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Key Points

Major theater war in the 21st century will feature highly contested combat environments requiring assured force projection, with conditions very different from current conflicts. The US and its allies must develop effective means to counter the advanced strategies and technologies of potential adversaries.

To achieve these ends, the US military must transition its operations from being merely synchronized via formulaic, doctrinaire prescriptions of “combined arms warfare,” to being fully interdependent and achieving the power of “combined effects” to optimize effectiveness.

An interdependent approach allows the military services to hone their core competencies within their respective domains, while capitalizing on the power of their combined component capabilities. When land, air, sea, space, and cyber forces seamlessly share information, the US military will hold an asymmetric advantage in all domains.

Interdependent Warfare: Combined Effects Power in the 21st Century

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Abstract

Major theater war in the 21st century will assuredly feature adversaries with advanced combat capabilities that will challenge US power projection, creating challenging conditions very different from what the US military and its allies experience in conflicts today. Tomorrow’s military forces will face weapons such as barrages of theater ballistic missiles, anti-satellite systems, swarms of non-stealthy drones, and offensive cyber operations, among other capabilities. The US must develop effective means to counter the advanced strategies and technologies that our potential adversaries are acquiring.

Agility, initiative, depth, and synchronization were tenets of the AirLand Battle concept 40 years ago. Those tenets have not changed, but to achieve them now, we must transition the US military services’ operations from being merely synchronized to being fully interdependent. Interdependence will foster an environment where the services can hone their respective core competencies—skill sets that require significant time, effort, and focus—thus maximizing what they bring to joint force operations. The US and its allies must evolve beyond the familiar notion of combined arms warfare and move towards exploiting combined effects power to achieving the right outcomes.

Information will be the dominant factor in future wars. Whoever has the greatest data interconnectivity and situational awareness will win in the conflicts of the future. An integrated network of air, space, and cyberspace capabilities can leverage military service contributions from all domains to sense, command, control, and employ effects to meet mission objectives. This creation of a paradigm described as a “combat cloud” will enable rapid, effective decisions at all levels of war and provide the US an operating advantage difficult for any adversary to overcome.

Introduction

During WWII and the Cold War, the US military's air, sea, and land forces worked together to overcome significant challenges to accomplish national military objectives. As a result, the United States prevailed against incredible odds. Today's US military must now confront its own unique set of circumstances.

The military situation of the United States of America today is stark. From around the globe the US faces a burgeoning number of threats spanning a wide spectrum, even as the resources allocated to meet these threats decline. To successfully confront this dynamic array of dangers, we must optimize US military organizations and concepts of operation.

We must take the next step in the evolution of our service relationships from ones of interoperability—a goal of the 1986 Goldwater-Nichols Act—to ones of full integration and interdependency.¹

A dollar spent on duplicative capability comes at the expense of essential capacity or capability elsewhere. Confused organizational structures lead to suboptimal employment of forces already stretched too thin. Outdated service roles, missions, and concepts of operation yield costly, inefficient acquisition programs. Security circumstances and fiscal pressures will no longer tolerate such conditions. We are not going to be able to blast or buy our way out of these challenges; we are going to have to think our way out of them.

If the United States is to succeed in protecting its core interests around the globe and deter aggression, we must have the strongest Army, Navy, Marine Corps, and Air Force in the world. Fiscal realities, however, dictate that the military must make difficult choices in balancing near term operational readiness with long term needs. This will demand greater clarity regarding goals and desired outcomes, with a special emphasis on how we can best project effective, prudent power to negate threats that we will face in the remainder of the 21st century.

The Department of Defense (DOD) and military services are conservative institutions.

While highly capable, they are slow to change. To operate effectively in the information age the US must develop and capitalize on the emergent concepts of operation and organizations that new technologies enable.

Dr. Thomas Kuhn, renowned American physicist, historian, and philosopher, noted that institutions only accept new paradigms when 1) there is a paradigm crisis, 2) the old people of a given paradigm die off, or 3) change is forced from the outside.² In 1986, Congress was the outside institution that forced much needed change in the DOD with the Goldwater-Nichols Act. It may be time to consider such action again. We cannot afford to wait for the “old guard” to depart, and the consequences may be too severe should we wait for an existential crisis.

Among many challenges, perhaps the biggest one the American defense establishment faces is the one of institutional inertia. We are well into the information age, yet our systems, organizations, and concepts of operations remain rooted in the industrial age of warfare. The diplomatic, economic, and informational elements of our national security enterprise are also largely unchanged since the mid-20th century, and require more integration than ever before. We can no longer afford this misalignment; not only is it costly, but it also poses an unacceptable risk.

Change in the military realm involves four principal factors: advanced technologies; new concepts of operation; organizational change; and the human dimension. Advanced technologies and the new capabilities they yield, enable new concepts of operation that can produce order-of-magnitude increases in our ability to achieve desired military effects. Organizational change codifies such changes and enhances our ability to execute the US National Security Strategy. The final and essential element to progress is the human dimension; people are fundamental to everything we do, especially when it comes to leadership.

The Realities of Combined Effects Power in the 21st Century

Major theater war in the 21st century will present many challenges. America's adversaries gained valuable insight from our success in Operation Desert Storm and the first few months

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of Operations Enduring Freedom and Iraqi Freedom. Specifically, they saw that unchallenged air superiority gave the American military a freedom of maneuver that facilitated dominance in other domains. Since then, they have invested tremendous resources in developing the tools, techniques, and strategies to counter this freedom of maneuver by advancing their capabilities, to restrict America's power projection.

It would be foolhardy to assume US forces will be afforded freedom of action in future engagements. We must actively pursue options to counter the increasingly advanced military strategies and technologies our adversaries are developing. Although the specifics will be dependent upon the specific engagement scenario, we must anticipate that future conflicts will differ from those of the past in three key areas:

- Information will be the dominant factor in future conflicts; whoever has the greatest data interconnectivity and situational awareness will win.
- Highly contested combat environments will be the norm, not the exception, creating conditions very different from today. Tomorrow's military will face modern weapons and capabilities such as heavy opposing armor, barrages of theater ballistic missiles, smart mines, quiet submarines, antisatellite systems, swarms of non-stealthy drones, and offensive cyber operations.
- Electronic warfare (EW) will no longer be simply an enabling capability; it will be required for survival. The proliferation of high-end electronics has made EW, including offensive cyber operations, today's great military equalizer.

American military strategies, planning assumptions, acquisition programs, and training need to account for more capable enemies. Agility, initiative, depth, and synchronization were tenets of the AirLand Battle concept 40 years ago. Those tenets have not changed, but to achieve them the US must transition our services'

operations from being merely synchronized to being fully interdependent to maximize joint force effectiveness. If the US and its allies are to prevail we must evolve beyond the familiar notion of combined arms warfare and move towards exploiting combined effects power to achieve the right effect, at the right place, at the right time.

Defining Elements of the 21st Century Security Environment

Security in the 21st century will be shaped by the following aspects that stand to redefine the character of combined arms warfare into a much more integrated warfighting paradigm known as "combined effects power."³

Increasing Complexity

The threats driving US national security strategy have never been more complex. We must contend with a myriad of challenges that span the full spectrum of conflict: non-state and transnational actors, a rising economic and military powerhouse in China, a resurgent Russia, declining states (some with nuclear weapons), the increasing likelihood of nuclear weapons proliferation, and the persistent dangers of international terrorism.

