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ALL ARMS WARFARE IN THE 21ST CENTURY

HEARING

BEFORE THE

SUBCOMMITTEE ON AIRLAND

OF THE

COMMITTEE ON ARMED SERVICES
UNITED STATES SENATE

ONE HUNDRED FIFTEENTH CONGRESS

FIRST SESSION

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ALL ARMS WARFARE IN THE 21ST CENTURY

WEDNESDAY, MARCH 15, 2017

U.S. SENATE,
SUBCOMMITTEE ON AIRLAND,
COMMITTEE ON ARMED SERVICES,
Washington, DC.

The subcommittee met, pursuant to notice, at 3:44 p.m. in Room SR–232A, Russell Senate Office Building, Senator Tom Cotton, chairman of the subcommittee, presiding.

Committee members present: Senators Cotton, Cruz, King, Donnelly, Warren, and Peters.

OPENING STATEMENT OF SENATOR TOM COTTON

Senator COTTON. The hearing will come to order.

Good afternoon, everyone. Welcome to the first hearing of the Airland Subcommittee of 2017.

Today we are going to discuss all arms warfare in the 21st Century, and we are going to hear from a distinguished group of soldier statesmen. We have retired Air Force Lieutenant General David Deptula, who is now the Dean of the Mitchell Institute of Aerospace Studies. Next, we have retired Army Colonel Douglas Macgregor, who is now Executive Vice President of the Burke-Macgregor Group. Finally, we have Mr. Paul Scharre, a senior fellow and Director of the Future of Warfare Initiative at the Center for a New American Security. I want to thank you gentlemen for your service and thank you all for agreeing to join us here today.

As I mentioned, the purpose of the hearing is to understand what all arms warfare might look like in the 21st Century. We are trying to figure out what the battlefield of tomorrow would demand, what will our soldiers and our airmen need to win, what will be the margin of victory. These are basic questions, but as we have learned, that does not mean they are any easier to answer.

The shear variety of threats is so vast that it seems the only thing that unites them is what it will take to defeat them: a highly agile and flexible United States Military.

I think back to Jim Woolsey, the former CIA [Central Intelligence Agency] Director, and something he said years ago. It was 1993, just a few years after the Berlin Wall had fallen, and he was testifying before Congress as part of his confirmation hearings. He said, in many ways, today's threats are harder to observe and understand than the one that was once presented by the USSR [Union of Soviet Socialist Republics]. Yes, we have slain a large dragon, but we live in a jungle filled with a bewildering variety of

poisonous snakes. I thought that was very well put at the time and today as well.

I might add we have been fighting one of those snakes for the past 16 years, radical Islamist extremism. It poses a direct threat to American lives, and as far as we can tell, this war will continue well into the foreseeable future.

We also know our Army and our Air Force will be crucial to the fight. Yet, we have been cutting our defense budget for years, and now our ground and air forces are the smallest they have been since the middle of the last century. This is especially concerning because lurking in that jungle of threats are all the same rivals we have been competing with for decades, a resurgent Russia, a newly assertive China, not to mention its temperamental and nuclear-armed ally, North Korea, and an aggressive Iran which is spreading its malign influence across the Middle East. While we have been busy fighting insurgents and terrorists, I am concerned that we have not been doing enough to maintain our overwhelming superiority on the battlefield and potential conflicts with countries like these. If we are going to have any hope of victory against major powers, all of our Military Forces will have to work together seamlessly.

That is why in the late 1970s the Army and the Air Force began developing the airland battle concept. They wanted to figure out how we could defeat a numerically superior adversary on the battlefield. Now, one can debate whether this particular conceptual framework was entirely effective, but there is no debating the need for well-coordinated and integrated forces.

As our rivals get their hands on the latest military technology, it is clear that when it comes to advance weaponry, we are not the only game in town anymore. We have to modernize the airland joint force for the new reality we face. We cannot take it for granted that the joint force will be able to operate anywhere and dominate any environment with minimal amounts of effort. We have to rethink how we project power, including even such seemingly mundane but indispensable things as logistics. This will not happen overnight, but if we invest in new technologies now, our military can make gradual but real gains over the next 5 years. It can also begin to develop a so-called high-low mix of capabilities that can address these emerging threats.

President Trump has said his new administration will embark on a great rebuilding of the armed services of the United States. I think modernizing our airland joint forces should be near the top of the to-do list.

I look forward to the witnesses' testimony.

I note that we have lost my wingman from the last Congress, Joe Manchin, not just to this subcommittee, but the full committee. However, we have gained a new wingman, who has equally impeccable taste in facial hair——

[Laughter.]

Senator COTTON.—Senator Angus King from Maine. Senator King?

STATEMENT OF SENATOR ANGUS S. KING, JR.

Senator KING. Thank you, Mr. Chairman. Thank you for holding the hearing. Since this is my first hearing as ranking member of the Airland Subcommittee, I want to say that I am honored and excited to be serving in this role. I appreciate the leadership Senator Cotton has provided based upon his experience and the work that he has already done, and I look forward to working with him on this committee. We have already had several discussions about how we wish to proceed.

I also want to welcome our witnesses today. I thank them for their testimony and look forward to hearing and exchanging views with you as this hearing goes forward.

As the subcommittee examines the future of all arms warfare, we must remember that the threats facing the U.S., as the chairman alluded, are complex and multifaceted. One of the major challenges our military will face in the coming decades is ensuring they are ready and capable of fighting across an entire spectrum of operations. Indeed, that spectrum seems to grow every day.

For over a decade and a half since the September 11th attacks, the U.S. Military has been heavily engaged in counterterrorism, counterinsurgency, and stability operations. Only recently have we begun to refocus on the potential for high-end conflict with a near-peer competitor or a conflict in a hybrid warfare situation. As we have seen with Russian action against Ukraine and the Islamic State in Iraq and Syria, hybrid warfare has become more commonplace. It has huge implications for the U.S. Military.

For example, in a future conflict, the United States may not engage directly with a near-peer competitor such as China or Russia, but could face proxy forces supplied with their advanced weaponry and supported by their sophisticated cyber and information warfare capabilities. The full spectrum of conflicts our armed forces must be prepared to face in the coming decades requires new warfighting concepts and potentially reorganizing the military to make it more adaptable and lethal in a future fight.

As we consider these issues, it seems to me we need to keep four points in mind.

First, the Trump administration is in the nascent stages of developing a national security strategy that will detail the administration's vision and priorities for U.S. global engagement, including how our military will support those efforts. As the Senate Armed Services Committee considers critical policy issues this year, such as increased end strength, additional force structure, it is critical that we ensure policy changes support our defense posture. If not, we run the risk of creating a hollow force.

Second, our committee has the solemn responsibility to ensure that the men and women who serve in uniform have the equipment and training necessary to safely complete their mission. The Service Chiefs have prioritized restoring full spectrum readiness, which takes time and requires sufficient funding. Furthermore, improving readiness levels also requires that our forces have access to modern and upgraded equipment.

Third, we must be sure that we are preparing for the next war. Cyber, area denial, hybrid conflict tactics, and political sabotage are all part of the 21st Century arsenal. Stubborn adherence to

outmoded or irrelevant strategies, weapons, or structures could be dangerous or worse.

