implications**

To make informed recommendations influencing strategic decisions about future technology needs, one must understand the world context in which those technologies will function. Though it is virtually impossible to *predict* the future accurately, it is possible and useful to *forecast* a range of plausible futures that are relevant to the technologies in question. As part of the Air Force Blue Horizons effort,[38] Majors Joel “Spicoli” Luker and James “Buster” Myers used the “scenario thinking” forecasting methodology to develop eight possible future stories of the enemy threat space in the year 2025, including “what the enemies may look like, how they may act/react, and what capabilities they may possess.”[39] Though not meant to be an all-inclusive list of potential futures, these eight scenarios provide a good framework for discussing what friendly capabilities we need based on possible enemy capabilities.

Scenarios are powerful stories about how the future might play out in relation to a certain issue or group. Scenario thinking is both the “process through which scenarios are developed and then used to inform strategy” and the “posture toward the world—a way of thinking about and managing change.”[40] A key step in the process involves exploring the driving forces that could mold the future. Majors Luker and Myers chose four drivers relevant to the nature of the 2025 threat: What type of actor (state or nonstate)?, What type of warfare (regular or irregular)?, Where will the actor fight (foreign soil or our soil)?, and With what will he fight (materiel or information)? By separating state from nonstate actors and by using the assumptions that in 2025 state actors will operate entirely on foreign soil and that no nonstate actors will fight using regular warfare, two scenario matrices resulted (figures 1 and 2).[41]

Following a description of the eight chosen scenarios, this section will analyze the utility of responsive space launch technologies in each of those eight futures. Famous war strategist Sun

Tzu made the oft-quoted statement in *The Art of War*: "Know the enemy and know yourself; in a hundred battles you will never be in peril."[42] These scenarios provide some insight into identifying and knowing the future enemy and will hopefully help us to "never be in peril."

**State Actor Threat Scenarios for 2025**

This section contains a brief summary of the four state actor threat scenarios and enemy capabilities posed by Maj Joel Luker. For a more in-depth look at each scenario, refer to Maj Luker's paper.[43]

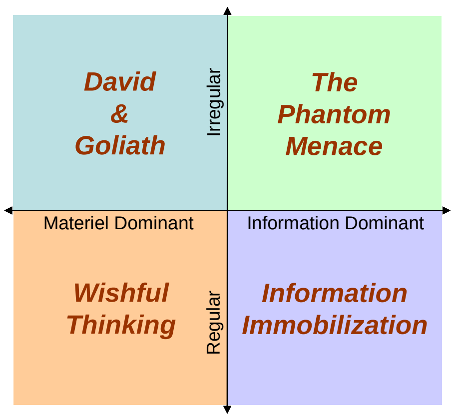


Fig. 1. State Actor Scenarios (Reprinted from Maj Joel J. Luker, "State Actor Threats in 2025" [master's research paper, Air Command and Staff College, 2007], A-11.)

The *Wishful Thinking* scenario looks much like traditional, conventional warfare, describing a materials-based enemy military fighting the US military in a large-scale, force-on-force conflict. In this future, state actors continue to take a long time acquiring major weapon systems; thus, anything we would expect to see in operation in 2025 would be in development now or in the near future, with the exception of rapid transfers of disruptive technologies into revolutionary weapon systems.

The *Information Immobilization* adversary will also attempt to fight the US military with regular warfare but instead using primarily information-based systems to counter US capabilities. Enemies in this alternative future will be able to immobilize our cyber-centric, warfighting machine using superior information operations. Their regular capabilities still exist but come primarily from purchases from other states.

In the case of *The Phantom Menace*, information-based, state actors will attack the US in an irregular manner. They must remain covert to avoid retaliation from the US with overwhelming force. Cyber attacks on our nation's critical infrastructures will be prevalent due to their potentially catastrophic effects and the difficulty in attributing them to a specific actor. These state actors will also conduct influence operations through public and private media sources to discredit the US and reduce our power in the world.

Finally, in *David and Goliath* a materials-based state fights the US using irregular tactics. This adversary is likely a small, regional power with weapons of mass destruction (WMD) and access to modern technology and weapons. They will use irregular, guerilla-style warfare generally in urban environments to level the playing field against a major military power like the US. Also, this type of enemy state is unable to project its military forces into US territory unless it uses special operations or terrorist-style tactics.

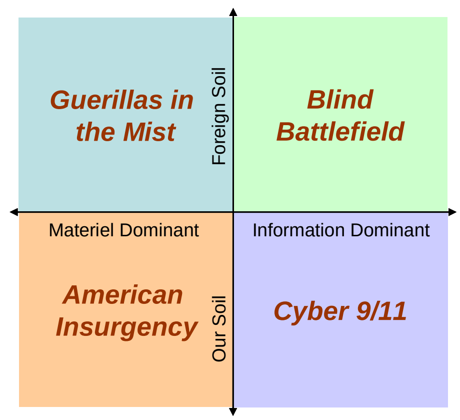

Fig. 2. Non-State Actor Scenarios (Reprinted from Maj James W. Myers, "Nonstate Actor Threats in 2025" [master's research paper, Air Command and Staff College, 2007], A-11.)

**Nonstate Actor Threat Scenarios for 2025**

This section contains a brief summary of the four nonstate actor threat scenarios and enemy capabilities posed by Maj James Myers. For a more in-depth look at each scenario, refer to Maj Myers' paper.[44]

In the *American Insurgency* future, nonstate adversaries fight on U.S. soil with material weapons including WMD, targeting infrastructures, institutions, and populations. The enemy's goal is to assault the American way of life and to effect the overthrow of the US government. We face a well-equipped, agile group comprised largely of American citizens that are interspersed throughout the US population, so their activity is difficult to detect or distinguish from that of criminals.

Similarly, in the *Cyber 9/11* scenario, the enemy targets infrastructures, institutions, and populations on our soil. These information-based attacks have large-scale crippling effects for relatively short periods to long periods of time, depending on the nation's readiness level. *Cyber 9/11* is an "information warfare allegory to the terrorist attacks of 11 September 2001, with a set of high-effect, coordinated attacks."[45] In addition to network warfare capabilities, these cyberterrorists will likely have access to electronic attack methods such as high power microwave (HPM)[46] and electromagnetic pulse (EMP) weapons.[47] Although the attacks will be on American soil, the enemy may reside anywhere in the world due to the global interconnectedness of the infosphere; thus, detection and attribution will be difficult.

In the *Blind Battlefield* scenario, the adversary fights US/Coalition forces on its own home—our foreign—soil, dispersed throughout the population, wearing the natural camouflage of a native. The enemy seeks a return to the pre-invasion status quo, and his modus operandi is all-out information combat to destroy coalition effectiveness by "replac[ing] the fog of war that US informational tools eliminated."[48]

Finally, in the *Guerillas in the Mist* future, a materials-based, nonstate actor on foreign soil works to turn the indigenous population against the US/coalition and drive them away for good. With his familiarity with his environment and ability to blend among the people, he can easily coordinate effects and capabilities, simultaneously making it nearly impossible to obtain useful intelligence against him. A dichotomy of sorts, the adversary minimizes collateral damage against his own civilization from his own attacks, while provoking the coalition to assault this same group that the enemy does not want to harm.

**Utility of Rapid Troop Space Transport in Eight Alternative Futures**

Rapid precision global intervention using space transport brings many benefits and capabilities to the warfront that do not currently exist: precision at a speed of response we have never seen before, extremely rapid replacement of capabilities (people/"brains"/boots, C4ISR, munitions, nonkinetic instruments) or resupply of goods, circumvention of overflight restrictions, and avoidance of forward basing, to name a few. How does this technology with its inherent benefits play out in the alternative futures posed in the previous sections?

First, it has virtually no utility in an *American Insurgency*. In this case, the enemy lives and fights on American soil. Much easier and cheaper means of getting to the enemy exist that are just as fast due to the relatively short distances to reach them within our borders and the abundance of resources readily available in close proximity.

In *Wishful Thinking* we might see some limited utility depending on what the enemy chooses to do. We can always stand to get people and things places quicker, but in this scenario, it may not be worth the cost and effort to develop the systems. We already excel at fighting this kind of conventional war and will probably continue to excel at it with incremental upgrades to existing systems. Similarly, in *The Phantom Menace*, we might see limited utility but for different reasons. In the *The Phantom Menace* it is extremely difficult to detect an attack or identify the attacker without other advances in information operations. Once an attack from this type of enemy occurs, it may be too late to respond because unlike the similar Cyber 9/11 scenario, "when The Phantom Menace attacks, [in order to protect against a swift, massive retaliation] it will do so in a massive, coordinated fashion to create synergy between the various assaults and minimize the US's ability to recover from one strike before the next one occurs."[49]

In the next three scenarios, we start seeing rapid space mobility really making a big difference. In *Cyber 9/11*, the US would benefit from the ability to provide rapid, persistent ISR, perhaps in the form of unmanned aircraft (UA) and a team of joint terminal attack controllers (JTAC) and Marines or SOF deployed from a space vehicle.[50] Quick response would be crucial since the intelligence in this case is limited, so we would want to follow any short-notice intelligence leads that we had. The availability of EMP weapons raises the stakes on this scenario as well. Next, if the *Information Immobilization* enemy successfully immobilizes our information, we need to rapidly mobilize it again to prevent the enemy from beating us with their less advanced material forces. Rapid replacement of UAVs, C4ISR equipment, and even satellites rendered inoperative from cyberattack are all possibilities. Thirdly, *Guerrillas in the Mist* are like the adversary in the *David and Goliath* scenario, but they are less dangerous, and probably will not use WMD due to the desire to minimize collateral damage on their own people; however, rapid space transport will pay dividends again by providing rapid ISR capabilities to follow short-notice intelligence leads.