Accelerating Change

Speed and complexity have merged, and now permeate the conduct of warfare. Key security events unfold in a matter of hours and days, not months or years, and the time windows in which to influence such events are shrinking. Future air, space, sea, cyber, and land warfare operations must be able to respond rapidly and decisively anywhere on the globe at any time.

The Dangers of Protracted Commitments

We have seen that strategies centered upon ground-centric military occupation expose American vulnerabilities; often result in anti-American backlash and domestic disapproval; and create destabilizing effects within the very states or regions they are intended to secure. Extended involvements in distant lands stretch America's resources thin in a fiscally austere environment.

Information Warfare

Recent events demonstrate our adversaries' intent to actively manipulate public perception and engage in cyber attacks against our military and civilian information systems. By contrast, the nature of our industrial age institutions and overconfidence in military might has made the US government woefully inept at strategic communications. Too often the US finds itself in a reactionary position, struggling to gain domestic and international public support.

These defining elements of the 21st century security environment provide a starting point for anticipating how the US and its allies will contend with future security challenges. The proliferation of technology, information flow, and the associated empowerment of nation-states, organizations, as well as individuals, presents one of the most daunting challenges our military has ever faced.

Enhancing Joint Operations for the 21st Century

Joint Functionality: The Services and the Combatant Commands

Force employment should not be dictated by a predetermined and formulaic solution. In Operation Desert Storm, ground forces were not used for the first 39 days of a 43-day operation. In Operation Allied Force, US ground forces were not employed in combat at all. These are examples of true joint operations: each joint task force commander has service component elements from which to craft a tailored solution to the particular contingency at hand. Joint operations, when done correctly, provide flexibility to shape the use of our forces when and where they are needed.

The Goldwater-Nichols Act of 1986 created significant change in the way America fights. No longer do the individual services fight our nation's wars as separate entities—unified combatant commands take the fight to the enemy. The services organize, train, and equip what are called service component forces. The strength in joint operations

resides in the separateness of the services; a function which allows them to focus efforts on mastering their principal domains of operation. The component forces are assigned to the unified combatant commands to conduct operations under a joint task force (JTF) commander. The JTF commander uses them to create an optimal, unique force matched to the contingency at hand. The service components do not fight as individual services but as a joint force, conducting operations at the time and place of the JTF commander's direction. Up to the present, this has required the services possess interoperable systems to ensure that they can communicate with one another for situational awareness to “deconflict” their operations, and to support one another when needed.

Today, to optimize US military power, the United States armed forces must move beyond interoperability to interdependency, a state in which all of the service components rely on the unique capabilities brought to the joint fight by other service components.⁴ An interdependent approach creates greater synergy by allowing the services to still hone their core competencies within their respective domains—skill sets that require significant time, effort, and focus—and thus maximize what they bring to the joint fight.

This notion is no different than allowing doctors to concentrate on healing the sick, while firemen focus their efforts on rescuing people from burning buildings. Drawing out this analogy, such an approach means joint task force operations have at their disposal the abilities to both put out fires and to cure sick people. However, both of these important tasks need to be performed by the specialists in their respective fields.

We must guard against the historical desire of services to possess redundant “organic” fighting capabilities that enable them to fight alone. This would be akin to having firemen also training to perform surgical procedures, and physicians darting in and out of blazing structures between seeing patients. If a single service strives to achieve warfighting independence instead of embracing interdependence, “jointness” unravels, trust is lessened, costly redundancies are created, and capability gaps increase. These impacts would reduce the nation's overall warfighting effectiveness.

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The Two-Edged Allure of Joint Programs

Experience has shown that joint or multi-service programs are not an effective way to drive down costs. In fact, they often produce just the opposite result. Creating a jointly managed program typically increases the size of the organization, slows down the process, mismatches expertise, and significantly delays and adds increased cost. In worst case scenarios, joint programs produce compromises that end up satisfying none of the stakeholders. The F-35 program is a recent example of this. Parts commonality is drastically less than originally envisioned and the compromises in aircraft performance were more than desired.

Far better outcomes are derived from a process that places operational effectiveness as the top goal, followed closely by cost efficiency. Each service provides operational requirements and a follow-on analysis helps avoid procuring two separate aircraft if one can be acquired

that satisfies the needs for both services. Once a decision is made to pursue a particular program it is best to put one service in charge of it, and to make that service responsible to Congress and the other services for that program. The other services remain engaged via representatives assigned to the program. These detailees supply their service expertise in all technical and program reviews to ensure that any requirement trade-offs are done so with a full understanding of the risks.

With a common understanding of the challenges in a future security environment, the rapid advance of technology and information flow, and a proper understanding of joint operations and joint programs, we then must examine the future of combined effects power in the 21st century, focusing specifically on air-ground operations.

Optimizing Joint Force Air-Ground Combat Operations

Beginning with the success of Operation Desert Storm in 1991, advanced technologies and innovative concepts of operations have come to dominate conventional joint force operations.

One of the most significant changes in the evolution of modern warfare resulted from a

combination of three technologies:

- Modern intelligence, reconnaissance, and surveillance (ISR) which yields persistent multi-spectral sensing
- The normalization of the use of precision weapons
- The dramatic improvement of system survivability (i.e., stealth)

These changes have flipped the traditional warfighting paradigm. Historically, ground forces led the fight and were supported by air forces. Now, air forces supported by ground forces offer a more responsive, effective, efficient, and less costly way to conduct warfare—in terms of both lives and dollars.⁵

The point of this realization is not to start a fight over doctrinal roles and functions between the Army and the Air Force, but rather to highlight the fact that capabilities change over time, and those changes should be exploited to our nation's warfighting advantage. This is particularly true in an era where near-peer adversaries are working hard to negate the warfighting advantages we have enjoyed over the past quarter of a century.

To best meet the challenges of future peer and near-peer adversaries we must continue to exploit modern ISR, routine precision strike, and improvements in survivability. However, we must also focus on two additional key actions. First, the US must work to remove service-centric organizational shackles and embrace more functional joint organizational constructs that achieve greater integration of our capabilities. Second, we must capitalize on the capabilities of the information age by exploiting seamless information sharing across systems in every domain.

Information Sharing: The Key to Victory

Since the introduction of mechanized technology in the early 20th century, the scale and scope of combat has been governed by industrial means of power projection. Advances in aircraft, ships, and ground vehicles increased speed, reach, and precision, but “mass” remained an essential aspect of force application. In the last century, military missions, historically restricted to land and sea, expanded into the air, space, and underwater domains. However, the ability to project power globally was wholly dependent upon mechanized technology.

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The United States and its allies are at a critical juncture in history. We are at the center of an “information in war revolution” where the speed of information, the advance of technology, and the designs of organizations are merging to change the way we all operate, fundamentally reshaping what it means to project power. This change has dramatically shortened decision and reaction times, and reduced the number of weapon systems needed to achieve desired effects. In World War II it took months of time, thousands of airmen, and hundreds of aircraft to neutralize a single target. Today we can find, fix, and successfully engage multiple targets with a single aircraft within minutes.