Fourth, we must be mindful of the budget as resources are never unlimited. Significantly increasing defense spending at the expense of other core elements of national security does not guarantee a more effective fighting force. The administration will soon release top line numbers for their fiscal 2018 budget request and, according to news reports, will propose dramatic cuts to the Department of State, USAID [United States Agency for International Development], and other agencies that in my view would seriously compromise our national security.

Therefore, today's hearing is an important precursor for the subcommittee's work this year since our witnesses will raise important questions for our Nation's military as we face the challenge in the 21st Century.

I welcome the thoughts of our witnesses today on the threats facing our country, whether they believe our armed forces are effectively organized and postured to counter those threats, and their recommendations for making the military more capable and lethal in the future.

Mr. Chairman, thank you again for holding the hearing. I look forward to this afternoon's testimony.

Senator COTTON. Thank you.

General Deptula?

STATEMENT OF LIEUTENANT GENERAL DAVID A. DEPTULA, USAF (RETIRED), DEAN OF THE MITCHELL INSTITUTE OF AEROSPACE POWER STUDIES

Mr. DEPTULA. Chairman Cotton, Senator King, members of the Subcommittee on Airland, I am honored and humbled that you invited me here today, and I will keep my comments brief. But with your permission, I offer an extended written version for the record.

In your invitation to speak today, you asked four questions that get to the heart of the challenges our military will face in the future. I answer those in my written testimony, but before discussing them with you here today, I would like to provide just a bit of context about U.S. warfare past, present, and future.

In the past, our military services fought as independent entities. Today that is no longer the case. Since the Goldwater-Nichols Act of 1986, the individual services do not fight. The unified combatant commands do the fighting. The services organize, train, and equip what are called service component forces. These are then assigned to the unified combatant commands to actually conduct operations under a joint task force commander. Said another way, jointness is using the right force at the right place at the right time.

Furthermore, jointness argues against a predetermined or formulaic mix or application of service components because every contingency is different. However, the U.S. Military still has challenges shedding anachronistic warfighting concepts and embracing new ones.

In the future, I would suggest we need to move beyond service interoperability, one of the goals of Goldwater-Nichols, to service interdependency, which means the service components rely on capabilities brought to the fight by other service components.

Now, to best meet the challenges of future peer and near-peer adversaries, we must continue to exploit modern intelligence, surveillance, and reconnaissance, routine precision strike, improvements in survivability, and maneuver by focusing on two key essential actions.

First, unshackle the service-based organizational paradigms of the past and embrace more functional joint organizational constructs that can be achieved by greater integration of these elements. You will hear more on that subject from my colleague, Colonel Macgregor.

Second, rapidly capitalize on the capabilities of the information age to actualize the ubiquitous and seamless sharing of information across systems in every domain as a vision of the Department of Defense. We are just not there yet, and we got a long way to go.

So with that prelude to our subject today, I encourage each of you to embolden our military to seek out, experiment, and test new concepts of organization and operation.

With that, I look forward to your questions.

[The prepared statement of Mr. Deptula follows:]

PREPARED STATEMENT BY DAVID A. DEPTULA, LT GEN, USAF (RETIRED)

INTRODUCTION

Chairman Cotton, Senator King, and members of the Subcommittee, thank you for inviting me to present my thoughts on the critical issue of the future of all arms warfare in the 21st century. Our air and land forces have an extensive history of operating in conjunction with one another to accomplish military objectives. WWII and the Cold War posed some very significant challenges for the members of the greatest generation. As a result of their efforts, the United States prevailed against incredible challenges. It is now up to us to confront our own unique set of circumstances.

Our military situation today is stark. The United States faces a burgeoning number, and a greater spectrum of threats around the globe. At the same time we have declining resources allocated to meeting these threats. To successfully confront this dynamic array of dangers, we must optimize our military organizations and concepts of operation. We must evolve service relationships from ones of *interoperability*—a goal of the Goldwater-Nichols Act, to ones of full integration and *interdependency*. This is the next step in the evolution of our military.

A dollar spent on duplicative capability comes at the expense of essential capacity or capability elsewhere. Confused organizational structures lead to sub-optimal employment of forces already stretched too thin. Outdated service roles, missions, and concepts of operation yield costly, inefficient acquisition programs. Clearly, things have to change—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.

I believe that 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. However, fiscal realities dictate that the military must make difficult choices in balancing near-term operational readiness with longer-term needs. This demands much more clarity regarding goals and desired outcomes, with special emphasis on how we can best project effective, prudent power to negate threats that would oppose us in the 21st century.

Our Department of Defense and military services are conservative institutions. While highly capable they are slow to change, but to operate effectively in the information age, we must develop and capitalize on the new concepts of operation and organizations that new technologies enable. Dr. Thomas Kuhn, renowned American physicist, historian and philosopher, noted 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.[1] We want to change before a crisis occurs, and cannot afford to wait for the "old-guard" to depart.

In 1986 Congress was the outside institution that forced much needed change in the Department of Defense with the Goldwater-Nichols Act. It may be time to consider such action again. I commend Chairman Cotton, Senator King, and the rest of the Airland Subcommittee for beginning this conversation and initiating this series of hearings regarding the future of all arms warfare in the 21st century. It is a much-needed start.

I believe the biggest challenge our defense establishment faces is 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. Our 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 undue risk.

Change with respect to the military 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 produce order-of-magnitude increases in our ability to achieve desired military effects. *Organizational change* codifies changes and enhances our ability to execute our 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 21st Century Security Environment

First, our defense strategy must contend with 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; evil actors of the most despicable nature; and a dynamic web of terrorism.

Second, the pace and tenor of our lives has been irrevocably altered by the acceleration of change. Global trade, travel, and telecommunications have produced major shifts in the way we live. Such developments are not isolated. Speed and complexity have merged, and now *permeate* the conduct of warfare. Consequently, one implication for future air and land warfare operations is that they *must* be able to respond rapidly and decisively anywhere on the globe at any time. As recent events have demonstrated, key security events now unfold in a matter of hours and days, not months or years. The window to influence such circumstances is increasingly fleeting.

Third, we have to contend with increasing personnel and procurement costs at a time when defense budgets are decreasing. Therefore, *the provision of flexibility of response across a wide spectrum of circumstances* should be foremost among the decision criteria we apply to our future military.

Fourth, we should acknowledge that deploying large numbers of American military forces onto foreign soil to nation-build vice accomplishing a defined mission and then leaving is counter-productive to securing our goals. Strategies centered upon occupation expose American vulnerabilities, often result in anti-American backlash and domestic disapproval, and create destabilizing effects within the very state or region they are intended to secure.

Fifth, we must actively pursue and invest in options we can use to counter the increasingly advanced anti-access strategies and technologies our adversaries are developing.

Precision weapons and stealth projected incredible lethality at the end of the Cold War. Those capabilities proliferated, and our adversaries are now equipping themselves with these systems, and seeking greater advancements. One quarter of a century later, it is foolhardy to assume U.S. forces will be afforded freedom of action in future engagements. Our strategies, planning assumptions, acquisition programs, and training need to account for more capable enemies.