In the final two alternative futures, the author argues that rapid precision global intervention is vital to the success of US operations. In a *Blind Battlefield*, rapid replacement of C4ISR is imperative to once again lift the fog of war and give the gift of sight (and other senses) to the military forces in the region that have been disabled. Finally, in *David and Goliath*, the US does not want the end result to be the same as the Biblical account, with the proverbial stone in our skulls and our heads cut off.[51] This enemy is dangerous with the power of a state and advanced technology and the will to use it, including WMD, but it fights with irregular warfare tactics in the city. Rapid global mobility through space will allow force projection of Marines, SOF, and munitions with supporting C4ISR to close with and destroy the enemy with lightning speed and precision.

The following specific scenario fits well with the *David and Goliath* case. In March 2006, Majors Sean Monogue and Pete Garretson from the Air Force Future Concepts Development Division, HQ USAF/A8XC, brainstormed a plausible scenario for delivering 13 people anywhere in the world in less than two hours. They titled the concept "Two Hours to Regime Change / Regime Change on Demand," and a brief paraphrase follows.

> Imagine that you have an indigenous group willing to execute a regime change beneficial to US interests, but they lack military power and need the benefits of airpower. JTACs are in short supply, you cannot expect to train your indigenous forces properly, and the JTACS are not needed until direct action commences. On command, in pops a team of JTACs to seed with the indigenous forces, and you simultaneously populate the environment with CAV-delivered,[52] dominator-type,[53] loitering, multi-target munitions, providing 1,000 individual munitions. Now your ground team has significant airpower—the equivalent of multiple manned strike sorties—but has more persistence; does not require theater basing, overflight permission, or a JSTARs-like capability;[54] and can be inserted both faster and with better survivability than via aircraft.[55]

One can certainly recognize the sizeable advantages to be gained by adding technologies and systems to our arsenal that greatly increase the speed, flexibility, and precision of our force projection. In seven of the eight scenarios, we can see utility in having rapid precision global intervention capabilities through space; in five of the eight we see great utility in it; and in two of the eight the capability is vital to US success, based on the author's assessment. This analysis demonstrates a need to at least fully explore the technological possibilities and make appropriate investments proportional to the operational and strategic advantages to be gained.

# CHAPTER 5: RECOMMENDATIONS

> *These airframe, propulsion, and guidance and control subsystems, together with extensions of advanced research presently underway…will make it possible to achieve other goals with the subsystem…a whole gambit of follow-on projects immediately becomes feasible.*[56]

- Major General Bernard Schriever, 1957

Commander, Western Development Division
Air Research and Development Command

The United States is a nation at war. In a resource-constrained environment, how does a nation at war fight the current fight yet still prepare for the next war and future wars? Understandably, when the budget and manpower are tight, research and development efforts take a back seat to current operations; however, if we expect to maintain our advantage in the world, the United States must determine a way to continue to invest in the future without sacrificing the present. The following recommendations address this problem as it relates to using space for rapid precision global intervention.

1. Air Force should put rapid troop space transport on the table
    a. At a minimum, the AF should engage in active dialogue with the USMC, USSOCOM, USTRANSCOM, and NASA to understand the rapid mobility needs and help find a way to satisfy them even if not with space power in the interim. USAF distinctive capabilities and DoD Executive Agent for Space responsibilities indicate it should lead the DoD in determining where the department needs to go with this.
    b. Air Force support USMC in officially entering SUSTAIN into the Joint Capabilities Integration and Development System (JCIDS) for joint acquisition consideration.
    c. Prepare for Initial Operational Capability (IOC) of rapid troop space transport capability by 2025. Costs expected to be on the order of $40M/year. Focus on

point-to-point, *suborbital* global transportation for manned system. Synergize with responsive orbital efforts.

d. Conduct trade studies to address the following questions: (1) Single system or family of systems?, (2) Launch from air or surface?, (3) What type of propulsion—rocket, hypersonic, hybrid, other?, (4) Does orbital insertion make sense or is point-to-point suborbital the way to go?

e. Investigate answers to the challenges and counterarguments posed in Chap. 4.

f. Conduct a Cost-Benefit Analysis (CBA) involving air, sea, and space transportation options. Variables for comparison include cost (lifecycle and per mission), distance, time, payload weight, and effects achieved.

2. Increase investment in AFRL's Fully-reusable Access-to-Space Technology (FAST) program. This program has the right management approach for how to proceed. Involve other stakeholders in evaluating and modifying the technical approach. Add troop mobility requirements.

3. Create a technology roadmap for responsive spacelift as a long-term plan for where the nation should be in 2025 to 2030 with clear milestones to get there. Assign responsibilities for execution of the plan.

4. Plan a series of incremental demonstrations and tests to prove specific advanced technologies and the overall concepts and CONOPS. Include a robust plan for experimental vehicles (X-vehicles) in the technology roadmap. With respect to the real need for X-vehicle demonstrations, Mr. Jess Sponable, AFRL's FAST Program Manager, aptly stated, "I fear we've forgotten that operations is itself a technology and a prerequisite to proving the potential for low-cost flight."[57]

5. Air Force continue investments in ARES, Falcon family, and CAV. Support Navy and NASA on hypersonic propulsion technology. Integrate them as part of one plan for the nation with a common end state. Reassess these programs after performing trade studies and developing the long-term plan.
6. Establish structured partnerships within military, civil, and commercial space specifically targeting rapid, responsive suborbital and orbital spacelift.
    a. Clearly outline responsibilities. No loose handshake agreements. Achieve buy-in from all stakeholders, including the President and Congress.
    b. Establish technology focus areas for each partner based on proven areas of expertise.
    c. Develop and execute a plan to share costs among all military, civil, and commercial space partners
7. Follow-on Research
    a. HQ USAF/A9 (Studies, Analyses, Assessments, Lessons Learned) conduct mobility study taking rapid space mobility options into consideration. By inserting these space transport capabilities into a simulated future war with future force structures, one could get a better understanding of the effects of projecting small teams forward in two hours or less.
    b. Explore "Rapid Precision Global Intervention" as an air, space, and cyberspace doctrinal construct. This concept encompasses aspects of Rapid Global Mobility, Global Attack, and Precision Engagement across the full spectrum of kinetic and nonkinetic response options to achieve global influence quickly and precisely.

Regardless of whether or not the USMC SUSTAIN need can or even should be completely satisfied, the Air Force should invest in technologies that enable more responsive, flexible transportation to and through space. We find ourselves now in a similar situation as General Schriever did exactly 50 years ago where successes in one project will open the floodgates for other projects that can benefit from similar technologies. If we are strategic in how we plan and organize our government and commercial space access technology development programs, we can maximize the potential for cross-flow of technologies and ideas and speed up the implementation cycle for all of the related capabilities.

## CHAPTER 6: SUMMARY AND CONCLUSIONS

*In this new century, those who effectively utilize space will enjoy added prosperity and security and will hold a substantial advantage over those who do not. Freedom of action in space is as important to the United States as air power and sea power. In order to increase knowledge, discovery, economic prosperity, and to enhance the national security, the United States must have robust, effective, and efficient space capabilities.*[58]

- President George W. Bush

US National Space Policy, 31 Aug 2006

The Marines and other services have demonstrated a need for flexible and rapid global mobility, manned and unmanned. The Air Force is the right service to lead the exploration and development of these capabilities. Technologies are maturing rapidly with the potential to deliver a SUSTAIN or other ORS capability sooner than 2025, but they have not been adequately demonstrated in a single system. With the proper investments, disciplined planning, and the right partnerships, the nation will see the opening of the space superhighway.

In the future, space will afford the Marines and other services an opportunity to respond quickly and effectively to crisis situations anywhere in the world. Although it will not likely completely replace more traditional mobility methods, space can offer a speed and responsiveness not currently available by land, sea, or air. As Brigadier General Richard C. Zilmer, commander of the Marine Air Ground Task Force Training Command, proclaimed, “Is it futuristic? Yes. Is it visionary? Yes. Is it a concept? Yes. But it’s going to get here eventually, and we want to be in on the ground floor”[59]

## NOTES

[1] The Marine Corps launched a recruiting campaign in the early 2000's that showed a single Marine taking on all kinds of grueling tasks, including fighting dragons. Since this is not a timeless reference, I include this note for posterity.

[2] Lt Gen E. R. Bedard. Deputy Commandant for Plans, Policies, and Operations. To Commanding General, Marine Corps Combat Development Command, (Memorandum, 22 July 2002), 1.

[3] Lt Col John Ackerman et al., "BLUE HORIZONS: Emerging Technologies for the USAF Syllabus," (Maxwell AFB, AL: Air Command and Staff College, 06 October 2006), 1. Both quotes in this paragraph are from the same source.