Advancements in computing and network capabilities are empowering information’s ascent as a dominant factor in warfare. No longer will it be sufficient to focus on simply managing the physical elements of a conflict—airplanes, satellites in space, tanks, amphibious elements or ships at sea. These individual platforms have evolved from a stove-piped, parochial service alignment to the loosely federated “joint and combined” operational construct of today.

These facts have major implications throughout the modern US military enterprise, particularly for air and land operations. They will shape key areas such as doctrine, organization, training, materiel acquisition and sustainment, along with command and control (C2). Leaders in the policy community must adjust to the new realities of information age combat operations. Cold War and counterinsurgency paradigms will fall short when building, sustaining, and employing military power in the modern era. To be effective in the future, US and allied forces must become a highly integrated enterprise that is collaboratively leveraged through the broad exchange of information.

Information’s value extends past its use by media. Faster and more capable networks and computing capabilities are turning information into the dominant factor in modern warfare. Aircraft like the F-22 and F-35 are information systems far above and beyond being fighters that shoot missiles and drop bombs. They are “sensor-shooters,” or more accurately, “sensor-effectors.” F-22 operations over Syria as part of Operation

Inherent Resolve highlight this reality. Today, information and its management are just as important as the lethality sought by integrating the effects of airplanes, satellites, infantry, and warships—the traditional tools of hard military power. Information is the force that is evolving all weapon systems from being isolated instruments of power into components of a highly integrated enterprise wherein the exchange of information will determine success or failure in the 21st century.

Bluntly stated, the armed services, DOD agencies, and other elements of our national security architecture have been slow to recognize the emerging new security environment. The US still has institutions and processes that were designed in the middle of the last century to accommodate what we now view, in retrospect, as a rather simple world of kinetics and traditional domains that characterized the Cold War era. Although nuclear threats remain, we must augment our traditional concepts of combined arms warfare with a broader “lens” that will enable us to exploit non-kinetic tools, information, space, and the cyber domain. Preoccupation with lethality and weapon platforms traditionally associated with combined arms warfare runs the danger of under-investing in emerging non-kinetic instruments. We cannot relive the mistakes of battleship admirals and cavalry generals who dismissed aviation as a passing fad. In the modern era, the US and its allies must increasingly seek to attain desired military effects through the prudent use of information.

The Combat Cloud: Bringing “The Big Picture” to US and Allied Forces

Desired effects of military operations will increasingly be attained through the interaction of multiple systems, each one sharing information and empowering one another for a common purpose. This phenomenon is not restricted to an individual technology or system, nor is it isolated to a specific service, domain, or task. It is a concept that can be envisioned as a “combat cloud,” an operating paradigm wherein information, data management, connectivity, and command and control are all core mission priorities.

In the current program-centric budgetary world of the DOD, narrow focus on individual platforms, sensors, and weapons is the norm.

Absent a clear definitive vision, and without a strategy to realize that vision, the big picture is lost among a collection of disparate, disconnected systems that are often kluged together to pass as “joint” capabilities. This is why the DOD needs to embrace the vision of attaining a joint and combined combat cloud. Future combined and joint operations will require new concepts and practices for how to join together and command and control desired effects, as well as prosecute distributed battle, and utilize intelligence, and surveillance networks.

When fully developed, a combat cloud will be self-forming, distributed through all domains, difficult for an enemy to strike, and self-healing when attacked. It will be strategically dislocating

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to any challenger, and significantly complicate an enemy’s planning cycle. It has the potential to provide conventional deterrence to a degree heretofore only achieved by nuclear weapons, and may enable operational dominance across all domains. This approach will not only change the way the US defines new requirements, but also more importantly, the way we think about operations, intelligence, C2, and support.

Mechanical technology will continue to serve as a key factor in future military operations, but the information empowering these systems will underpin their potential.

As the combat cloud is developed, it promises to afford an expansive, highly redundant defense complex with radically enhanced data gathering, processing, and dissemination capabilities. These attributes will offer actors at every level of war, and in every service component, dramatically enhanced situational awareness (SA) by transforming masses of disparate data into decision-quality knowledge. This represents an evolution whereby individually networked platforms transform into a broader system of systems enterprise, integrated through domain and mission agnostic information linkages.

Turning this vision into reality will require a significant effort. Many militaries are evolving toward “informationized” forces, but the

integration of that information, and the realization of new capabilities such integration affords, is incomplete. Forces are still predominantly organized, trained, and equipped to fight a mechanized war, one in which information integration is a secondary support function. Most bureaucratic organizations and current programs of record reflect the linear extrapolation of the combined arms warfare construct dating back to the industrial age of warfare. Program oversight efforts within the DOD are also lagging, with antiquated governance impeding information age endeavors.

Any assessment of the likely landscape of future conflict must recognize that no matter what type of engagement occurs, the outcome will increasingly be determined by which side is better equipped and organized to collect, process, disseminate, understand, and control information. Furthermore, budget austerity dictates the US military’s need to devise more effective and efficient means to secure desired effects with existing capabilities. The combat cloud concept is a paradigm that allows us to do this successfully.

US and allied commanders must change the way they view networks and information systems. Rather than value only the weapons and platforms that launch them, commanders need to recognize the value of the effects they can create based on the seamless sharing of information. Every asset employed will be gathering relevant information and sharing that data with other assets to paint a real-time picture of what is occurring.

The combat cloud is not simply a network, but an operating concept that integrates every warfighting platform as a node in an ISR, strike, maneuver, and sustainment complex. Because of its nature as a distributed sensor-shooter-effector composite, it will require command and control standards and sets of operating procedures different from that which the services employ today. It must possess a command and control structure capable of operating within multiple domains and across multiple echelons while allowing operational units to operate interdependently with shared knowledge in a contested area. US forces can continue to operate by understanding commander’s intent and guidance through mission directives or orders. But command and control structure must be adaptive

and responsive enough to support decentralized execution with authorities delegated to the lowest echelon practical.

This shift in perspective will involve much more than simply material changes involving technology. Indeed, this is a completely different way of thinking about how the US and its allies will use weapon systems in the future. Transitioning from industrial age, platform-centric methods of force employment to an interconnected, information-driven model presents numerous challenges:

- Doctrine, organization, training, material, leadership, personnel and education, facilities, and policy will require review and appropriate changes to define a “template” to guide modernization policy, acquisition, and concepts of operation.
- The military services must develop collaborative structures for operations and reliable, robust, and anti-jam data connectivity with automated, multi-level security to ensure coalition participation.
- Finally, we must move from measures of merit based on cost per-unit to cost per-desired effect, and eliminating the stove piping of kinetic and non-kinetic options, creating a sufficiently diverse approach to employment to avoid single points of failure.

The central idea of this change is cross-domain synergy. The complementary employment of capabilities in different domains, instead of

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merely additive employment, is the goal—such that each capability enhances the effectiveness of the whole, and compensates for the vulnerabilities of other assets. This combined approach will lead to the integration of existing and future operations across all domains with an agile operational framework guided by human understanding.