Sixth, we need to challenge our adversaries' domination of public perception. We have to learn how to use the application of accurate, compelling information as a core element of our security apparatus. We are woefully inept at strategic communications and too often put ourselves in a reactionary versus proactive position in struggling to gain domestic and international public support.

Finally, information's value also extends past the media. Just as wireless connectivity, personal computing devices, and cloud-based applications are revolutionizing life in the civilian sector; these trends are also altering how our military

[1] Thomas S. Kuhn, *The Structure of Scientific Revolutions,* University of Chicago Press, 1962.

forces project power. Faster and more capable networks and computing capabilities are turning information into the dominant factor in modern warfare. We need to understand that 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. F–22 operations over Syria validate this statement. Given this reality, we must now acknowledge that information and its management are just as important today as the traditional tools of hard military power—airplanes, satellites, infantry, warships. Information is the force evolving all weapon systems from isolated instruments of power into a highly integrated enterprise where the exchange of information and data will determine success or failure in the 21st century.

These facts have major implications throughout the military enterprise, particularly air and land operations—shaping key areas like doctrine, organization, training, materiel acquisition and sustainment, along with command and control. Top 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.

These trends provide a starting point for anticipating the future with which we will have to contend. Bluntly stated, all the services, Department of Defense (DOD) agencies, and the other elements of our national security architecture have been slow to recognize the emerging new security environment. Our focus has remained on traditional weapons platforms. We still have 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. While nuclear threats have not gone away, we need to supplement our traditional focus on combined arms warfare with a broader "lens" that exploits non-kinetic tools and the cyber domain. Excessive emphasis on traditional weapon platforms associated with combined arms warfare runs the danger of underinvesting in emerging non-kinetic instruments. We cannot relive the era of battleship admirals and cavalry generals that dismissed aviation as a passing fad.

Summarizing, 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.

The Cornerstones of the U.S. Military: Services and Combatant Commands

Interservice rivalry is a vivid part of American military history stretching forward from the earliest days of our Republic. The most intense period of competition occurred at the close of World War II. Drawing on the lessons of that war and seeking to address years of agonizing political turmoil fueled by service rivalries, President Truman prodded Congress to pass the National Security Act of 1947 and its first amendment in 1949. This legislation established the fundamental postwar defense organization for the United States. They created, among other entities, a new Department of Defense (DOD), intended to unify the earlier separate Departments of War and Navy, and an independent air force as a third military department within DOD.

In 1958, additional legislation created the unified combatant commands that were designated as the headquarters for the conduct of actual warfare. However, this objective remained theoretical for many years, with the services remaining dominant in all aspects of organization, training, equipping, and planning. Land, sea, and air forces tended to operate autonomously. A service would develop weapons and equipment without regard to their compatibility with that of the other services. Army and Navy communications systems could not talk to one another; equipment was acquired by the Army and Navy that could not be loaded into Air Force cargo planes; and each service had its own doctrine for employing aircraft. This did not change until the Goldwater-Nichols Act of 1986. Its passage was prompted when years of interservice dysfunctionality manifested tragic results during the 1980 Iranian hostage rescue mission and the less than optimal invasion of Grenada three years later.

The Goldwater-Nichols Act was not intended to erase the differences in service philosophies and cultures. However, it was hoped that the unique characteristics and strengths of each service could be molded to complement one another so the whole would be greater than the sum of its parts. Jointness became the mantra of the Armed Forces after passage of the Goldwater-Nichols in 1986. So just what did the Goldwater-Nichols act do? And what is the proper meaning of jointness?

Here are the basics of the Goldwater-Nichols Act. First, no longer do the individual services fight our nation's wars as separate entities—the unified combatant commands do the fighting. The services organize, train, and equip what are called service *component* forces. These are then assigned to the unified combatant commands to actually conduct operations under a joint task force commander. The way America fights essentially boils down to this: individual services organize, train, and

equip to master their principal domains of operation. The combatant commands assemble service and functional components to fight under the unifying vision of a joint force commander. It does not mean four separate services deploy to a fight and simply align under a single commander. It does not mean, "going along to get along." Nor does jointness mean everybody necessarily gets an equal share of the action. Jointness does not mean homogeneity. Jointness means using the right force, at the right place, at the right time—not an equal apportionment of all services.

Joint operations are often misunderstood. The strength in joint operations resides in the *separateness* of the services. Joint force operations create synergies because they capitalize on each services' core functions—skill sets that require much time, effort, and focus to cultivate. It takes 20–25 years to develop a competent division commander, a surface action group commander, a Marine Expeditionary Force commander, or an air and space expeditionary force commander.

The beauty of the joint approach to warfare is that because every contingency will be different, a joint approach allows a joint task force commander to tailor-make a force optimal and unique to the particular contingency at hand. The service component force make-up for Operation Desert Storm (or the first Gulf War) was very much different than that required for Operation Allied Force (the air war over Kosovo and Serbia); which was very much different than that required for Operation Unified Assistance (the South Asia Tsunami relief); which is very much different than that required for Operation Inherent Resolve (the current counter Islamic State operation); and so it will be in the future.

Since the passage of the Goldwater-Nichols Act, a joint approach was first intended to move contingency organizations and operations from independent, de-conflicted, service approaches, to sustained *interoperability.* Today, we need to move beyond interoperability to *interdependency,* which means the service components rely on capabilities brought to the joint fight by other service components. The services must shed their historical predilection for self-sufficiency, or "owning" everything required to fight and win independently. The reason joint task force operations create synergies is because an *interdependent* approach allows each service to focus on, hone, and offer *its* core competencies. Services trying to control everything is unsustainable from a resource perspective and yields sub-optimized, compromised capabilities. Control of all the capabilities in a fight is the role of the combatant commanders when employing forces. It is far better for the services to invest and excel in their respective domains.

This idea is similar to doctors concentrating on healing the sick, and firemen focusing 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, no matter which is needed where—and both of these important tasks are being performed by specialists in their fields. The unfavorable alternative to interdependence is to have firemen also attempting surgical procedures, and physicians darting in and out of blazing structures between seeing patients.

Effective jointness relies upon having *separate* services; it is an *imperative* that service members understand how to best exploit the advantages of operating in their domains. Articulating the virtues and values of a member's service is being "joint." However, when a single service attempts to achieve warfighting *independence* instead of embracing *interdependence,* "jointness" unravels, trust is lessened, warfighting effectiveness is reduced, and costly redundancies and gaps will likely increase. We do not want to reduce the effectiveness of Goldwater-Nichols by allowing services to develop redundant "organic" capabilities, thereby rejecting the premise of joint warfighting.

With a common context of the challenges of the future security environment; the rapid advance of technology and information flow; and a proper understanding of joint operations, I now address the four specific requests for comment by the Subcommittee on the future of all arms warfare in the 21st century, and specifically air-ground operations.