[4] United States Marine Corps (USMC), *Universal Need Statement (UNS) -- Small Unit Space Transport and Insertion (SUSTAIN) Capability* (Washington D.C.: HQ USMC Plans, Policies, and Operations Department, July 2002), 1.

[5] Samuel P. Huntington, "The Clash of Civilizations," *Foreign Affairs* 72, no. 3 (1993): 22.

[6] Ibid.

[7] CBRNE stands for Chemical, Biological, Radiological, Nuclear, and high-yield Explosive weapons. The acronym CBRNE indicates the five recognized types of weapons of mass destruction (WMD).

[8] HQ USSOCOM Space IPT, "Special Operations Forces Space Enabling Concept," (18 March 2004), 4, 6.

[9] Brig. Gen. Richard C. Zilmer, "The Trainer: Zilmer Quickly Adopts Lessons and Tactics from Iraq and Afghanistan to Prepare Marines for Combat." By Sue A. Lackey. Sea Power 48, no. 7 (July 2005), http://www.navyleague.org/sea_power/jul_05_32.php.

[10] United States Marine Corps (USMC), *UNS SUSTAIN*, 1.

[11] Colonel John. R. Wassink (HQ USMC Plans, Polices, & Operations; Information Operations and Space Integration Branch Head, Pentagon), interview by the author, 13 March 2007. Also, the acronym MEU stands for Marine Expeditionary Unit.

[12] HQ USSOCOM Space IPT, "Special Operations Forces Space Enabling Concept," 9.

[13] HQ AFSPC/DRS, "Mission Need Statement AFSPC 001-01 for Operationally Responsive Spacelift, ACAT Level I," (20 December 2001), 2.

[14] Maj Bob Lancaster (USAF Force Protection Battlelab), interview by the author, 05 April 2007. Maj Lancaster's statements are his own personal opinions and not official Battlelab or Security Forces positions.

[15] Maj Andy Hunt (HQ USAF/A9FC, Logistics Analysis), interview by the author, 07 March 2007.

[16] This paper does not attempt to explore the range of issues associated with the arguments of global range versus forward basing. This issue could easily be one or more papers in itself. Suffice it to say that global range and forward basing each have their benefits and drawbacks. More in-depth study needs to occur to find the right balance between the two.

[17] Colonel John. R. Wassink (HQ USMC Plans, Polices, & Operations; Information Operations and Space Integration Branch Head, Pentagon), interview by the author, 13 March 2007.

[18] Air Force Doctrine Document (AFDD) 1, *Air Force Basic Doctrine* (17 November 2003).

[19] Ibid., 76.

[20] Barry R. Posen, "Command of the Commons: The Military Foundation of U.S. Hegemony," *International Security* 28, no. 1 (Summer 2003): 7.

[21] Air Force Doctrine Document (AFDD) 1, *AFDD 1*, 80-81.

[22] Ibid., 79-80.

[23] Ibid., 80.

[24] Department of Defense Directive (DoDD) 5101.2, *DoD Executive Agent for Space* (03 June 2003), 2. In the selected quote, I italicized "nature's" for emphasis.

[25] Ibid., 4-5.

[26] Department of Defense Executive Agent for Space, "National Security Space Plan: Fiscal Year 2008 and Beyond," (U). May 2006. (Secret/NOFORN) Information extracted is unclassified).

[27] Patrick J. G. Stiennon and David M. Hoerr, *The Rocket Company* (Reston, Va.: AIAA/American Institute of Aeronautics and Astronautics, 2005), ix.

[28] Richard Silberglitt et al., "The Global Technology Revolution 2020, in-Depth Analyses: Bio/Nano/Materials/Information Trends, Drivers, Barriers, and Social Implications," in *Technical Report Series* (Santa Monica, CA: RAND Corporation, 2006), xix.

[29] Wikipedia: The Free Encyclopedia, "SUSTAIN (Military)," http://en.wikipedia.org/wiki/SUSTAIN_(military).

[30] Kevin Davis, "USAF to Test Concept RLV Airframe," *Free Republic* 11 April 2007.

[31] GlobalSecurity.org, "ARES - Affordable Responsive Spacelift," http://www.globalsecurity.org/space/systems/ares.htm.

[32] SpaceX, "Falcon 1 Overview," http://www.spacex.com/falcon1.php.

[33] Encyclopedia Astronautica, "Falcon," http://www.astronautix.com/lvs/falcon9.htm.

[34] Terry Phillips and Bob O'Leary, "Common Aero Vehicle (CAV) on Orbit," Schafer Corporation, http://www.dtic.mil/dticasd/sbir/sbir041/srch/af031d.doc.

[35] NASA Dryden Flight Research Center, "NASA "Hyper-X" Program Demonstrates Scramjet Techologies: X-43A Flight Makes Aviation History," http://www.nasa.gov/centers/dryden/news/FactSheets/FS-040-DFRC.html.

[36] Scaled Composites website, "Tier One: Private Manned Space Program," http://www.scaled.com/projects/tierone/message.htm.

[37] Diana Scearce, Katherine Fulton, and the Global Business Network community, *What If? The Art of Scenario Thinking for Nonprofits* (Global Business Network, July 2004), 1.

[38] It has been more than ten years since the USAF has engaged in a long-range assessment to help guide its strategic planning, investment and capability decisions. This year's ACSC Blue Horizons research seminars are an integral part of a CSAF-mandated effort, not only to accomplish a new long-range technological and strategic assessment, but also to make "taking the long view" a standard part of USAF strategic planning. Air University and AF/A8 have formalized an ongoing examination of the impact of accelerating technological change on the Air Force and provide to the Air Staff in-depth research on technologies vital for the future of the Air Force. The results of this research will feed directly into staff reports, futures games and importantly – help guide Air Force positions in the QDR process. This course will examine the impact of accelerating technological change on the world and the implications of this for the USAF between now and 2025. It will focus on areas of accelerating technological change and the potential for symbiotic interaction among technology areas. Ackerman et al., "Blue Horizons Course Syllabus."

[39] Maj Joel J. Luker, "State Actor Threats in 2025" (Research Paper, Air Command and Staff College, Air University, April 2007), 2, A-11. Maj James W. Myers, "Nonstate Actor Threats in 2025: Blue Horizons Scenarios" (Research Paper, Air Command and Staff College, Air University, April 2007), A-11. These two references describe in detail the process Majors Luker and Myers used to develop their eight future scenarios.

[40] Scearce, Fulton, and community, *What If? The Art of Scenario Thinking for Nonprofits*, 8. This source does a great job of explaining the purpose of scenario thinking and the basic process.

[41] Maj Joel J. Luker and Maj James W. Myers, *2025 Threat Scenarios* (Briefing Slides: 10 January 2007).

[42] Sun Tzu and Samuel B. Griffith, *The Art of War; Translated with an Introduction by Samuel B. Griffith and with a Foreword by B. H. Liddell Hart* (Norwalk, CT: The Easton Press, 1991), 84.

[43] Luker, "State Actor Threats".

[44] Myers, "Nonstate Actor Threats".

[45] Ibid., 11.

[46] "The general public is familiar with the [HPM] technology as it applies to household microwave ovens that use this form of energy to penetrate and cook food. Whereas a typical microwave oven generates less than 1,500 watts of power, [HPM devices] can generate millions of watts of power. When microwaves encounter modern microelectronics-based systems, the results can be disastrous to the electronics – causing systems to "burn out" and fail or function improperly. This heavy reliance on electronic components in today's weaponry makes highpower microwave weapons attractive. A short burst of highpower microwave energy can be lethal to electronics while having no affect on humans operating the equipment." For more information see the following: United States Air Force Research Laboratory, "Fact Sheet: High-Power Microwaves," http://www.kirtland.af.mil/shared/media/document/AFD-070404-036.pdf.

[47] "The high-altitude nuclear weapon-generated electromagnetic pulse (EMP) is one of a small number of threats that has the potential to hold our society seriously at risk and might result in defeat of our military forces. The damage level could be sufficient to be catastrophic to the Nation, and our current vulnerability invites attack. Briefly, a single nuclear weapon exploded at high altitude above the United States will interact with the Earth's atmosphere, ionosphere, and magnetic field to produce an electromagnetic pulse (EMP) radiating down to the Earth and additionally create electrical currents in the Earth. EMP effects are both direct and indirect. The former are due to electromagnetic "shocking" of electronics and stressing of electrical systems, and the latter arise from the damage that "shocked"—upset, damaged, and destroyed—electronics controls then inflict on the systems in which they are embedded. The indirect effects can be even more severe than the direct effects. The electromagnetic fields produced by weapons designed and deployed with the intent to produce EMP have a high likelihood of damaging electrical power systems, electronics, and information systems upon which American society depends. Their effects on dependent systems and infrastructures could be sufficient to qualify as catastrophic to the Nation. Depending on the specific characteristics of the attacks, unprecedented cascading failures of our major infrastructures could result. In that event, a regional or national recovery would be long and difficult and would seriously degrade the safety and overall viability of our Nation. The primary avenues for catastrophic damage to the Nation are through our electric power infrastructure and thence into our telecommunications, energy, and other infrastructures. These, in turn, can seriously impact other important aspects of our Nation's life, including the financial system; means of getting food, water, and medical care to the citizenry; trade; and production of goods and services. The recovery of any one of the key national infrastructures is dependent on the recovery of others. The longer the outage, the more problematic and uncertain the recovery will be. It is possible for the functional outages to become mutually reinforcing until at some point the degradation of infrastructure could have irreversible effects on the country's ability to support its population." For more information see the following: Jr. Dr. John S. Foster et al., "Report of the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack, Volume 1: Executive Report," (Washington D.C.: US Congress, 2004).