If the US and its allies are going to win the next war, we need to gain persistent access to data networks while denying this same capability to any adversary. To be serious about this effort, military services need to embrace doctrinal and conceptual

changes to how their forces are organized, trained, and equipped. The concept of the combat cloud stands as a framework to empower this vision.

Offensive Operations Against Adversaries in Contested Environments

By definition, contested environments will complicate, if not hinder, the ability of the United States to conduct offensive power projection operations. As potential adversaries expand their modern capabilities, the US' ability to conduct offensive operations will be reduced, especially if we fail to keep pace by inadequately investing both qualitatively and quantitatively in advanced technology. The armed forces of the US can currently achieve any military objective they are given, but the sacrifice in casualties our service members will have to make to achieve those objectives is increasing. Today the US has the capability to establish a joint integrated air defense system (IADS) and maintain air dominance over the battlespace in a limited engagement or small-scale contingency, but only in small segments of a major regional conflict. As our forces get older, our capabilities relative to modern threats are declining, while investment to reverse these negative trends is still not adequate.

Warfare against an adversary in a significantly contested environment will be very different than the experience of the members of the US military in contemporary conflicts.⁶ Treatises of the recent past on sharing “three cups of tea,” and “eating soup with a knife” will have little applicability in such future conflicts.⁷ To be successful, tomorrow’s combat forces fighting in these environments will need the following capabilities and characteristics:

- The ubiquitous and seamless sharing of information to achieve dominant situational awareness. Building a combat cloud where every weapon system is a sensor as well as an effector will enable the US and its allies to actualize the power of an ISR-strike-maneuver-sustainment complex which must become a fundamental element of warfare in the 21st century.
- Speed, in the context of rapid execution of all functions and operations related to the war.
- The provision of flexibility of response across a wide spectrum of circumstances. Current

defense budgets will not accommodate large increases in personnel and procurement costs. Even if military budgets increase, external realities will still dictate that we must create the capability for broad, flexible response to contingencies.

- Concentration of effects to replace mass. In other words, the focusing of conventional force application, maneuver, offensive and defensive cyber, stealth, speed, and electronic attack as a cohesive whole.
- Unmatched readiness. Future war will happen quickly with no time to play catch up. The US and its allies need ready forces now if we are going to win in the future. Protracted entanglements degrade readiness. We should engage overseas in selective narrowly defined missions, and then depart when our objectives are met.

Capabilities from any domain can contribute to precision effects in and across all five domains. In order to maximize operational agility against advanced adversaries, actions must be designed to include integrated operations and effects in more than one domain.

Warfare is evolving as we transition out of the industrial age and further into the information age. Accordingly, we must be bound by a common appreciation for the value of sharing information as a critical element of national security operations. This is about a vision based on building a combat cloud, and moving beyond combined arms warfare to embrace an approach of “combined effects power”—the kind of combined effects resident in a unified ISR, strike, maneuver, and sustainment complex integrated across the electromagnetic spectrum.⁸

The combat cloud inverts the paradigm of combined arms warfare, making information the focal point, not the traditional domains in which the military operates. This concept represents an evolution where individually networked platforms—in any domain—transform into a “system of systems” enterprise, integrated by domain and mission-agnostic linkages.

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than one domain. For example, the application of precision rocket artillery is part of the joint solution to battlefield success. It is more important to fully understand how we use it in an interdependent way. This and other desired effects must be well timed, synchronized, immediately assessable, and scalable. American soldiers, sailors, airmen, and marines must collaborate with joint and coalition counterparts and with networked experts worldwide to synthesize combinations of kinetic/non-kinetic, lethal/non-lethal, direct/indirect, and permanent/reversible effects to effectively and efficiently strike targets in hours, minutes, or seconds.

To succeed against an adversary in a contested environment, we must encourage the DOD to develop and embrace concepts that have as their basis the linking of information-age aerospace systems with cyber, sea, and land-based capabilities in ways that will enhance their combined effectiveness, while compensating for their individual vulnerabilities.

Warfare in the future will by necessity become more disaggregated than in the past. The US and its allies must train to fight effectively in a much more decentralized and degraded set of conditions than we have become accustomed to over the past 16 years. We need to reverse the culture of “mother, may I?” force application that was enabled by operations in permissive and uncontested airspace since 9/11, and empower combatants with execution authority—authority that they will need to survive and succeed in future contested environments. Senior commanders will need to provide guidance regarding desired effects of a campaign, and then empower individuals to fight using the tools and techniques that they know how to best employ to accomplish mission intent—in other words, the US military must move away from mission micromanagement to the construct of mission command.⁹

The commander’s intent needs to be understood by all the warfighting elements so that if they are disconnected they can still fight and contribute to the overall mission commander’s objectives until they are able to reestablish connectivity. Such ability to operate in degraded structures is essential, and must be part of our training processes.

Key Attributes of a Modern, Fully Integrated, Joint Air-Ground Task Force

Over the last quarter-century that the US has dominated military operations, our air forces have been fighting in and around relatively permissive airspace. Similarly, our ground forces have been engaged in counterinsurgency and counterterrorism fights with little exposure to modern high-tech threats. Combat operations against peer and near-peer competitors in heavily contested environments will demand a new, more agile, and integrated operational framework for the employment of US military power to succeed. While terrorism and insurgencies have proliferated more than traditional conventional combat since the 9/11 terror attacks, a failure to be ready for state on state warfare would be catastrophic. We must be ready to engage and succeed across the entire spectrum of conflict.

Standoff ranges imposed by area denial capabilities degrade the effectiveness of long-range sensors in a highly contested environment.

To overcome these limitations, the US Air Force must build an integrated network of air, space, and cyberspace-based capabilities and leverage other service contributions from all domains to achieve a robust, reliable, redundant, sustainable means of sensing, commanding and controlling, and employing effects to meet mission objectives. Underlying this set of capabilities is the combat cloud operating paradigm. This

vision will enable more rapid and effective decisions at the tactical, operational, and strategic levels of war and will provide an operating advantage that will be difficult for any adversary to overcome.

Key capability development areas in the Air Force specifically need investment to achieve this operating paradigm. They include:

- *Data-to-Decision*: The objective is to fuse data from cloud-based sensor-effector networks into decision quality information for use at the tactical as well as operational levels of war. Machine-to-machine automation and artificial intelligence will be integral to allow for the rapid turning of data into information and knowledge to informed decision making.

Big data analytics; incorporation of all-source information; and sensor-to-sensor cueing must become the norm.

- *ISR Collect and Persistent ISR*: These are capabilities that focus on multi-domain alternatives for placing the right sensor in the right place at the right time.
- *Penetrating Counter-Air (PCA)*: PCA aims to maximize tradeoffs between range, payload, survivability, lethality, affordability, and supportability to achieve penetrating counter-air effects in contested environments. We must establish PCA as a network nodal element to relay data from penetrating sensors enabling the employment of standoff or stand-in weapons.
- *Agile Communications*: This is the increase in the resiliency and adaptability of integrated networks. Our focus must be on responsive, adaptable network architectures with functionality across all platforms, weapons, apertures, and waveforms operating in a highly contested environment.