1. An Assessment of the Future of Joint Force Air-Ground Combat Operations Against Peer And Near-Peer Competitors.

Beginning with Operation Desert Storm in 1991, in operations over the next decade, and into the beginning of the 21st Century, nascent joint force operations, combined with advanced technologies and innovative concepts of operations aimed at achieving desired effects, have dominated conventional warfare. As a result, our adversaries and potential peer and near-peer competitors have watched and learned the lessons of what happens if the U.S. is allowed to project power into a region of interest. They have used this time to develop systems, concepts, and organiza-

tions to attempt to deny us in the future the advantages that our military has relied upon for success in the past.

One of the most significant changes in the evolution of modern warfare is the result of the impact of the combination of three technological changes: 1) modern intelligence, reconnaissance, and surveillance (ISR) yielding persistent multi-spectral ISR; 2) the normalization of the use of precision weapons; and 3) the dramatic improvement of system survivability (stealth). This combination has resulted in the reversal of the traditional paradigm of the use of air and ground forces to defeat adversary forces. The traditional warfighting paradigm of ground forces leading the fight supported by air forces has been supplanted by a construct where air forces supported by ground forces is often a much more responsive, effective, efficient, and less costly—in terms of both lives and dollars—manner in which to conduct warfare.[2] Validating this observation, a platoon leader during Operation Iraqi Freedom (Iraq 2003) at the leading edge of the push to Baghdad by the 1st Marine Expeditionary Force, wrote: "For the next hundred miles, all the way to the gates of Baghdad, every palm grove hid Iraqi armor, every field an artillery battery, and every alley an antiaircraft gun or surface-to-air missile launcher. But we never fired a shot. We saw the full effect of American air power. Every one of those fearsome weapons was a blackened hulk."[3]

In the context of this hearing, the point of raising this realization is not to start a doctrinal roles and functions fight between the Army and the Air Force, but rather to highlight the fact that capabilities change over time and the fundamental causes 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 exhibited 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, improvements in survivability, and maneuver by focusing on two key essential actions. First, unshackle the service-based organizational paradigms of the past and embrace more functional joint organizational constructs that can be achieved by greater integration of these elements. Second, rapidly capitalize on the capabilities of the information age to actualize the ubiquitous and seamless sharing of information across systems in every domain as a vision of the Department of Defense.

We are at a critical juncture in history. We are at the center of an, "Information in War Revolution" where the speed of information, advance of technology, and designs of organizations are merging to change the way we operate. 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.

Since the introduction of mechanized technology in the early twentieth 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.

In the 21st century, we face another technology-driven inflection point that will fundamentally reshape what it means to project power. 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—planes, satellites in space, tanks, amphibious elements or ships at sea. These individual platforms have evolved from a stove-piped, parochial service alignment to a loosely federated "joint and combined" construct today. To be effective in the future, these same forces must become a highly integrated enterprise collaboratively leveraged through the broad exchange of information.

Said another way, 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 op-

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[2] For a comprehensive treatment on this phenomena see, *The Urgent Necessity to Reverse Service AirLand Roles,* by Price T. Bingham, Joint Forces Quarterly 84, 1st Quarter 2017.

[3] Nathaniel Fick, *One Bullet Away: The Making of a Marine Officer* (New York: Houghton Mifflin, 2005), p. 289.

erating paradigm where information, data management, connectivity, and command and control are core mission priorities.

While mechanical technology will continue to serve as a key factor in future military operations, the information empowering these systems will stand as the backbone maximizing 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 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.

This approach will not only change the way we define new requirements, but also more importantly, the way we think about; operations; intelligence; command and control; and support. A distributed, self-forming, all-domain Combat Cloud that is difficult to attack and self-healing when attacked, significantly complicates an enemy's planning and will compel enemies to dedicate more resources toward its defense and offense. In its ultimate instantiation, Combat Cloud will be: 1) strategically dislocating to any challenger; 2) provide conventional deterrence to a degree heretofore only achieved by nuclear weapons; and 3) will enable operational dominance in multiple domains.

Turning this vision into reality will require a significant effort. While many militaries are evolving toward informationized forces, the integration and assimilation of related capabilities 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 combined arms warfare construct developed in the industrial age of warfare. Program oversight efforts within the DOD are also lagging—with antiquated industrial age governance impeding information-age endeavors.

Any assessment of the likely landscape of future conflict with peer and near peer adversaries 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, with budget austerity as the new normal our military needs 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.

If we, along with our 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 concept changes to how their forces are organized, trained, and equipped. The concept of the Combat Cloud stands as a framework to empower this vision.

In the current program-centric budgetary world of 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." This is why 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; and distributed battle, intelligence, and surveillance networks.

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. 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 we will use weapon systems in the future. Transitioning from industrial age, platform-centric methods of force employment to an interconnected, information-driven model involves numerous challenges. It will require a review of, and appropriate changes to doctrine, organization, training, material, leadership, personnel and education, facilities, and policy to define a "template" to guide modernizing policy, acquisition, and concepts of operation; seeking collaborative solutions among the services; moving from measures of merit that replace cost per-unit to cost per-desired effect; eliminating stove-piping of kinetic and non-kinetic options; developing reliable, robust, and anti-jam data links; creating sufficient diversity of employment approach to avoid single points of failure; and realizing automated multi-level security to ensure coalition participation.

2. The Conduct of Offensive Operations Against Adversaries in Anti-Access, Area Denial Environments.

Over the last quarter-century that the U.S. has dominated military operations, our air forces have been fighting in 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 anti-access, area denial environments will demand a new, more agile, and integrated operational framework for the employment of U.S. military power to succeed. While terrorism and insurgencies have proliferated more than traditional conventional combat since 9/11, 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.

Warfare against an adversary in an anti-access, area denial environment of the future will be very different than the experience of the members of the U.S. military today.[4] Heavy armor; barrages of theater ballistic missiles; rear areas under attack; surface to air missiles ranging hundreds of miles; smart mines; quiet submarines interdicting friendly shipping; anti-satellite capabilities shutting down GPS; non-stealthy friendly drones falling from the sky like rain—are all more likely to characterize warfare in the future than will the treatises of the recent past on sharing "three cups of tea," and "eating soup with a knife."[5]

Furthermore, if we are to succeed in fighting in anti-access and area denial environments, critical areas that require serious attention are not getting it. Potential opponents capable of creating an anti-access, area denial environment are capitalizing on electronic warfare (EW) tools and techniques to do so. The proliferation of high-end electronics has made offensive cyber operations and EW the modern military equalizers. Russia is now routinely attacking Ukraine and the Baltic states via the net. As a nation we are losing hundreds of billion dollars a year of commercial/military value due to Internet thefts. Many of China's newest weapons systems look eerily familiar to United States systems—they should, they stole our designs. However, in the DOD, getting traction for electronic warfare requirements and investment is painfully slow, and inadequate to properly prepare us for the future. Here is what the DOD electronic warfare strategy states in its introduction, "...our EW work force is currently fragmented and ill-equipped to dominate a pacing competitor."[6] In 2014 the Defense Science Board highlighted the insufficient attention paid to electronic warfare by all Services, and recommended a 75 percent markup in electronic warfare investments over the next 5 years—from $3 billion a year to over $5 billion a year. Electronic warfare is no longer just an enabling capability—it is a survival capability.