[48] Myers, "Nonstate Actor Threats", vi.

[49] Luker, "State Actor Threats", 26-27.

[50] A joint terminal attack controller (JTAC) is a qualified (certified) Service member who, from a forward position, directs the action of combat aircraft engaged in close air support and other offensive air operations. Air Force Doctrine Document (AFDD) 2-1.7, *Airspace Control in the Combat Zone* (13 July 2005), 36, 80.

[51] 1 Samuel 17:49-51 (New American Standard Bible).

[52] Phillips and O'Leary, "Common Aero Vehicle (CAV) on Orbit."

[53] Mr. Benjamin T. Plenge, "Area Dominance with Air-Delivered Loitering Munitions Aids the Warfighter.," Air Force Research Laboratory Munitions Directorate, http://www.afrlhorizons.com/Briefs/Apr04/MN0308.html.

[54] Air Combat Command, "Fact Sheet: E-8C Joint STARS " Public Affairs Office, http://www.af.mil/factsheets/factsheet.asp?fsID=100. JSTARS stands for Joint Surveillance and Target Attack Radar System.

[55] Maj Peter Garretson,  e-mail message to author, 13 December 2006.

[56] Major General Bernard A. Schriever, "ICBM: A Step toward Space Conquest" (paper presented at the Astronautics Symposium, San Diego, CA, 19 February 1957), 3.

[57] Jess Sponable, "The Next Century of Flight," *Aviation Week & Space Technology*  (24 May 1999): 94.

[58] George W. Bush, "U.S. National Space Policy,"  (Washington D.C.: 31 August 2006), 1.

[59] Brig. Gen. Richard C. Zilmer, "The Trainer: Zilmer Quickly Adopts Lessons and Tactics from Iraq and Afghanistan to Prepare Marines for Combat." By Sue A. Lackey.," *Sea Power* 48, no. 7 (July 2005), http://www.navyleague.org/sea_power/jul_05_32.php.

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# APPENDIX A: UNIVERSAL NEEDS STATEMENT (UNS) AND DRAFT INITIAL CAPABILITIES DOCUMENT (ICD) – SMALL UNIT SPACE TRANSPORT AND INSERTION (SUSTAIN) CAPABILITY

DEPARTMENT OF THE NAVY
HEADQUARTERS UNITED STATES MARINE CORPS
2 NAVY ANNEX
WASHINGTON, DC 20380-1775

IN REPLY REFER TO:
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22 JUL 2002

From: Deputy Commandant for Plans, Policies, and Operations
To: Commanding General, Marine Corps Combat Development Command

Subj: UNIVERSAL NEED STATEMENT (UNS) – SMALL UNIT SPACE TRANSPORT AND INSERTION CAPABILITY

Encl: (1) Hard copy of "UNS Part 1a of 5 – Operators Request"
(2) Electronic copy of complete subject UNS

1. The enclosures are provided to begin analysis and fulfillment of the need for a small unit space transport and insertion capability for Marine Corps forces in the future. The UNS submission timing coincides with an awareness of emerging advanced defense and commercial technologies and programs. The earlier identification of desired capabilities will allow the USMC to steer those technologies to favorable material solutions. Space is the only practical environment through which small numbers of combat Marines can be transported at sufficient speed to ensure the relevance of global terrestrial force projection at the earliest stages of conflict.

2. Our points of contact are LtCol R. G. Lafontant (DDMS, NRO), and Mr. F. J. Gayl (PP&O). They can be reached at commercial (703) 614-3277 (ext. 1006) and (703) 692-4321 respectively.

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E. R. BEDARD

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## UNIVERSAL NEED STATEMENT (UNS)
## Part 1a of 5 - Originator's Request

**PURPOSE**

The completed Universal Need Statement is the most important information component in the Concept Based Requirements Process (CBRP). As the primary means of entry into the CBRP, the UNS acts as a "work request" for current and future capabilities. The UNS identifies operational enhancement opportunities and deficiencies in capabilities. Opportunities include new capabilities, improvements to existing capabilities, and elimination of redundant or unneeded capabilities. "Universal" highlights its common use by any Marine Corps organization to capture both current needs and future needs developed through analysis, assessment, and experimentation with future warfighting concepts.

### Originator

| Name (Last, First, Initial) | | Rank/Grade | | Phone | | FAX | |
|---|---|---|---|---|---|---|---|
| Lafontant, Roosevelt G.<br>Gayl, Franz, J. | | Lieutenant Colonel, O-5<br>GS-15 | | 703 614 3277 ex 1006<br>703 614 0859 | | 703 614 1420<br>703 614 1420 | |
| Available for phone or personal follow-up? | Yes | Interested in participation on Solution Course of Action IPT? | Yes | Request UNS status updates by e-mail? | Yes | E-mail<br>Roosevelt.Lafontant@<br>pentagon.af.mil<br>gaylfj@hqmc.usmc.mil | RUC<br>54008<br>54008 |

### Type of Need (select one that best describes the need)

| ADD a new capability that does not exist | X | IMPROVE or FIX an existing capability | | REMOVE an existing capability | |
|---|---|---|---|---|---|

### Description of Need

Describe the nature of the need and the cause (if known). Explain how the need was identified (operational deployment, training exercise, experimentation, formal study, mission area analysis, observed operating deficiencies).

Nature of Small Unit Space Transport and Insertion Capability Need (General):

The Marine Corps needs a capability to transport small, mission-tailored units through space from any point on the globe to a contingency at any other point on the globe within minutes of a National Command Authority (NCA) decision to introduce such forces. This includes a need for flexibility, such as the ability to loiter in low earth orbit to optimize the time of insertion, as well as the ability to be extracted from the contingency area without a need for transport refueling. Finally, this capability needs to include a self-sufficient combined arms weapons capability for self-defense enroute, during terrestrial mission execution, and during extraction and egress.

The War on Terrorism highlights the need for flexible, rapid US response options to contingencies around the world at their earliest stages, ideally within seconds and minutes of their identification. It is plausible that despite the continuous forward presence of deployed expeditionary forces such as Marine Expeditionary Units, the US will not be able to immediately appear on the battlefield to exploit strategic opportunities at any point on the globe. The scope of intervention necessary to contain or neutralize a contingency grows exponentially as the time between the decision to take action and the physical intervention increases. Earliest intervention results in minimal force application, with consequent minimal visibility at the lowest national cost. The range of early intervention options needs to span the lethality-response spectrum from the soft and impersonal, electromagnetically delivered messages of the Information Operations campaign, to hard and impersonal area and precision munitions effects delivery, to the immediate physical presence of fully mission-tailored Marine Corps small units on the ground at the site of the developing contingency. In addition to the War on Terrorism, this need applies to other Marine Corps actions in Operations Other Than War (OOTW) and conventional operations, where the strategic opportunities of immediate intervention using the full range of US options, including Marines on the ground, outweigh the risks and costs of such actions.

A clear deficiency remains with respect to any US ability to physically deliver relevantly tailored forces to any terrestrial point globally in order to act on current intelligence relevantly. Instead, small unit insertion options are limited by the speed, range, signature, and vulnerability of tactical terrestrial insertion technologies, as well as the proximity of host platforms. The highest speed of global small

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unit insertion from CONUS is limited to that of jet aircraft arriving within the constraints of in-flight refueling, foreign airspace over-flight restrictions, possible non-permissive air-defense environments, and the absence of suitable airfields. Under the more favorable circumstance where host platforms are in-theater, such as Navy ships or foreign expeditionary, commercial, and military airfields, previously noted shortfalls are compounded by lower transport altitude, airspeed, or water speed in the case of small boats.

Nature of Small Unit Space Transport and Insertion Need (Characteristics):

The capability that results from the fulfillment of the Small Unit Space Transport and Insertion Need must include the following characteristics:

1. Negligible sensor-detectable cross-section. Capability must have a minimal radar and magnified-optical cross-section as it enters the theater in which the contingency is located. During atmospheric reentry and tactical flight operation it also needs to have a minimal acoustic signature.

2. Kinetic air defense survivability. The combination of speed, altitude, and stealth of the capability must place it outside of the ballistic or kinematic engagement envelopes of current and future evolutionary anti-aircraft gun and missile systems.

3. Orbital sustainment. The capability must enable the attainment and maintenance of low-earth orbit, for loiter as required to optimize insertion timing or to stand-by pending mission abort, depending on how the developing contingency is interpreted by supported Commander or NCA in real-time.

4. Transport of up to 13 combat-equipped personnel, not including the transport crew. Needs to have the passenger cube capacity and on-board life support for a 13-person Marine infantry squad or task organized team(s).