Each of the US military services are working to create architectures to rapidly sense, collect, process, and analyze data; turn this data into knowledge; and then disseminate it among their component forces to create desired effects. The DOD vision must be to integrate each of the service architectures to create a completely integrated combat cloud where information and knowledge is shared in a ubiquitous and seamless fashion across service organizations.

A fully integrated joint air-ground theater joint task force capable of decisive offensive campaigns must be capable of disrupting key adversary systems, especially air defenses. A prerequisite to effective joint operations—a sine qua non—is the need to gain and maintain air superiority. In all recent operations, we have gained air superiority rapidly and have not faced threats denying us freedom of action. In a contested environment, air superiority will be continuously important and will pace all other operations.

The recently released USAF Air Superiority 2030 Flight Plan states that the Air Force's projected force structure in 2030 "is not capable of fighting and winning against the array of potential adversary capabilities" now being pursued.¹⁰ This

A fully integrated joint air-ground theater joint task force capable of decisive offensive campaigns must be capable of disrupting key adversary systems, especially air defenses.

The US Air Force creates effects in multiple domains. It is essential that the service develop the capability for real-time battlespace command and control to achieve combined effects power for operations in dynamic environments against a near-peer, global power competitor.

is an official statement from the US Air Force, and it should provoke great concern, since without air superiority there can be no successful land (or sea surface) operations against such systems.

Developing and delivering air superiority for the highly contested environment envisioned by 2030 requires a multi-domain focus on capabilities and capacity. Importantly, the rapidly changing operational environment means the military can no longer afford to develop weapon systems on traditional acquisition and development timelines.

Air superiority, as well as other military capability development, requires adaptable, affordable and agile processes with even more collaboration between science and technology, acquisition, requirements and industry professionals than ever before. Failure to adopt agile acquisition approaches is not optional. The traditional approach guarantees adversary cycles will outpace US development, resulting in “late-to-need” delivery of critical warfighting capabilities and technologically superior adversary forces.

The US Air Force creates effects in multiple domains. It is essential that the service develop the capability for real-time battlespace command and control to achieve combined effects power for operations in dynamic environments against a near-peer, global power competitor. Recently Air Force Chief of Staff Gen David Goldfein placed an emphasis on multi-domain C2 to tie these capabilities together more effectively.

The Army and Marine Corps are beginning to pay attention to this construct as well, but all the military services have a long way to go. As this construct grows in capability and acceptance, the US military and DOD also need to look at the notion of an “information strategist.” With all of these data streams available, who decides in a real-time fashion how priorities rank?

Many information architectures remain stove piped without adequate “translators” and security permissions to move information between them. Network examples include the Link-16, IFDL,

TTNT, MADL, and JALN datalinks. These are useful datalink systems, but the military services developed each of them in a stand-alone manner, without an overarching construct to ensure joint or allied partner interoperability, much less interdependency. Establishing the combat cloud as the operational template for various linkages will afford a basis of interoperability and (more importantly) interdependency, allowing the US military services to normalize existing systems, guide development on emerging programs, and establish common requirements.

The Reconnaissance Strike Group Concept

The Reconnaissance Strike Group (RSG) organizational construct posited by Col Doug Macgregor, US Army (Ret.) is a step in the right direction towards better integrating multi-domain combat effects. This concept would provide the Army an organizational entity that at its core is interdependent with the other service components, particularly the Air Force, for its success. Conversely, it provides the impetus to the other services to develop and provide capabilities to dramatically enhance the effectiveness of the RSG as a means to better secure joint task force objectives. Macgregor described the RSG in his testimony before the Senate AirLand Subcommittee in March of 2017:

“Formations on land need to look a lot more like ships at sea, because we have the ability within these formations to build an ISR strike construct that can be linked to larger constructs in the other services—an integrated structure organized around ISR, strike, maneuver, and sustainment. The RSG is a testbed that can provide us with a roadmap into the future for a different kind of formation designed for a form of warfare that is now emerging as a result of dramatic advances in technology and changes in the international environment. We need to leverage what already works in the other services. If we do this thing properly—prototype the platforms, use new communications technology, involve the Air Force and the Navy—we are going to discover what we don’t need anymore, things that we can shed. We can also discover what it is that we need that we don’t have, only if we put these things into the hands of soldiers and say ‘Tell us what this does. Show us how this works.’ They will come back and

The US and its allies have to be prepared for adversary attacks that degrade the ability for military forces to exchange information.

tell you what the answer is. That answer may or may not be popular with the status quo, but it's the answer that we have to find. Parallel to all arms, all effects joint warfare, we need the C2 structure to develop simultaneously so that we end up in three to eight years with the solutions."¹¹

Macgregor's concept boils down to information exchange, both in terms of being aware of what's going on and then being able to capitalize on forces that are part of the RSG or Air Forces that are operating in the vicinity. For example, the RSG will have rocket artillery, loitering munitions, and automatic mortars that can reinforce and magnify the striking power of aircraft, both manned and unmanned.

The Challenges of Deploying, Employing, and Sustaining Expeditionary Forces Across the Globe

These more flexible and agile concepts reflect the demands of modern warfare in a global era, where the US and its allies must be able to project force around the world quickly and decisively, and sustain these forces as needed. The major challenges of deploying and sustaining expeditionary forces across the globe are twofold:

First, there is the difference in the nature of air and land forces. Air forces can be rapidly deployed and employed anywhere in the world in a matter of hours even from thousands of miles away. Land forces, unless pre-deployed to the specific area of concern, take weeks or months to deploy depending on the size of the force elements required.

Second, the explosive growth in the ease and speed at which ideas and technologies are created and spread around the world has yielded a new, more unpredictable threat environment. Rapid advancements in the capabilities of our potential adversaries, notably in electronic warfare, cyber, drones, counter-space, and long-range precision attack all present unique challenges and expose vulnerabilities. The US' ability to deploy and sustain forces to areas needed for deterring or countering malicious actors or adversaries is becoming ever-more contested and subject to reach by surface-to-surface and surface-to-air weapons.

The US and its allies have to be prepared for adversary attacks that degrade the ability for military forces to exchange information. The US military has been carrying out such training for years, in exercises such as the Red Flag large force employment event. Initially, US Air Force aircraft train with full use of their radios, but as the training progresses they encounter increased jamming, requiring them to complete their missions without reliable communications. There is good reason for this training scenario. Potential adversaries are developing capabilities to degrade American GPS-based precision, navigation and timing (PNT) capabilities, but measures and capabilities to account for this possibility are now being taken.¹²

The spread of advanced technologies, enhanced by rapid advances in computing power, places increasingly sophisticated ballistic and cruise missiles, integrated air defense systems, submarines, anti-ship missiles, guided rockets, fourth and fifth-generation aircraft, as well as advanced space and cyber capabilities in the hands of potential adversaries. The range and scale of possible effects with these new capabilities present a new military problem set that threatens the US and allied expeditionary warfare model of power projection, freedom of action, and maneuver.

The necessity of deploying and sustaining expeditionary forces across the globe is absolutely fundamental to US national security strategy. In the most demanding contested combat scenarios, the US will be challenged to do what it has become accustomed to doing: building up combat power in an area, sustaining that force, performing detailed rehearsals and integration activities, and then conducting operations when and where desired.