We need sufficient numbers of advanced munitions to prevail in the high-end anti-access, area denial fights of the future. Today we are we are running low on these kind of munitions due to their regular use in conflicts in southwest Asia. We also need to pay attention to the numbers and capabilities of the people required to accurately target these advanced weapons. In Desert Storm only about 5 percent of all the weapons employed were precision-guided, but we had over three times the number of targeteers in our intelligence force than we have today where precision weapons now make-up over 95 percent of weapons employed from our combat aircraft.

However, these needed resources are going unfunded because there is little public awareness of the problems we face relative to the reduction in resources allocated to Defense. As a result, the hollow force that the 2011 budget control act and sequestration it imposed will not be readily apparent until those forces are required. What is so devastating about the 2011 budget control act—and not obvious in a 20 second sound byte—is that it is now affecting U.S. capability to provide rapid response sufficient to meet the demands of our national security strategy. Said another way, we have a growing strategy-resource mismatch. The dichotomy between what we say we want to accomplish, and what we can actually accomplish is growing. Without action to eliminate sequestration, that mismatch will get worse. I believe it is vitally important to remember that the first responsibility of the United States government is the security of the American people. As the preamble of our Constitution states, the federal government was established to first, *"provide* for the

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[4] Over 80 percent of the active duty U.S. military has joined since 9/11/2001, so their experience is primarily in the counterinsurgency and counterterrorism environments of Iraq and Afghanistan.

[5] *Three Cups of Tea: One Man's Mission to Promote Peace—One School at a Time, and Learning to Eat Soup with a Knife: Counterinsurgency Lesson from Malaya and Vietnam* were popular books reinforcing the primacy of counterinsurgency warfare that affected the first decade of the 21st century.

[6] *The Department of Defense Electronic Warfare Strategy,* 2017, p1.

common defense" and subsequently to, *"promote* the general welfare." Recent decisions have confused this prioritization, with sequestration taxing defense spending at a rate greater than twice its percentage of the total federal budget. It is time to return to the first principles of our Constitution and get our priorities straight.

The most important element in the U.S. military's ability to fight and win in any conflict in the future—much less against one in an anti-access, area denial environment—is restoring the readiness that has been robbed from it by the irresponsible budget control act of 2011. No amount of innovation, reorganization, or restructuring will allow the U.S. military to succeed in meeting its national security objectives without 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."[7]

Warfare is evolving as we transition out of the industrial age and further into the information age. Advancements in computing and network capabilities are empowering the ascent of information as a dominant factor in warfare. 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—aptly described as Fusion Warfare based on building a Combat Cloud—moving beyond combined arms and into an approach of *combined effects power.*[8] The kind of combined effects resident in a unified ISR, strike, maneuver, and sustainment complex integrated across the electromagnetic spectrum.

The Combat Cloud inverts the paradigm of combined arms warfare—making information the focal point, not the 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.

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. Desired effects must be well timed, synchronized, immediately assessable, and scalable. 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, striking targets in hours, minutes—or seconds.

To succeed against an adversary in an anti-access, area denial environment you must encourage the Department of Defense 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.

3. The Key Attributes of a Modern, Fully Integrated Joint Air-Ground Theater Joint Task Force Capable of Decisive Offensive Campaigns.

By definition, anti-access, area denial environments will complicate, if not hinder, our ability to conduct offensive operations. As potential adversaries expand their anti-access, area denial capabilities, our ability to conduct offensive operations is reduced, especially if we fail to keep pace by inadequately investing both qualitatively and quantitatively in advanced technology. I have the fullest confidence that our armed forces can currently achieve any military objective they are given. However, the sacrifices in casualties our service members will have to make to achieve those objectives are increasing. As our forces get older, our capabilities relative to modern threats are declining, while investment to reverse these negative trends is still not adequate.

Standoff ranges imposed by area denial capabilities degrade the effectiveness of long-range sensors in a highly contested environment. To overcome these limitations, the 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 where every platform is capitalized upon as both a sensor as well as an "effector." This vision will enable more rapid and effective decisions at the tactical, operational, and strategic levels

[7] Gen David Goldfein, remarks to the Center for Strategic and International Studies in Washington, D.C., Feb 23, 2017 as reported in the Air Force Association Daily Report, Feb 24, 2017.

[8] For greater insight into this concept for thinking about warfare in the 21st century see; Rokke, Drohan, Pierce, Combined Effects Power, Joint Forces Quarterly 73, 2nd Quarter 2014.

of war and will provide us an operating advantage that will be difficult for any adversary to overcome. Key capability development areas in the Air Force to achieve this kind of operating paradigm include:

a. *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 will be integral to allow for the rapid turning of data into information and knowledge to inform decision-making. Big data analytics; incorporation of all-source information; and sensor-to-sensor cueing must become the norm, not the exception in creating a combat cloud.

b. *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.

c. *Penetrating Counter-air (PCA):* PCA maximizes tradeoffs between range, payload, survivability, lethality, affordability, and supportability to achieve penetrating counter-air effects in anti-access, area denial environments. Establish PCA as a network nodal element to relay data from penetrating sensors enabling the employment of standoff or stand-in weapons.

d. *Agile Communications:* This is increase in the resiliency and adaptability of integrated networks. Focus on responsive, adaptable network architectures with functionality across all platforms, weapons, apertures, and waveforms operating in a highly contested environment.

Each of the services are working to create architectures to rapidly sense, collect, process, and analyze data; turn it 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 joint Combat Cloud where information and knowledge is shared in a ubiquitous and seamless fashion.

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 Air Force Air Superiority Flight Plan states, "The Air Force's projected force structure in 2030 is not capable of fighting and winning against the array of potential adversary capabilities." This is an official statement from the United States Air Force, and that statement should concern you, because without air superiority there can be no successful land (or sea surface) operations.

Developing and delivering air superiority for the highly contested environment in 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 the linear acquisition and development timelines using traditional approaches.

Air superiority—as well as other military capability development—requires adaptable, affordable and agile processes with increasing collaboration between science and technology, acquisition, requirements and industry professionals. Failure to adopt agile acquisition approaches is not an option. The traditional approach guarantees adversary cycles will outpace U.S. development, resulting in "late-to-need" delivery of critical warfighting capabilities and technologically superior adversary forces.

In the future we must possess an agile operational framework that enables the integrated employment of joint and allied military power. It means taking the next step in shifting away from a structure of segregated land, air, and sea warfare approaches to truly integrated operations.

The central idea is cross-domain synergy. The complementary employment of capabilities in different domains, instead of 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 effects approach will lead to integrating existing and future operations across all the domains with an agile operational framework guided by human understanding.

The reconnaissance-strike group (RSG) organizational construct posited by Doug Macgregor is a step in the right direction in this regard. 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.

Beyond the RSG, all the services, and combatant commands need to be focusing on moving to a future operating paradigm of the Combat Cloud. The Combat Cloud

is not simply a network, but an operating concept that integrates every warfighting platform as a node in the 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. U.S. forces can continue to operate, to move the fight, by understanding commander's intent and guidance through mission directives or orders. The command and control structure must be adaptive and responsive enough to support decentralized execution with authorities delegated to the lowest echelon practical.