5. Flexible launch on demand. Needs to adhere to short launch timelines from expeditionary spaceports and/or airfields, and be capable of launching into any orbital inclination as required.

6. Combined arms weapons suite. Needs to combine advanced electromagnetic and kinetic energy weapons in a fully integrated suite for the purpose of system self-defense in space, in flight, and on the ground, as well as provide fire support to inserted personnel while they are engaged in missions on the ground.

7. Multiple personnel insertion options. Needs to provide pilot operators the option of terrestrial in-flight high altitude, low altitude, or ground passenger exit capability.

8. Unrefeuled transport operation for entire mission cycle. From the time the transport is launched to the time it returns to secure CONUS or expeditionary spaceport/airfield it needs to be capable of operating without being refueled. This includes any demands placed on the system for CIFS in support of ground missions and any energy requirements for on-orbit Delta V (i.e. changes to orbital altitude, elliptical eccentricity, and/or plane inclination) and parking/loiter.

9. Vertical Short Take-Off and Landing (VSTOL). Operator-determined VSTOL transport options are needed during insertion and extraction to maximize both surprise and survivability in adaptation to situation, mission, terrain, and environmental conditions,

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10. Avoidance of foreign airspace over-flight restrictions. Must attain and reenter from space altitude at sufficient rate or employ a non-standard decent mechanism to minimize violation of sovereign foreign airspace.

**When Needed**

| URGENT | 6 Months | 1 Year | 2 Years | 5 Years | 10 Years | Other (date) |
|---|---|---|---|---|---|---|
| | | | | | X | |

**Rationale** Describe why the need requires resolution in timeframe selected (e.g., safety issues, Congressional mandate, etc.)

At virtually any geographic point or area on the globe that is of potential interest to US national security, events that are unfavorable to US interests can develop and escalate at an ever-increasing rate due to the impact of technologies in the hands of others. This rate of escalation is aggravated by the organization of many of our potential adversaries' capabilities into small units, teams, and platforms for speed and flexibility. This is especially true for adversaries that seek an asymmetric advantage to compensate for their other comparative weaknesses. In the end, events around the globe can unfold much more rapidly, and in many circumstances call for the earliest intervention if larger conflicts or other negative international implications are to be averted. Space transport and insertion is the only means of attaing the needed speed of response for virtually immediate physical appearance of fully relevant small units at any point on the globe.

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Describe mission or task to be accomplished that is related to the need.

The missions and tasks that this need relates to are those contingencies that require the presence of task-organized teams of specialized Marine Corps combat personnel for physical presence and physical intervention, on-site, in order to exploit time-sensitive strategic opportunities to influence US national security interests early and favorably. Space transport and insertion is the only means of attaining the needed speed of response for virtually immediate physical appearance of fully relevant small units at any point on the globe.

How does the need improve your ability to perform the mission or task?

The expressed need identifies a technology-enabled opportunity to support the evolving nature and increasing strategic significance of Marine Corps small unit missions and tasks with heretofore non-existent global transport and insertion timeliness. Space transport and insertion is the only means of attaining the needed speed of response for virtually immediate physical appearance of fully relevant small units at any point on the globe.

If the need is not satisfied, how will it effect your ability to perform the mission or task?

While the speed of terrestrial and national security space Intelligence Surveillance, and Reconnaissance (ISR) capabilities (to include collection, analysis, and dissemination) is keeping pace with the accelerated tempo of localized events, the ability of small Marine Corps units to physically respond (troops on the ground) at any global locality is not. As previously stated, space transport and insertion is the only means of attaining the needed speed of response for virtually immediate physical appearance of fully relevant small units at any point on the globe. If this need is not satisfied, Marine operating forces will continue to lack the corresponding ability to appear on the scene and respond relevantly and effectively to exploit strategic opportunities or minimize strategic damage at the earliest stages of a contingency.

**Approval Authority** (General Officer level)

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| Office (symbol)<br>PP&O | Name of Approval Authority (Last, First, Initial)<br>Bedard, Emil R. | Rank/Grade<br>LtGen |
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| | Date Received | Date Fwd'd to Assessment Br, MCCDC |
| Approval Authority Comments (optional) | | |

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INITIAL CAPABILITIES DOCUMENT (ICD)
FOR
SMALL UNIT SPACE TRANSPORT AND INSERTION (SUSTAIN)

Potential ACAT ID
Requirements Authority: JROC
Approval Authority: JROC
Milestone Decision Authority: USD(AT&L)
Designation: JROC Interest/Joint Impact
Prepared for Concept Refinement Decision
10 February 2003

1. Joint Functional Area

a. General. The SUSTAIN ICD defines a capacity for the Joint Force Commander (JFC) to rapidly transport strategic capabilities to any point on the globe. Strategic capabilities of SUSTAIN should span the full spectrum of conflict, from strategic special weapons employment to small unit insertion. Space transport and insertion are the only means of attaining the needed speed while avoiding overflight restrictions in order to guarantee the virtually immediate physical appearance of fully relevant combined arms Joint Forces anywhere, anytime.

b. Functional Area. The Joint Functional Area applicable to SUSTAIN addresses the rapid employment of forward Joint Forces and tailored expeditionary forces from the Continental United States (CONUS) and elsewhere. Rapid employment includes the use of National Security Space (NSS) in order to provide initial engagement capabilities through organic SUSTAIN firepower or to marry up forces with pre-positioned weapons and equipment, and in both cases facilitate the introduction of follow on forces. SUSTAIN also seeks to enhance the following Joint Force Attributes:

(1) Expeditionary. This describes the need for designated Joint Forces to be rapidly deployable, employable, and sustainable throughout the global battlespace regardless of anti-access, or area-denial environments and independent of existing infrastructure. Designated elements of the Joint Force must be configured as expeditionary forces (based in CONUS or abroad), capable of rapid deployment and immediate employment, and capable of seamlessly transitioning to sustained operations as a crisis or conflict develops.

(2) Decentralized. This describes a Joint Force that operates based on clear strategic objectives and commander's intent, allowing subordinate commanders to compress decision cycles and seize the initiative. Decentralization provides increased freedom of action for subordinate forces to operate near-autonomously and to be re-tasked to exploit fleeting opportunities.

(3) Adaptable. This describes a Joint Force prepared to quickly respond to any contingency with the appropriate capabilities mix. This requires versatile forces that are tailorable and scalable for employment and able to adapt fundamental capabilities in a multi-use manner as mission requirements dictate without losing significant operational capability.

(4) Decision Superiority. This is the state at which better decisions are reached and implemented faster than an adversary can react, or in a noncombat situation, at a tempo that allows the force to shape the situation or react to changes and accomplish its mission.

c. Functional Concepts. The functional concepts to which the operational capability primarily applies include:



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(1) Dominant Maneuver. The SUSTAIN ICD describes a capability for the Joint Force to gain positional advantage with decisive speed and overwhelming operational tempo through the execution of distributed maneuver and application of continuous pressure to an adversary's system.

(2) Precision Engagement. The SUSTAIN ICD describes a JFC's capability to employ dispersed joint capabilities generating effects across all battlespace, vertically, horizontally, and over great distances, to achieve a desired end state. This includes focusing precisely on single targets or broadly applied in sustained, large-scale operations, and producing the desired precise lethal and non-lethal outcomes while controlling undesired effects.

(3) Information Operations (IO). The SUSTAIN ICD describes JFC engagement and protection capabilities in the information domain across the full Range of Military Operations (ROMO). This includes the employment of electronic warfare (EW) attack, psychological operations (PSYOPS), and military deception to affect adversary decision-making and behavior.

(4) Space Operations. The SUSTAIN ICD describes a JFC's capability to execute Space Control missions in support of the Joint Force or other NSS objectives.

d. Range of Military Operations. The range of specific military operations to which SUSTAIN applies includes, but is not limited to: Global Assault Support, Special Operations, Combined Arms Escort of Joint Forces, Global Tactical Recovery of Aircraft and Personnel (TRAP), Expeditionary Fire Support, Global Hunter-Killer Operations, Advanced Command and Control (C2), and Space Control.

e. Time Frame. The objective SUSTAIN operational capability is desired for the time frame of 2025 to 2030.

2. Capability Gap

a. Functional Concept Component. The primary functional component deficiency that this ICD addresses is a projection that given current trends, Joint Forces will lack an Expeditionary Attribute in the future. In coming years there will exist a gap between Joint Forces real-time, speed-of-light awareness of details regarding unfolding global contingencies and their actual ability to respond relevantly and effectively to said contingencies. From the standpoints of relative tempo, operational security (OPSEC), and geographic proximity, Joint Forces will become less rapidly deployable, employable, and sustainable throughout the global battlespace. Anti-access and area-denial environments combined with longer range and more lethal adversary weapons will compound this relatively slowed responsiveness. Joint Force elements will not be capable of rapid deployment and immediate employment, or be capable seamlessly transitioning to sustained operations as a crisis or conflict develops.

b. Operational Mission and Function Deficiencies. The following functions that are essential to the JFC to achieve military objectives cannot be performed without unacceptable limitations.