As far back as 2000 it was suggested that the US military consider teaming Army warfighting units with Air Force Air Expeditionary Forces (AEFs) specifically for this purpose. The Army's response at the time was that it was a garrison-based force, and did not need to train for, or practice, expeditionary deployments. The post September 11, 2001 world, however, changed that perspective.

AEFs provide joint force commanders with ready and complete air and space forces to execute their plans. They can also serve as a construct for

EW is no longer just an enabling capability, it is a survival capability.

better teaming with the Army on a regular and recurring basis to organize, prepare, and train together so when it does come time to fight, our air and land forces present seamless capability. Today it is common practice for airmen, soldiers, sailors, and marines to join together for the first-time in the battlespace. US forces need to train as integrated fighting forces. We must create combat structures wherein our forces inherently rely on one another for maximum advantage, and train them to operate in those structures well before they deploy to fight.

With the potential of the interdependent RSG, and its ISR and strike components that parallel Air Force capabilities, it may be time to move toward greater air land interdependency by aligning RSGs with AEFs at some point in the future. RSG's are characterized as lighter, more agile, more mobile, and more interoperable than current Army warfighting organizational structures allow. This opens the possibility of greater synergy with the air, space, and cyber capabilities of the Air Force. RSGs matched with AEFs could provide the basis for a step increase in the partnership between air and land force organizations in the future.

The Air Force and Army air defense organizations have a very good working relationship in our current combined air operations centers (CAOCs) where the combined/joint force air component commander is also the area air defense authority. Planning for joint air defense in a location such as the Korean Peninsula and high threat areas of Southwest Asia is critical, but we need greater upfront integration of effort elsewhere. Implementation of the RSG concept would drive more interest on both the part of the Army and the Air Force because of the interdependent nature of the RSG.

Getting There from Here: Requirements to Realize the Vision _____

The past several decades since the end of the Cold War have been defined by cutbacks to military force structure, sometimes known as the "peace dividend." The road back to a having a US military capable of carrying out a robust national security policy in an era of growing, capable, and

complex threats will be long and expensive, but necessary. The costs of not taking action are far greater. The following are the key areas that require immediate attention to meet the future demands of US national security objectives.

Electronic Warfare: Long Overdue for Investment

The proliferation of high-end electronics has made offensive cyber operations and electronic warfare (EW) capabilities the modern military equalizers. Potential opponents capable of creating significantly contested combat environments are capitalizing on EW tools and techniques to do so. Russia is now routinely attacking Ukraine and the Baltic states via the Internet. As a nation, the United States is losing hundreds of billions of dollars a year of commercial and military value via Internet thefts and industrial espionage. Many of China's newest weapons systems look eerily familiar to US systems to a casual observer. They should, they are based on stolen US designs.

EW is no longer just an enabling capability, it is a survival capability. Despite this, getting traction in the DOD for electronic warfare requirements and investment is painfully slow and inadequate to properly prepare the US for the future. The DOD electronic warfare strategy states in its introduction that the EW work force is currently fragmented and ill-equipped to dominate a pacing competitor.¹³ In 2014 the Defense Science Board highlighted the insufficient attention paid to EW by all military branches, and recommended a 75 percent markup in EW investments over the next 5 years: from three billion dollars a year to over five billion a year. The Air Force is addressing this requirement by planning its EW force construct in its Air Superiority 2030 Flight Plan. The Air Force Deputy Chief of Staff (DCS) for Operations is championing EW, supported with effective plans and programs. It is key to the future success of the Air Force and joint force operations in the contested environments of the future.

In order to realize the EW capabilities that the nation needs, we should focus on accomplishing the following in the coming years:

- Accelerate the stand up of US Cyber Command (CYBERCOM) as a separate Unified Combatant Command.

Today the Air Force has 24th Air Force assigned to Air Force Space Command (AFSPC), yet 24th AF is responsible for cyber operations that permeate all aspects of every major command in the Air Force.

- Learn how to use the application of accurate, compelling information as a core element of the American security apparatus.
- Stand up a major command in the US Air Force that integrates ISR, cyber operations, and electronic warfare. Today the Air Force has 24th Air Force assigned to Air Force Space Command (AFSPC), yet 24th AF is responsible for cyber operations that permeate all aspects of every major command in the Air Force. Likewise, the Air Force has 25th AF assigned to Air Combat Command, yet it is responsible for ISR operations that permeate all aspects of every major command in the Air Force. An “Electronic Effects Command” as a major command in the Air Force that combines 24th and 25th Air Forces, and incorporates the planning and programming responsibility for EW as well, would go a long way in moving the Air Force into the information age. This would recognize information as an integral part of warfighting, not just support, and would provide a critically needed operational champion for actualizing information age constructs like the combat cloud.

Other Technologies with Potential

Several other areas of technology warrant further investment to realize more effective combined effects operations.

- The explosion of remotely operated vehicles, both airborne and on the ground, is an area of great potential.
- The US must continue to exploit the advantages of the persistence of remotely piloted aircraft (RPA). These assets provide the US the most ethical oversight options before weapons employment is considered, and are the most precise means of employing force at a distance. The Air Force is already pursuing the concept of the “loyal wingman,” in which RPA can act as weapons “mules” carrying additional weapons and other effects capabilities, and could leverage aircraft like F-35s, F-22s, and B-21s. Those sensor-effectors could control a series of RPA to amplify their effectiveness in a particular operation.

- While still challenged by the limitation and restriction of directed energy beams inside the atmosphere, there are very successful applications for directed energy across short distances. The use of microwaves in a close-in environment as a non-lethal means to render an adversary’s ground forces incapable of fighting holds great promise.

Required Force Structure

In light of trends and the challenges laid out in this paper, some ten Air Expeditionary Forces could provide the force-sizing framework to achieve sufficient expeditionary aerospace power to sustain rotational needs and personnel tempos to meet the requirements of the US national security strategy. The key to Air Force expeditionary force structure is to ensure that those ten AEFs are structured, equipped, and equivalent in capability and capacity for each of the Air Force’s mission areas: gaining control of air, space, and cyberspace; holding targets at risk around the world; providing responsive global integrated ISR; rapidly transporting people and equipment across the globe; and underpinning each of these unique contributions with robust, reliable, and redundant global command and control. However, air and space capability is not wholly defined by expeditionary forces. Nuclear deterrence, space and cyber operations, national missile defense, intelligence, and infrastructure are but a few of the enabling functions that provide the foundation the AEF structure stands on.

To meet the nation’s security challenges of the future, the Air Force will require sufficient force structure to maintain both an adequate rotational base of expeditionary capabilities in addition to the foundational capabilities required to meet national security objectives. That level of force structure does not exist today, however. The Air Force does not have ten equally capable AEFs currently, thus it must “borrow” forces in training to make AEFs that are deploying whole.

The Air Force does not approach force presentation in the same rigid manner that the other armed services do. The major combat elements of the US Navy are directed by Title 10 US Code § 5062: “The naval combat forces of the Navy shall include not less than eleven operational aircraft carriers.” In contrast, the Air

Force is a highly agile and tailorable force designed to respond rapidly to achieve desired effects. As such, its force presentation model is not as easily defined. Airpower is ideally suited to fighting over long distances in highly complex environments. The responsive and agile nature of airpower drives the Air Force to prioritize its programming by way of DOD's Defense Planning Guidance (DPG) document, regarding the timing and strategy in different theaters.