In the future, increases in threat warfighting capability that can hinder or deny traditional U.S. warfighting advantages will grow. In an era of constrained resources, the best bet for defeating modern threats is implementing the Combat Cloud concept. This approach will not only change the way we define new requirements, but more importantly, the way we think, command, control, and operate those systems. This is the essence of the Combat Cloud—it is not just the network—it is the entire enterprise of sensors; shooters; effectors; and connectors, all part of a cohesive, coherent whole and it must extend across all operating domains.

4. The Challenges Of Deploying And Sustaining Expeditionary Forces Across The Globe.

The major challenges of deploying and sustaining expeditionary forces across the globe are two-fold. 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 predeployed 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 environments. Rapid advancements in the capabilities of our potential adversaries, notably in electronic warfare, cyber, drones, and long-range precision attack, all present unique challenges and expose vulnerabilities. Our 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 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 U.S. 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 the U.S. national security strategy. There are two enduring tenets of our national security strategies over the years regardless of Administration party affiliation. One, that we will maintain sufficient forces and capabilities to engage around the world to encourage peace and stability to prevent conflict. Two, that in the event that conflict is unavoidable, we will maintain the ability to fight and win in more than one conflict at a time and do so away from U.S. territory.

In order to be able to accomplish both of these fundamental tenets, each of the services requires a set of robust, capable, and ready forces to establish a rotational base sufficient to sustain operations. To do that the Air Force uses its "Air and Space Expeditionary Force" (AEF) structure to maintain sufficient numbers of rotational base forces to engage in regions around the world to shape and maintain peace and stability. AEFs provide joint force commanders with ready and complete air and space forces to execute their plans.

In the most demanding anti-access/area denial scenarios, the U.S. 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. AEFs provide a construct for the potential of 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.

During the 2000/2001 Quadrennial Defense Review (QDR) where I was the lead of the Air Force QDR team, I suggested to my Army counterpart that we consider

assigning and teaming Army warfighting units with Air Force AEFs specifically for this purpose. I was told by him that the Army was a garrison-based force and didn't need to train for or practice for expeditionary deployments. That was before 9/11 and much has transpired since then.

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. The characteristics of the RSG as lighter; more agile; more mobile; and more interoperable than current Army warfighting organizational structures, opens the possibility of much greater synergy with the air, space, and cyber capabilities of the Air Force. RSGs matched with AEFs provide the basis for a step increase in the partnership between air and land force organizations in the future.

Ten AEFs provide the *framework* to achieve sufficient expeditionary aerospace forces to sustain rotational base requirements and personnel tempos to meet the dual requirements of our 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. Aerospace capability does not stop with expeditionary assets. Space, ISR, cyber, national missile defense architecture, intertheater airlift, and others, provide the foundation upon which the AEF structure stands. 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, as well as its foundation—that level of force structure does not exist today. Currently, the Air Force does not have ten equally capable AEF's—it "borrows" those forces in training to make those preparing to deploy whole.

In the face of the expanding set of threats around the globe, the United States government has elected to fund fewer resources to meet them.[9] At the same time, our aerospace capabilities have reached an inflection point. Last year we celebrated the 25th anniversary of Operation Desert Storm—the first Gulf War. Your Air Force has been at war not just since 9/11/2001, but since 1/16/1991. After over 25 years of continuous combat operations coupled with budget instability and lower-than-planned budget top lines have made the Air Force *the smallest, the oldest, and the least ready force in its entire history.*

Yet, our nation faces an ever growing and evolving list of challenges. While each of them drive an increase in the demand for aerospace power, the Air Force has to deal with unpredictable and eroding budgets that have shrunk force structure, as well as the defense industrial base upon which it heavily relies.

Today we have 59 percent fewer fighter squadrons than during Operation Desert Storm in 1991 (134 in 1991, 55 today). We have 30 percent fewer people, and 37 percent fewer total aircraft. At the height of the hollow military of the 1970's, and when President Reagan took office pledging to rebuild it, our Air Force aircraft averaged 12 years of age. Today the *average age* of Air Force aircraft is over 200 percent older . . . 28 years.

The Air Force is operating a *geriatric* force that is becoming more so every day. Bombers and tankers over 50 years of age, trainers over 40, fighters and helicopters over 30—for comparison purposes the average age of the U.S. airline fleet is about 10 years . . . and they don't pull 6 to 9 "Gs" on a daily basis as do our fighters. Pilots are qualifying on the same bombers and tankers that their *grandfathers* qualified on.

In the 70's, nearly half our military planes could not fly because there were no spare parts and proper maintenance. It is just as bad today. Between 2009 and 2018, the US military will sustain budget cuts totaling over $1.5 trillion dollars. Many of these cuts have been arbitrary and not reflected in strategy or analysis. Yet, the demand for airpower keeps growing while the Air Force is seriously underfunded. This is perhaps the greatest challenge to deploying and sustaining expeditionary forces across the globe.

CONCLUSION

The challenge before us is to transform today to dominate an operational environment that *is rapidly evolving,* and to counter adversaries who *are rapidly advancing in capability.* The 9/11 commission report's now famous summary that the cause of

[9] In 2009 the U.S. spent 4.6 percent of its gross domestic product (GDP) on defense. In 2017 the U.S. spent 3.2 percent of its gross domestic product (GDP) on defense.

that disaster was a "failure of imagination" cannot be allowed to be repeated across our security establishment.

I finish with a plea for new thinking. In the face of disruptive innovation and cultural change, the military can maintain the status quo, or it can embrace and exploit change. I suggest that the latter is preferred. Our services need to learn better how to rapidly adapt new technology to the innovative concepts of operation that technology enables. Our 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. We should take maximum advantage of the asymmetric capabilities America possesses with her air, space, and cyber forces operating in conjunction with her land and maritime forces in innovative ways. A concerted focus on further developing and expanding these forces would serve the United States well, as they are uniquely positioned to underpin the kind of defense strategy and force structure appropriate to America's future.

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

Senator COTTON. Thank you, General.

Colonel Macgregor?

STATEMENT OF COLONEL DOUGLAS A. MACGREGOR, USA (RETIRED), EXECUTIVE VICE PRESIDENT OF THE BURKE–MACGREGOR GROUP

Mr. MACGREGOR. Mr. Chairman and Senator King, members and staffers, thanks very much for inviting me to be here today. I appreciate it.

I too am going to provide some points rather than go through in detail the 5,000-word statement for the record, which I am sure you are grateful for. But I do encourage you to read it.

To continue the discussion that my colleague on my left, Dave Deptula, has begun, first of all, we—that is, Americans in general—have missed a number of strategic inflexion points over the years, points in time where the rules of the game, the rules set governing how warfare is conducted have changed. We have simply missed those.

An excellent example was before the First World War. We fought a very long and hard campaign in the Philippines to suppress an insurrection. We lost 6,000 men, had 3,000 wounded in the space of about 3 and a half years. That insurrection, hard-fought campaign that it was, taught us the importance of the individual riflemen and the rifle squad because it was the kind of war that exalted the riflemen and the squad.