(1) General. While the speed of terrestrial and national security space Intelligence Surveillance, and Reconnaissance (ISR) capabilities is keeping pace with the accelerated tempo of localized events in the modern world, the ability of combined arms Joint Forces to physically respond (troops on the ground) at any global locality is not. If this deficiency is not resolved, Joint Forces will become increasingly less capable of appearing on the scene to respond relevantly and effectively to exploit strategic opportunities or minimize strategic damage at the earliest stages of a contingency.

(2) Mobility/Maneuver. A deficiency exists with respect to a JFC's ability to deliver tailored forces

to any terrestrial point globally in order to act on current intelligence. Instead, Joint Force insertion options are limited by speed, range, signature, and vulnerability of evolutionary insertion technologies, as well as the vulnerability of expeditionary host platforms. The highest speed of global Joint Force insertion from CONUS is limited to that of jet aircraft arriving within the constraints of in-flight refueling, foreign airspace over-flight restrictions, non-permissive air-defense environments, and the absence of suitable airfields. It should be noted that airspace sovereignty extends to an altitude of 50 miles above the surface of the earth. When host platforms are in-theater, such as ships or foreign expeditionary, commercial, and military airfields, previously noted shortfalls are compounded by lower transport altitude and airspeed. Similarly, the highest speed of global surface Joint Force insertion from CONUS is limited to that of combinations of ships, boats, assault amphibians, hovercraft, and wheeled and tracked land vehicles, all of significantly slower responsiveness than aviation. Here, constraints include underway replenishment, Naval expeditionary force protection, 12-mile littoral coastal sovereignty, emergent anti-ship threats, cooperation of foreign ports or forced amphibious entry, and known challenges of overland movement in restrictive or non-permissive land combat environments.

(3) Firepower. The weapons that will threaten Joint Forces in the 21st Century will continue to advance in terms of range, speed, survivability and lethality. The pace of the advancements in adversary tactical, offensive anti-air, land, and surface threat capabilities has been greater than the pace of our capability to counter them with evolutionary improvements to protection and conventional kinetic weapons technologies alone. Revolutionary weapons capabilities are needed to preserve assault support insertion of Joint Forces as a viable course of action for the JFC.

c. Desired Effects. The SUSTAIN should enable the earliest operationally relevant and effective intervention of Joint Forces, resulting in minimal force application, with consequent minimal visibility, at the lowest national cost. Earliest should be understood as Joint Force combined arms, tailored, troops on the ground intervention anywhere on earth within two hours of an execution order.

d. Functional Area Analysis. To be executed during further Joint concept refinement.

e. Functional Needs Analysis. To be executed during further Joint concept refinement.

3. Threat/Operational Environment

a. Operational Environment. At virtually any geographic point or area on the globe of interest to United States (US) national security, events unfavorable to US interests can develop and escalate at an ever-increasing rate due to the impact of technologies in the hands of adversaries. This rate of escalation is aggravated by the organization of many of our potential adversaries into small units, teams, and mobile platforms for speed and flexibility. This is especially true for adversaries that seek an asymmetric advantage to compensate for their other comparative weaknesses. Future contingencies will call for earliest intervention if larger conflicts or other negative international implications are to be averted.

b. Threat Environment. Although the US and its partners still face a threat from existing nation-states, a more significant threat comes from the proliferation of their capabilities and the tacit support they provide non-state and rogue actors. Non-state and rogue actors pose an immediate and unpredictable threat. These adversaries do not share the same level of global interdependence as the US and its partners and are not as susceptible to the traditional influence of diplomatic, information, military, economic, and law enforcement power. They will find avenues of attack, resources, and basing without regard to national boundaries, governments, or geography. Our adversaries can be expected to seek to gain an advantage by blurring the distinction between combatants and non-combatants. They will not hesitate to target civilian populations or use noncombatants to shield their operations. They may operate from ungoverned spaces and draw support from radical causes. Our potential adversaries will increase their



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access to a range of deadly capabilities such as ballistic and cruise missiles, and weapons of mass destruction, such as Chemical, Biological, Radiological, Nuclear, and High-Yield Explosive (CBRNE) weapons. Potential adversaries already have access to the global commercial industrial base and many of the same technologies as the United States and its allies. They are using these technologies to develop an inexpensive networked system that uses information, mobility, and speed of execution to gain power. Our potential adversaries are complex and adaptive, and may interact and function through a system of globally distributed nodes and linkages, some of which are critical to their operations and survival. The relationships, dependencies, vulnerabilities and strengths within this complex system are important to understand since our potential adversaries will adapt and attempt to work around destroyed nodes or cut linkages. To help ensure success, the Joint Force must adapt to changing circumstances faster than the adversary system.

4. Functional Solution Analysis Summary

a. DOTMLPF Analysis

(1) Doctrine. While the family of SUSTAIN capabilities will not alter the basic tenants of maneuver warfare, strategic doctrine for employment of Joint Forces will necessarily change, with a dramatic impact on the National Military Strategy.

(2) Organization. A SUSTAIN Family of Assault Support Capabilities (SUSTAIN FASC) is seen as follow-on to evolutionary air, land, and sea assault support capabilities is envisioned. Traditional warfare would adapt in the same manner as was implemented in the adoption of these evolutionary aviation and armor platforms. The fundamental SUSTAIN transport is designed around the precept of a 13-person small unit, as this accommodates the current team and squad structures of several Services, as well as Special Operations Command (SOCOM). It could be fielded and manned in quantities similar to Amphibious Assault Vehicle (AAV) Battalions, or Composite Assault Support Squadrons. Logistics, Command and Control (C2), and fire support capabilities variants would be fielded and organized in appropriately complementary numbers.

(3) Training. Significant training would have to be undertaken to employ and maintain SUSTAIN. A revolutionary leap as proposed herein will require increased familiarization and training time for all operators and maintainers. SUSTAIN should incorporate integrated training and simulation devices to the maximum extent possible due to the significant projected expense associated with any SUSTAIN operations. While extensive simulator training would be required to train for global missions, limited local missions could still be selectively executed along the lines of training and experience of Department of Defense (DoD) and other agencies. Extensive familiarization with equipment would have to be undertaken by ground combat units. Training for fire support roles using SUSTAIN would have to be undertaken. Operator training for employment, embarkation, and debarkation would be required, though ground combat may only require evolutionary change.

(4) Material. SUSTAIN is proposed as a material solution only, as it is believed that the required global response timelines could not be met by a non-material solution. It is believed that a competitive comparison of candidate solutions could occur in 2025, followed by fielding in 2030. Due to the nature of employment, the Table of Equipment (T/E) should encompass a SUSTAIN capabilities embodying assault support transport, logistics/recovery, fire support, and C2, similar to evolutionary families of land, sea, and air assault.

(5) Logistics. Logistics doctrine is currently being defined/explored for maneuver warfare, and such doctrine will provide a good starting point for SUSTAIN as well. Logistics training requirements to support SUSTAIN, as well as all of its sub-capabilities, should make the greatest possible use of existing



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Joint Forces experience and facilities. The designation of new Military Operational Specialties (MOS) may become necessary with regard to SUSTAIN maintenance and supply generally, and advanced capabilities repairmen and technicians specifically. Training of operators and maintainers should be compatible with existing training concepts, whenever possible. The introduction of new classes of advanced weapons and equipment will also likely generate new maintainer MOSs. Additional required training must be integrated into the future curricula taught at Joint Schools.

(6) Personnel. Revolutionary equipment will require development of new MOSs. A crossover between current air, land and sea assault support MOSs is seen as a possibility for the sourcing of new MOSs.

(7) Facilities. SUSTAIN should seek to minimize construction or procurement of new facilities to the greatest extent possible.

b. Ideas For Material Approaches

(1) Increased Forward Presence. Increase U.S. forward presence by prepositioning both covert and overt Joint Forces in-theater for more rapid response to arising contingencies using conventional assault support.

(2) Evolutionary Improvements to Conventional Assault Support. Improve conventional tactical aviation, amphibious, and overland transport capabilities for higher speed and longer range insertion of sea and land-based Joint Forces.

(3) Revolutionary Improvements to Terrestrial Aviation Capabilities. Develop an innovative combination of complementary aviation capabilities to more rapidly transport conventional tactical assault support aircraft and Joint Forces into theater.

(4) Space Insertion -- Terrestrial Extraction. Develop a two-stage or single-stage to orbit platform from which to insert Joint Forces into contingencies from orbit or sub-orbital exoatmospheric altitudes. Following insertion Joint Forces would receive mission execution support, extract, and egress by means of longer-range terrestrial capabilities.

(5) Space Insertion and Extraction With Refueling. Develop a family of transformational high altitude/space assault support vehicles capable of launch on demand and assisted/refueled injection of task organized combined arms Joint Forces into any contingency. Develop an innovative combination of on-orbit support infrastructure for space-based support, and allowing the timed injection of Joint Forces into any contingency.