Until the turn of the century, the DOD had two concepts it used to identify force structure requirements: the planning force and the

programming force. The planning force dictated the number and type of forces spelled out by the combatant command war plans, numbers unconstrained by the budget. The programming force dictated the number and type of forces allowed by current budget constraints. The difference between the two numbers represented the risk that the US would accept by not fully funding the planning force requirements. The planning force concept was dropped because it became apparent that there would never be funding for that

level of force structure. As expected, only using the programming force number eventually led to the incorrect assumption that the force that was funded is the force that is needed.

Historically, the Air Force Air and Space Expeditionary Force (AEF) construct was used as a means of force management to allocate force structure to meet demands of overseas contingencies. It could also be used as a force planning tool for the Air Force. The AEF provides the Air Force a means to clearly show the force structure requirements necessary to address the two enduring aspects of US National Security Strategy that have endured over the years. First, it allows airmen to show and quantify the US military air forces required for deployment around the world in a peacetime environment, for shaping and pre-conflict scenarios. Second, if conflict is unavoidable, the AEF construct can be used to mobilize the force structure required to fight

and win in more than one regional conflict at a time. To meet the first requirement, the Air Force created a rotational base of 10 AEFs that were sufficient for sustained peacetime operations. To meet the second demand, 10 AEFs comprise the rotational base. A typical major regional conflict historically would require about five AEF's worth of USAF force structure; Therefore, 10 AEFs are required for the Air Force to be prepared to successfully conduct two major regional conflicts simultaneously, per the second requirement of the US National Security Strategy.

The AEF construct was used one time as a force-sizing mechanism, and helped calculate the military requirement of the F-22 force, which yielded an objective force of 381 aircraft.¹⁴ The decision to terminate F-22 procurement at less than half of that number has had far-reaching negative effects. To correct this shortfall the Air Force will need to accelerate its plans to build and develop a Penetrating Counter-Air (PCA) aircraft. In the future, applying the AEF as a force-sizing construct with respect to long-range strike capability—particularly in a contested combat environment—will yield a minimum of one squadron of B-21s per AEF, or 174 aircraft in total.¹⁵

The Air Force will also need sufficient numbers of advanced munitions to prevail in the high-end fights of the future, and assure necessary force projection capability. Today's counter-terrorism wars have caused severe shortages of several types of munitions, and more high threat contingencies may require more sophisticated munitions in larger numbers. The US also needs to pay attention to the numbers and capabilities of the people required to accurately target these advanced weapons, as the stresses on activities such as targeting have grown. In Desert Storm, only five percent of all weapons employed were precision-guided. Today, precision weapons make up over 95 percent of total employment from US combat aircraft. However, only one third of USAF targeteers are now in the intelligence force compared to the number of targeteers used in Desert Storm.

A Budget: The *Sine Qua Non* of the US Military

The needed capabilities addressed above are going unfunded today because there is little public awareness of the problems inherent in the reduction

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of defense resources. As a result, the hollow force that the 2011 Budget Control Act (BCA) and sequestration imposed will not be readily apparent until those forces are required. The BCA's timing was devastating. It came into effect during a period of rapidly increasing threats to US security, and exacerbated a growing strategy-resource mismatch. The dichotomy between what the United States says we want to accomplish, and what we can actually accomplish is growing. Without action to eliminate sequestration, that mismatch will get worse. It is important to remember that the first responsibility of the United States government is the security of the American people.

The most important element in the US military's ability to fight and win in any conflict in the future, much less against one in a significantly contested environment, is restoring the readiness

that has been robbed from it by the BCA. No amount of innovation, reorganization, or restructuring will allow the US military to succeed in meeting its national security objectives without the proper equipment, tools, people, and training essential to execute its assigned missions. Air Force Chief of Staff Gen David Goldfein succinctly described the criticality of the role of the Congress in this

regard when he stated, "There is no enemy on the planet than can do more damage to the United States Air Force than us not getting a budget."¹⁶

The US military's aerospace capabilities have reached an inflection point. In early 2018, the United States and its allies mark the 27th anniversary of Operation Desert Storm—the first Gulf War. The Air Force has been at war not just since September 2001, but truly since January 16, 1991. Twenty seven years of continuous combat operations, coupled with budget instability and lower-than-planned budget top lines have reduced the Air Force to the smallest, the oldest, and the least ready force in its entire history. In the 1970s, nearly half of the US military's airplanes could not fly because there were no spare parts and proper maintenance. It is just as bad today: The Air Force now has 59 percent fewer fighter squadrons than

during Operation Desert Storm in 1991 (134 in 1991, 55 today). The Air Force also has 30 percent fewer people, and 37 percent fewer aircraft.

The Air Force is operating a geriatric force, growing older by the day. By the time President Ronald Reagan took office, pledging to rebuild the military from the "hollow force" era of the 1970s, Air Force aircraft averaged 12 years old. Today the average age of Air Force aircraft is 28 years. Bombers and tankers average over 50 years of age, trainers over 40, fighters and helicopters over 30. For comparison, the average age of the commercial US airline fleet is about 10 years, and these aircraft do not face the same stresses as frontline combat aircraft.

The US faces an expanding set of threats around the globe, each of these threats increase the demand for aerospace power, while the United States government continues to fund fewer resources to meet them.¹⁷ From 2009 to 2018, the US military will have sustained budget cuts totaling over \$1.5 trillion dollars. The Air Force has had to deal with unpredictable and eroding budgets that have shrunk both its force structure and the defense industrial base upon which it heavily relies. Many of these cuts do not reflect any strategy or analysis, and appear arbitrary. Meanwhile, the demand for aerospace power keeps growing. This is perhaps the greatest challenge to deploying and sustaining expeditionary forces across the globe.

The Hidden Costs of Doing Nothing: A Historical Example

Failure to invest in promising technologies often exacts tremendous opportunity costs seldom recognized by shortsighted leaders.

For example, the Mach three B-70 Valkyrie bomber was slated to replace the B-52 by 1970. It was cancelled in 1961 because piloted bombers were expected to soon become obsolete, a prediction that has fallen a bit short of reality.¹⁸

The B-1A was the next aircraft intended to replace the B-52 in the 1970s. An excellent aircraft, it won the coveted Collier Trophy in 1976 for "the greatest achievement in aeronautics or astronautics in America."¹⁹ However, the program was cancelled a year later, the given reason being that the still conceptual stealth bomber was expected to be far superior. When the stealth bomber failed to

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Just as combat tomorrow will look different than it did yesterday, so too should the military with which we prosecute it.

materialize in a timely fashion, the B-1 program was restarted. Only 100 were built, though—too few to replace the B-52.²⁰

When the B-2 stealth bomber finally materialized at the end of the Cold War after enormous investment, Congress slashed its planned production from 132 aircraft to just 21, again a number woefully insufficient to replace the B-52.²¹

Today, the Air Force hopes that the B-21 Raider will finally retire the B-52. Some Air Force pilots are flying the same B-52 bombers that their grandfathers flew 50 years ago, not because something better was unavailable, but because successive generations of civilian leaders chose to “kick the can” and delay important decisions repeatedly. The US Air Force, and the Department of Defense, can no longer afford to ignore the opportunity costs of doing nothing.