Unfortunately, there was another war well underway at the time, almost immediately after our insurrection ended, called the Russo-Japanese War in 1905. That was a very different war that caused hundreds of thousands of lives, Japanese and Russian, introduced the world to machine guns, massed artillery fire, barbed wire, mines. Unfortunately, we did not pay very much attention to it, and the general officers in the United States Army and, by the way, in the British and the French armies who did look at it tended to extract lessons from that experience that reinforced their preferences, which was for more men with rifles.

The consequence of having missed this inflexion point was that we lost 1,000 dead in every battle that we fought during World War I. Keep in mind, ladies and gentlemen, we only fought for 110 days. We took 318,000 casualties. We were simply unprepared for that battlefield. We were not trained properly. We really were not equipped properly, and we sustained enormous losses as a result.

The reason I bring that up is that we have just had a hard-fought campaign in the Middle East. It is not over by any means. But we have fought very hard for a very long time against a very specific kind of enemy, reminiscent in many ways of the insurgents in the Philippines. But at the same time, we are seeing events in eastern Ukraine, even now events in Syria involving larger forces, conventional forces, and as Senator King pointed out, these hybrid forces that consist of the full range or spectrum of military power. The lethality of these battlefields is striking. It is frightening.

So I think the lesson that we have to take away from this is that we have to be prepared to accept the fact that the organizations, the structures of the recent past, and the lessons of the recent past may not do very much to prepare us for what lies ahead.

Now, the joint operational concept, all arms-all effects warfare, and its supporting operational framework, which I hope we will discuss today in some detail, the ISR, strike, maneuver, sustainment complex, is, ladies and gentlemen, the military equivalent of "Moneyball." For of those of you who have been to the movies and seen "Moneyball" with Brad Pitt who played Billy Beane, it was based on a Michael Lewis book about profound change in baseball. What Billy Beane did was that he looked at what he said was analytical, evidence-based evidence to create a box score. He looked at each individual player, assessed their capabilities, then looked at the collective capabilities of the team from a very radically new standpoint. The outcome was that he turned in a brilliant record, and his approach is now widespread in professional baseball.

We are talking today about effectively the same thing. We have something called the reconnaissance strike group, a 6,000-man prototype formation that is in the current national defense authorization bill. It is effectively "Moneyball." It is an attempt to cast aside a lot of the conventional wisdom and assumptions about warfare in the past and to look at warfare through a very different lens, through this ISR, strike, maneuver, sustainment lens, through the lens of cross-domain operations in warfare, through the lens of integrative operations, and then finally, to look at integrative command structures because we know from experience that when war comes along, the biggest mistake you can make is to march into it with single service headquarters that have to be painfully lashed up to create some measure of effectiveness for a new enemy. That is simply not going to work for us in future conflicts and crises in the 21st Century.

So we have to begin to look at innovative and integrative command structures that already integrate members of all the services in a way that creates coherence across service lines in a coherent view of warfare. This involves full spectrum, rapid prototyping not just of technology but of the human organizational construct, look-

ing at this combination of human capital and technology in new ways across service lines.

So I hope we will have the opportunity to discuss these issues in detail, and I look forward to your questions. Thank you, sir.

[The prepared statement of Mr. Macgregor follows:]

PREPARED STATEMENT BY DOUGLAS A. MACGREGOR

Mr. Chairman (Senator Cotton), Senator King (ranking member), and members of the Air-Land Subcommittee of the Senate Armed Services Committee, thank you for inviting me to appear today to present my thoughts on "all arms" warfare in the 21st century, and their implications for Army force design in the context of a fully integrated joint air-ground theater joint task force (JTF).

The American Republic, the U.S. Armed Forces and the U.S. Army stand at the cross roads of history. We cannot predict with certainty what great power or constellation of great powers may directly challenge the United States in 5, 10 or 20 years. But we can say with confidence that the outcome of a future major regional war involving the existential interests of the American Republic will be determined by the preparations we make during the next 5–10 years.

We know from blood-spattered experience that armed forces and armies in particular are more often defeated in war by clinging to doctrine, tactics and organizations that evolved from earlier successful operations than by the superior skills and capabilities of their opponents.[1] In this connection, the contemporary U.S. Army is in a strategic position reminiscent of the two decades that preceded the First World War (WW I).

From 4 February 1899 – 2 July 1902 roughly 126,000 U.S. Troops consisting primarily of infantry, cavalry, and horse-drawn artillery fought 80,000 to 100,000 Filipino insurgents supported by perhaps another hundred thousand Filipino auxiliaries. In a hard fought campaign that lasted more than three years approximately 6,000 U.S. soldiers were killed and 2,818 were wounded. Filipino combat losses exceeded 16,000, while Filipino civilian casualties numbered up to 200,000.[2]

The Army's experience of combat in the Philippines confirmed the Army generals' opinion that the rifleman rather than massed artillery fire was the decisive factor in warfare.[3] This was certainly true for the Philippine insurrection, but WW I demonstrated the reverse: Accurate, quick-firing heavy artillery in combination with mines, machine guns and, eventually, tanks and aircraft, constituted a new dominant paradigm of warfare.

Nevertheless, like the generals commanding the British and French Armies, the United States Army's senior leadership failed to grasp this reality even though the 1905 Russo-Japanese War actually threw it into sharp relief.[4] The results were tragic. In 110 days of fighting during 1918, the U.S. Army sustained 318,000 casualties including 115,000 dead. In other words, on average, 1,000 American infantrymen died in every battle fought against the German Army.[5]

In a parallel analysis, suppressing the rebellion in the Philippines no more prepared the United States Army for World War I than the last 15 years of suppressing insurgents in Iraq and Afghanistan will prepare the United States Army for a future war involving peer or near-peer opponents. Yet, whereas the Philippine Insurrection made little difference to the grand sweep of human history, the United States Army's arrival on the battlefields of France in 1918 rescued French and British Forces from defeat and changed the course of world history.

The WW I experience helps to explain why the U.S. Army's future, exploitation of powerful new warfighting technologies and the emergence of a new, integrated, "All Arms-All Effects" warfighting structure—the ISR *(intelligence, surveillance, reconnaissance)*-STRIKE *(standoff, beyond-line-of-sight attack, theater air and missile defense)*-Maneuver *(positional advantage on land)*-Sustainment *(logistics)* Complex—must not be constrained by the insertion of new technologies into organizational

[1] J.F.C. Fuller, Memoirs of an Unconventional Soldier, (London, UK: Ivor Nicholson and Watson Ltd, 1936), page 26.

[2] Timothy K. Deady, "Lessons from a Counterinsurgency: The Philippines 1899–1902," Parameters, spring 2005, page 64.

[3] Edmund Morris, Theodore Rex, (New York, NY: The Modern Library, 2001), page 127.

[4] Paddy Griffith, Battle Tactics of the Western Front: The British Army's Art of Attack 1916–1918, (New Haven: Yale University Press, 1994), pages 48–49.