(6) Space Insertion and Extraction Without Refueling. Develop a family of transformational high altitude/space assault support vehicles capable of launch on demand and insertion of task organized combined arms Joint Forces into any contingency globally. This includes the capability to execute an entire mission cycle from launch, through transit, insertion, terrestrial or space execution, extraction, and finally egress to any global point of origin, without the need for refueling. It also includes a low earth orbit (LEO) loiter capability.

c. Analysis of Material Approaches

(1) Increased Forward Presence. In the absence of any other assault support material alternatives this could be viewed as a reactionary stopgap solution for the near term. It is conventional in nature and representative of how a conventional conflict is addressed when a contingency has escalated beyond the

point of efficient containment, negation, or resolution. It is also representative of Cold War containment practices that are still evident in Korea, Europe, and the Middle East. In the future, such forward-basing will be further curtailed, if not eliminated due to a lack of domestic and host nation popularity, lack of effectiveness against asymmetric threats, and significant US national cost. Even expeditionary Joint Force operations employing sea-based assault support will face curtailment through emergent threats of increasing range and lethality, reducing their traditional psychological and time/distance advantages. Over the mid-and long-term CONUS-basing must be pursued.

(2) Evolutionary Improvements to Conventional Assault Support. This constitutes a virtually identical solution to forward-basing, since conventional/evolutionary assault support technologies overwhelmingly require forward land and sea-basing. Similarly, it should only be viewed as a reactionary stopgap solution for the near term.

(3) Revolutionary Improvements to Terrestrial Aviation Capabilities. Although this approach falls far short of the objective SUSTAIN, it could be an excellent interim solution. This would act both as a proof of operational utility of some aspects of the objective SUSTAIN, while providing an expeditionary aviation small unit complement to sea-based combined arms Marine Air Ground Task Forces (MAGTF). It would be especially valuable for Joint Special Operations Forces who might prefer to be remotely inserted with organic Gunship and other forms of combat support for longer duration self-sufficiency.

(4) Space Insertion – Terrestrial Extraction. As reusable launch technologies become more cost effective this would serve as the next logical step in fully operationalizing the SUSTAIN. Although terrestrial extraction would remain dependent on evolutionary technologies and techniques, the space insertion phase would combine speed of transit with freedom to enter the contingency area in a transformational manner heretofore not yet demonstrated. This would serve as a further step in refining and proving the value of the objective SUSTAIN.

(5) Space Insertion and Extraction With Refueling. This step represents the operationalization of the objective SUSTAIN in most respects, with the exception of unrefueled mission cycle self-sufficiency. Options include on-orbit SUSTAIN refueling prior to insertion and following egress, space station logistical or personnel reconstitution, or a combination of all.

(6) Space Insertion and Extraction Without Refueling. Discussed in greater detail below, this is the objective SUSTAIN material approach, and the ultimate beneficiary of the interim capability steps discussed above. If the various science and technology (S&T) paths and resultant capabilities are rationally integrated, the objective SUSTAIN will be realized sooner and more cost-effectively.

5. Final Material Recommendation

a. Objective SUSTAIN. Launch on demand space transport and insertion is the only means of attaining the needed speed without overflight restrictions that are required for response to ensure virtually immediate physical appearance of fully relevant combined arms Joint Forces at any point on the globe. This will provide the JFC the ability to appear on the scene and respond relevantly and effectively to exploit strategic opportunities or minimize strategic damage at the earliest stages of contingencies. A family of capabilities will be required in order to achieve limited operational self-sufficiency. C2, transport, gunship, and logistics variants, similar to the range of conventional aviation and light armor assault support variants with which Joint Forces are traditionally familiar will be required for a range of missions including the following:

(1) Global Assault Support. The SUSTAIN should enable mission-tailored Joint Forces to be transported from any point on the globe to a contingency at any other point on the globe within minutes of

a National Command Authority (NCA) decision to introduce such forces. This SUSTAIN must include flexibility of response that allows the combined arms Joint Force to loiter on-orbit in reasonable time/distance proximity of the battlespace of interest to optimize the time of intervention. It also includes the requirement to transport, insert, support maneuver of, extract, and egress the Joint Force without the requirement for intermediate logistical reconstitution. The SUSTAIN calls for a basic modular transport system that enables a small Joint Force unit to be inserted. The small unit parameter may correspond approximately to the sizes of team and squad sized units of Joint Force components today, or of those projected for the SUSTAIN operationalization timeframe. As a modular capability, SUSTAIN system will be flexible for compositing, and be able to transport small and large combined arms units alike. The evolutionary analogy that SUSTAIN will supersede is the combined arms transport of sticks and waves by means of traditional air, sea, and land assault support systems.

(2) Special Operations. SUSTAIN-enabled operations across the full spectrum of conflict for selected missions of strategic significance that are constrained by global reach and immediate response requirements.

(3) Combined Arms Escort of Joint Forces. This constitutes the SUSTAIN capability to detect, acquire, negate and/or conduct preemptive spoiling operations against threats to other SUSTAIN assets, their transported forces, and/or their cargo continuously throughout a mission cycle.

(4) Global Tactical Recovery of Aircraft and Personnel (TRAP). SUSTAIN will provide Joint Forces a global TRAP capability that includes global Search and Rescue (SAR). Other TRAP-like contingency air, land, and sea battlespace functions are conceivable.

(5) Expeditionary Fire Support. This constitutes the capability to provide fire support to inserted Joint Forces engaged in close combat, as an organic fire support asset under the command of the inserted force Commander. Advanced weapons technologies would enable the full spectrum of lethality options, with tunable precision and effectiveness in support of IO objectives.

(6) Global Hunter-Killer Operations. This constitutes the capability of SUSTAIN to enter selected battlespace, and independently engage targets of opportunity in less permissive environments globally, either for their strategic value or in support of a composited SUSTAIN.

(7) Advanced Command and Control (C2). This constitutes the SUSTAIN to be fully integrated within and to actively contribute to the global common operating picture. This includes SUSTAIN ability to facilitate seamless communications between the Joint Force Commander and higher, adjacent and subordinate elements throughout the battlespace and globally.

(8) Information Operations (IO). SUSTAIN will have the operational capacity to assist the Joint Force Commander in the achievement of IO objectives. The SUSTAIN IO capability-set will include Electronic Warfare (EW), Computer Network Operations, Psychological Operations (PSYOPS), Operations Security (OPSEC), and Military Deception.

b. Interim Material Recommendations for Further Analysis

(1) Increased Forward Presence. This would involve an increase in the sea-basing of expeditionary Joint Forces close to potential contingency areas in international waters.

(2) Evolutionary Improvements to Conventional Assault Support. This near-term material approach includes evolutionary air, land, and sea follow-on capabilities to such current assault support capabilities like tactical rotary wing air (V-22), tracked amphibious assault (AAAV), tracked infantry



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fighting vehicle (M2), small boat, and others.

(3) Revolutionary Improvements to Terrestrial Aviation Capabilities. This intermediate material approach can consider innovative long-range Vertical Take-Off and Landing (VTOL) transport aircraft (Defense Advanced Research Projects Agency [DARPA] Hitchhiker Program), long-range VTOL transport pods (National Aeronautics and Space Administration [NASA] B52-launched Crew Escape Vehicle), and other air, land, and sea experimental programs.

(4) Space Insertion – Terrestrial Extraction. This intermediate material approach could benefit from leveraging the technologies of several programs. These include the Air Force Common Aero Vehicle (CAV), AF Space Maneuvering Vehicle (SMV), DARPA- Lawrence Livermore National Lab (LLNL) HyperSoar, and NASA X-43 Hyper X, along with NASA Shuttle, and International Space Station Programs (ISS) for both systems and man-rating.

(5) Space Insertion and Extraction With Refueling. The DARPA Future Vision capability may apply to this intermediate material approach.

(6) Space Insertion and Extraction Without Refueling. An advanced follow-on to the Future Vision capability meeting all of the objective Boundary Conditions and Constraints noted below may apply to this material approach. This also constitutes the objective SUSTAIN capability

c. Analysis of Alternatives (AoA) Boundary Conditions/Constraints. Each of the material solutions in the AoA has merit for periods of various durations in the future. However, each is merely a stage in an integrated, rational, phased, long-term effort that will lead to the objective SUSTAIN identified in the Final Material Approach above. The Boundary Conditions and Constraints below apply to the technologically ambitious objective SUSTAIN, to set the bar high for forging a SUSTAIN S&T roadmap.

(1) Platform Boundary Conditions/Constraints

(a) General. A man-rated, launch on demand, space transport and insertion family of vehicles is likely the only means of attaining the needed speed of CONUS-based response for virtually immediate physical appearance of fully relevant combined arms Joint Forces at any point on the globe. It is also the only means of avoiding operationally undesirable coordination with or violation of third party sovereign air, sea, and land battlespace in conjunction with global expeditionary reach. A family of capabilities will be required in order to achieve combined arms operational self-sufficiency. C2, transport, gunship, and logistics variants, similar to the range of conventional aviation and light armor assault support variants with which Joint Forces are familiar will be required. Certain technology areas will require breakthroughs in order to realize the objective expeditionary SUSTAIN capability. These include fuels, hypersonic aerodynamics, materials, and weapons technologies.