Conclusion

“The most important failure was one of imagination. We do not believe leaders understood the gravity of the threat.”

Final Report of the National Commission on Terrorist Attacks Upon the United States²²

The challenge before the United States is to transform today to dominate an operational environment that is rapidly evolving, and to counter potential adversaries who are rapidly advancing in capability. Another “failure of imagination” such as the one that preceded the 9/11 attacks cannot be repeated.

It is time for new thinking. In the face of disruptive innovation and cultural change, the military and national security bureaucracy can maintain the status quo, or it can embrace and exploit change. The latter is preferred. The US

military services need to learn better how to rapidly adapt new technology to the innovative concepts of operation that technology enables. At the same time, the US intelligence community, military, and other security institutions will suffer if their internal organizations fail to adapt to new, disruptive innovations and concepts of operation.

Just as combat tomorrow will look different than it did yesterday, so too should the military with which we prosecute it. The US should take maximum advantage of the asymmetric capabilities America possesses with its air, space, and cyber forces operating in conjunction with land and maritime forces in innovative ways. A concerted focus on further developing and expanding the interdependency of these forces would serve the United States well, as they are uniquely positioned to underpin the kind of defense strategy and force structure needed to face the US’ future security challenges.

One of the most significant challenges facing the United States is the structural and cultural barriers that stifle new ideas that challenge the status quo. That is the challenge for not just the US military, but for all the other pillars of the national security architecture. We must challenge our institutions to have an appetite for innovation—and foster a culture that rewards innovative solutions. We must embolden our military to seek out, experiment, and test new concepts of organization and operation.

In the end, leadership must rise to the challenge. We should incentivize the services to work together to assure compatibility and interoperability, and have them avoid diverging onto different paths by encouraging interdependency. If the Secretary of Defense and the Chairman of the Joint Chiefs of Staff make this effort one of their top priorities, the services will inevitably follow. ✪

Endnotes

- 1 Author's note: This paper is based on the testimony of Lt Gen David A. Deptula, USAF (Ret.), presented at a hearing titled "The Future of All Arms Warfare in the 21st Century," hosted by the US Senate Armed Services Committee Subcommittee on Airland, March 15, 2017. Deptula's complete testimony and statement for the record can be found archived at the Senate Armed Services Committee's website here: <https://www.armed-services.senate.gov/hearings/17-03-15-all-arms-warfare-in-the-21st-century> (All web links accessed in February, 2018).
- 2 Thomas S. Kuhn, *The Structure of Scientific Revolutions*, University of Chicago Press, 1962.
- 3 Author's note: For an elaboration on the concept of combined effects power see, Ervin J. Rokke, Thomas A. Drohan, and Terry C. Pierce, "Combined Effects Power," *Joint Forces Quarterly*, No. 73, Second Quarter 2014, <http://ndupress.ndu.edu/JFQ/Joint-Force-Quarterly-73/Article/577501/combined-effects-power/>.
- 4 Lt Gen David A. Deptula, USAF (Ret.), "Beyond Goldwater-Nichols: Roles and Missions of The Armed Services In The 21st Century," *Mitchell Institute Policy Papers*, Vol. 1, March 2016, Mitchell Institute for Aerospace Studies, http://docs.wixstatic.com/ugd/a2dd91_1cf552c303cd4daeb637287f05635237.pdf.
- 5 Price T. Bingham, "The Urgent Necessity to Reverse Service AirLand Roles," *Joint Forces Quarterly*, No. 84, First Quarter 2017.
- 6 Author's note: By many estimates, over 80 percent of the active duty US military has joined the service since September 2001, so their experience is primarily in the counterinsurgency and counterterrorism environments of Iraq, Afghanistan, and other War on Terrorism campaigns.
- 7 Author's note: Books such as *Three Cups of Tea: One Man's Mission to Promote Peace - One School at a Time* by Greg Mortensen, and *Learning to Eat Soup with a Knife: Counterinsurgency Lesson from Malaya and Vietnam* by John Nagl were popular among national security professionals in the post-9/11 period, and helped reinforce the primacy of counterinsurgency warfare in the first decade of the 21st century.
- 8 Rokke, Drohan, Pierce, "Combined Effects Power," *Joint Forces Quarterly*, 2nd Quarter 2014.
- 9 Author's note: For more elaboration on mission command see, James D. Sharpe Jr. and Thomas E. Creviston, "Understanding Mission Command," *Army Sustainment*, July-September 2013, p 10-13, http://www.alu.army.mil/alog/PDF/JulySept2013/Jul_Sep2013.pdf.
- 10 US Air Force, *Air Superiority 2030 Flight Plan: Enterprise Capability Collaboration Team*, May 2016.
- 11 Author's note: This information came from a briefing on the Reconnaissance Strike Group (RSG) as presented in the Fiscal Year 2017 National Defense Authorization Bill, October 31, 2016.
- 12 US Army, "Assured Positioning, Navigation and Timing," US Army Communications-Electronics Research, Development and Engineering Center (CERDEC), https://www.cerdec.army.mil/inside_cerdec/core_technology/apnt/.
- 13 Deptula, "The Future of All Arms Warfare in the 21st Century," Statement Before the Senate Armed Services Subcommittee on Airland (Washington, D.C.: US Senate, March 15, 2017), 9.
- 14 Author's note: The Air Expeditionary Force construct was used as a force-sizing mechanism for calculating the required number of F-22s: one squadron contains 24 aircraft. One squadron per AEF means 240 combat-coded F-22s. Adding another 25-percent for training aircraft, plus 10 percent for attrition reserve, 10 percent for backup aircraft inventory, and 5-percent for required test flights yields a grand total of 381 F-22s.
- 15 Author's note: Applying this method to calculate the required number of B-21 Raider aircraft yields 174 aircraft. This represents one squadron with 12 B-21s per AEF, totaling 120 Combat Coded B-21s, plus 25 percent for training (30), 10 percent for attrition reserve (12), and 10 percent for backup aircraft inventory (12).
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- 17 Author's note: In 2009, the US spent 4.6 percent of its gross domestic product (GDP) on defense related expenditures. By 2017 the US spent 3.2 percent of its gross domestic product (GDP) on defense.
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About the Author

Lt Gen David Deptula, USAF (Ret.), is dean of the Mitchell Institute for Aerospace Studies, and a decorated military leader with decades of experience in both combat and leadership roles in major joint contingency operations. He has planned, flown, and commanded air operations ranging from humanitarian relief efforts, to small-scale contingencies, to major theater war. Deptula served as the principal air attack planner for Operation Desert Storm in 1991; was a joint task force commander in Iraq from 1998 to 1999; led the initial air campaign of Operation Enduring Freedom in late 2001, and led several other significant joint military operations. Deptula retired after 34 years on active duty, serving in his last assignment as the US Air Force's first deputy chief of staff for intelligence, surveillance, and reconnaissance. He is a prolific author on aerospace power, and a thought leader on defense, strategy, and ISR.