(b) The Common SUSTAIN Vehicle Requirements. In addition to the Air Force (AF) (Executive Agent [EA] for NSS), DARPA, and NASA programs noted earlier, the thrusts of the National Aerospace Initiative (NAI) complement the overall SUSTAIN effort well. Each NAI thrust area represents a necessary technological demonstration step towards the objective SUSTAIN capability. While NAI is not focused on man-rated space systems demonstrations, other programs such as Shuttle are, and these technologies and experiences can be overlain for efficiency. The critical commonality between NAI and SUSTAIN objectives is related to lowering the cost of routine access to space; i.e. reducing the cost of placing payloads in low earth orbit from $10,000 per pound to approximately $100 per pound. Unrefueled launch, transport, insertion, actions in the objective area, and extraction, in addition to man-rating, presents further challenges. The NAI thrusts below are the common necessary first steps:

1 High Speed Hypersonics. This involves the development and demonstration of an expendable Supersonic Combustion RAMJET (SCRAMJET) capable of speeds up to Mach 4, expendable SCRAMJET capable of speeds between Mach 4 and Mach 15, reusable long range strike SCRAMJET propulsion capable of Mach 0 through Mach 7, and eventually an air breathing 1st stage capable of Mach 0 through Mach 12.

2 Access to Space. This thrust also has common interest in an air breathing 1st Stage capable of Mach 0 through Mach 12, as well as a reusable launch vehicle; 2nd stage rocket engine, and an SMV.

3 Responsive Payloads. Payload interests of NAI also encompass SMV, and include flexible communications, ISR, and space control payloads, all necessary to the development of the objective SUSTAIN.

(c) Platform Fuels. Objective SUSTAIN capability will require breakthroughs and innovation with respect to fuels. In addition to evolutionary advances to hydrogen, oxygen, kerosene, and solid rocket fuels/engines, other technologies must be investigated. These include, but are not limited to, on-orbit ion-engine propulsion, nuclear propulsion, and the ability of SUSTAIN to generate and liquefy its own hydrogen and oxygen fuels in-theater, mid-mission, from indigenous water sources using electrolysis.

(d) Platform Power. The SUSTAIN platform will require a significant reservoir of pulsed and continuous electrical power for a wide variety of life-support, protection, weapons, space propulsion, terrestrial propulsion-enabling, ultrasonic acoustic refrigeration, and thermal management functions. SUSTAIN should drive the state-of-the-art in compact battery, capacitor, and cryogenically (cryo)-cooled generator technologies. SUSTAIN may also incorporate a nuclear power source for full realization of its physical potential.

(e) C4I. SUSTAIN needs a suite of sensors in multiple bands, with a fusion-technology-synthesized, single view for operators, and complete integration within a largely automated fire control system. Furthermore, SUSTAIN will require sensors and detectors that provide precise environmental data on charged particle, EMP, and nuclear radiation conditions both in space and terrestrially. SUSTAIN will also need to be fully integrated with US Strategic Command (STRATCOM) space surveillance common space picture.

(f) Human Factors. The SUSTAIN must adhere to a broad range of stringent specifications with regards to safety in order for it to be considered operationally suitable. The SUSTAIN should leverage the extensive research, development, demonstration, and routine operations of the US manned space program, with particular emphasis on life support and spacecraft survivability experiences and technologies associated with the Shuttle, ISS, Apollo, and earlier US and Russian manned space programs. SUSTAIN life support systems will need to be hardened against electromagnetic pulse (EMP), energetic charged particles, nuclear radiation, high energy laser (HEL), high power microwave (HPM), thermal, kinetic fragmentation, space debris, launch, reentry, and deliberate Anti-Satellite (ASAT) weapons effects of the future space warfighting environment.

(g) Nuclear, Biological and Chemical (NBC) Considerations. There is a pronounced SUSTAIN requirement for hardening against nuclear weapons effects beyond those of most current combat systems. SUSTAIN must be capable of operating in the space environment after pollution of low earth orbit(s) by the charged particle streams created by high altitude nuclear detonations. SUSTAIN must also be capable of being operated following the line-of-sight exposure to EMP emanating from high altitude or terrestrial nuclear detonations. Finally, SUSTAIN man-rating must accommodate Joint Forces in all MOPP postures, and possess chemical and biological survivability equal to that of other Joint Force aviation platforms.

(3) Firepower Boundary Conditions/Constraints.

(a) General. Speed of light Directed Energy Weapons (DEW) would provide heretofore non-existent capabilities to engage inbound anti-aircraft missiles in flight, suppress-defeat ground and airborne anti-aircraft systems and operators while the SUSTAIN is still well outside the kinematic envelopes of those weapons, deliver instantaneously responsive, precision lethal and non-lethal fires to the supported-inserted Commander in response to Operations Other Than War (OOTW) threats, and the capability to engage a variety of targets at extended range with precision and effects tunability in support of the IO objectives. Conversely, SUSTAIN Kinetic Energy Weapons (KEW) guns, bombs, and missiles will be critical for the wide variety of space, air, and surface targets where penetration, fragmentation, mass lethality, and material destruction are required. KEWs and DEWs possess mutually exclusive, mutually complementary effects that compensate each other's inherent limitations.

(b) Directed Energy Weapons (DEWs). Speed-of-light, optical wavelength weapons of extreme precision (tactical point of aim being point of impact) and graduated effects are necessary for the advanced weapons suite to engage both material and personnel threats. DEWs should be long-range lethal weapons with frequency, pulse format, and peak/average power agility for precision effects and to limit collateral damage both laterally and in depth. HEL, HPM, and other EMP weapons are suggested here. As they mature, Neutral Particle Beam (NPB) and Electrostatic Discharge (ESD) weapons should be considered.

(c) Advanced Kinetic Energy Weapons (KEWs). Small to medium caliber rapid-fire gun technologies of high muzzle velocities are needed for the SUSTAIN advanced combined arms weapons suite. Projectile acceleration/launch should be electromagnetic/magnetic for compatibility with other electric weapons. In the absence of EM Gun technology, advanced propellant Gatling, or other evolutionary high rate of fire machine gun technology would suffice. SUSTAIN also calls for guided missiles and precision gravity bombs, to include special strategic weapons munitions/payloads.

(d) Integrated Combined Arms Fire Control. The SUSTAIN advanced weapons suite and the operator need to be integrated through a user friendly and responsive fire control system. Simplicity and automation will be crucial in the case that the SUSTAIN weapons suite operator must also serve as either the pilot or copilot.

(e) Rheostatic Lethality. The SUSTAIN advanced weapons suite must produce tunable precision effects for employment throughout the spectrum of conflict. Whenever possible, counter-capability applications should also be non-lethal to personnel, and be supportive of other attack capabilities, particularly as they relate to IO.



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Mandatory Appendices

Appendix A. Mandatory Architecture Framework Documents

- OV-1, OV-2, OV-3, OV-5
- SV-5

Appendix B. References

- Joint Capstone Document, Full Spectrum Dominance Through Joint Integration SV-1, dated 22 January 2003
- CJCSI 3170, Joint Capabilities Integration and Requirements System, dated 22 January 2003
- Marine Corps Universal Need Statement for a Small Unit Space Transport and Insertion Capability, dated 22 August 2002
- Marine Corps Universal Need Statement for an Advanced Gunship Combined Arms Weapons Suite, dated 13 May 2002

Appendix C. Acronym List

- ACAT: Acquisition Category
- AF: Air Force
- AoA: Analysis of Alternatives
- ASAT: Anti-Satellite
- CBRNE: Chemical, Biological, Radiological, Nuclear, and High-Yield Explosive
- C2: Command and Control
- CAV: Common Aero Vehicle
- CONUS: Continental United States
- Cryo: Cryogenically
- DARPA: Defense Advanced Research Projects Agency
- DoD: Department of Defense
- DEW: Directed Energy Weapons
- DOTMLPF: Doctrine, Organization, Training, Material, Logistics, Personnel, and Facilities
- EW: Electronic Warfare
- EMP: Electromagnetic Pulse
- ESD: Electrostatic Discharge
- EA: Executive Agent
- FASC: Family of Assault Support Capabilities
- HEL: High Energy Laser
- HPM: High Power Microwave
- IO: Information Operations
- ICD: Initial Capabilities Document
- ISR: Intelligence, Surveillance, and Reconnaissance
- ISS: International Space Station
- JFC: Joint Force Commander
- JROC: Joint Requirements Oversight Council
- KEW: Kinetic Energy Weapons



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- LLNL: Lawrence Livermore National Laboratory
- MAGTF: Marine Air Ground Task Force
- MDA: Milestone Decision Authority
- MOS: Military Occupational Specialty
- NASA: National Aeronautics and Space Administration
- NAI: National Aerospace Initiative
- NCA: National Command Authority
- NSS: National Security Space
- NPB: Neutral Particle Beam
- NBC: Nuclear, Biological and Chemical
- OPSEC: Operational Security
- PSYOPS: Psychological Operations
- ROMO: Range of Military Operations
- S&T: Science and Technology
- SCRAMJET: Supersonic Combustion RAMJET
- SUSTAIN: Small Unit Space Transport and Insertion Capability
- SMV: Space Maneuvering Vehicle
- SOCOM: Special Operations Command
- T/E: Table of Equipment
- TRAP: Tactical recovery of Aircraft and Personnel
- USD(AT&L): Under Secretary of Defense for Acquisition, Technology and Logistics
- US: United States
- VTOL: Vertical Take-Off and Landing