[5] Leonard P. Ayres, Colonel, US Army, The War with Germany: A Statistical Summary, (Washington, DC: Government Printing Office, August 1919), pages 121–123.

constructs in use since 1942 or tactics tied to the recent past.[6] Streamlined, integrated Command and Control (C2) on the operational level of war will not only deliver the timely and effective integration of warfighting capabilities across Service lines, joint integrated C2 promises a profound strategic advantage in war that will save American lives. With these points in mind, my presentation is organized into three sections:

1. Section I briefly sketches the environmental character of future operations against adversaries deployed into anti-access, area denial positions from an Army perspective;
2. Section II addresses the new Joint Operational Concept of "All Arms-All Effects," Cross Domain warfare and the concept's implementation through the ISR–STRIKE–Maneuver- Sustainment Complex and the Sustainment required to support a fully integrated joint air-ground theater JTF;
3. Section III examines the need for integrated command and control in the form of *Standing Joint Force Commands* to conduct integrated, "All Arms-All Effects warfare" and the strategic implications for sustainment operations.
4. Summary and (2) Recommendations.

Before turning to the first section, it is important to understand that the rapid assembly of Army ground forces anywhere on the greater Eurasian landmass depends on several preconditions: First, the creation of hardened national space-based C4ISR infrastructure combined with resilient, integrated cyber capabilities for electromagnetic spectrum domain dominance; Second, the availability of large numbers of advanced, survivable long-range reconnaissance and strike, manned and unmanned, aircraft with stand-off precision weapons; and, Third, U.S. Army ground forces developed, organized, trained and equipped from the bottom up for joint, integrated operations.

Otherwise U.S. Forces are unlikely to prevail against an established major power or alliance of regional powers fighting to sustain or expand their regional dominance. A long, arduous and exhausting conflict, rather than a decisive victory, would then ensue; the worst possible outcome for an American society intolerant of heavy casualties and the reduced living standards that such a war would entail.

SECTION 1 (CHARACTER OF FUTURE OPERATIONS)

Predicting the character of future conflict is always hazardous. Every war is unique, requiring an understanding of the warring parties' intentions, as well as, their capabilities. Yet, there is one inescapable conclusion about the future character of warfare: The proliferation of precision strike and persistent surveillance technologies presents extraordinary challenges to the projection of U.S. Military power.

Many countries, not just China and Russia, are developing and will implement A2AD strategies.[7] They will exploit sea mines, space and terrestrially based surveillance, precision strike, cyber-attacks, and electronic warfare to create "no-go" zones into which it will be difficult and costly for the United States to project military power.[8] In a future conflict with near-peer or peer nation-state opponents on the Eurasian landmass, U.S. Forces must anticipate all or most of the following conditions:

On a strategic level: U.S. command, control and communications, particularly space-based capabilities, will be disrupted, if not for long periods, then, certainly long enough to create operational havoc. In addition, even mid-sized powers are building a large, diverse, and reliable range of conventional ballistic missiles for deep precision strikes designed to operate within terrestrial and space-based sensor networks. As a result, U.S. Forces must expect that future opponents to launch theater ballistic missiles and self-navigating long range cruise missiles to strike ports, airfields, refineries, desalinization plants and food storage facilities vital to U.S. Forces. For example, unless United States and allied air defenses can shoot down Russian Kaliber Cruise Missiles, these missiles can strike all European ports and airfields with the exception of those in the far southwestern corner of the Iberian Peninsula.

On the operational and tactical levels: the skies over U.S. Army Forces will be crowded with loitering munitions, or unmanned combat aerial vehicles (UAVs or drones). These agile UCAVs are really cruise missiles designed to engage beyond line-of-sight ground targets. With proximity-fused, high-explosive warheads, these

[6] "Strike" as defined here can be kinetic or non-kinetic depending on the mission.

[7] Ankit Panda, "After China, India Will Become Second Buyer of Advanced Russian S–400 Missile Defense Systems," The Diplomat, 5 November 2015. http://thediplomat.com/2015/11/after-china-india-will-become-second-buyer-of-advanced-russian-s-400-missile-defense-systems/

[8] Barry Watts, "Precision Strike: An Evolution," NationalInterest.org, 2 November 2013.

systems will remain airborne for hours, day or night. Equipped with high resolution electro-optical and infrared cameras, enemy operators will locate, surveil, and guide these drones to targets on the ground—primarily, U.S. ground forces.[9]

When these loitering missiles are integrated into the enemy's Strike Formations armed with precision guided rocket artillery that fires high explosive, incendiary, thermobaric, warheads including sub-munitions with self-targeting anti-tank and anti-personnel munitions *warfare as we know it changes.*[10] Rockets fired from just 5 of these modern rocket launchers can devastate an area the size of New York City's Central Park (843 acres or 3.2 square miles) in minutes.[11]

Meanwhile, at every level—tactical, operational and strategic—integrated air defenses protect the enemy's Strike Formations from U.S. air and missile attack. It would be a serious mistake to underestimate the impact of integrated air defenses with phased array radars. Some of the newest air defense systems—like the Russian S–500—are so capable that many United States Defense Officials privately worry that even warplanes like the F–22, F–35 and the B–2 risk destruction if they attempt to penetrate them.[12] There is, however, no debate about the impact of new increasingly lethal and accurate air defense technology on the tactical level: Any manned or unmanned, low-flying, subsonic platform, whether it is a conventional rotorcraft, a tilt-rotor, or a fixed wing prop/turboprop aircraft, will be highly susceptible to detection, engagement and destruction.[13]

While U.S. Forces struggle with the combined power of enemy IADS and Strike systems the enemy's armored forces maneuver to exploit the ensuing chaos on the ground to close in with accurate, devastating direct fire from automatic cannon, anti-tank guided missiles and high velocity guns.[14] The close battle also takes place on the opponent's geographical doorstep conferring a serious home court advantage on the opponent's attacking ground forces.

The implications of this snapshot of future warfare are clear: "Holding ground" in the face of ubiquitous overhead military surveillance and reconnaissance linked to an array of precision guided weapons is extremely dangerous. Survivability depends on mobility and protection from top, as well as, direct attack. Mobility depends on off-road maneuver. Off-road maneuver requires tracked (not wheeled) mobility. Protection necessitates armor (active and passive) in combination with accurate, devastating firepower and integration within the aerospace-maritime dominated ISR–Strike complex. For reasons of physics, tracked armored platforms provide superior all-around survivability and stability for modern weapon systems during on-the-move engagements.[15]

The requirement that results from the proliferating ISR–Strike revolution is a warfighting environment that rewards *dispersed, mobile warfare,* a brand of warfare that elevates tactical dispersion to the operational level of war. To cope with the

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[9] At least 9 nation-states including Russia, China, Israel, Turkey, Iran and India possess these precision weapon systems. The U.S. Army fields the Switchblade, a miniature, remotely-piloted 5.5 pound vehicle with ten kilometer range and ten minutes endurance in the air. This is purely tactical weapon with limited utility compared with the systems discussed here.

[10] Sydney Freedberg, "Russian Drone Threat: Army Seeks Ukraine Lessons," Breaking Defense, 14 October 2015. http://breakingdefense.com/2015/10/russian-drone-threat-army-seeks-ukraine-lessons/

[11] The Russian Smerch-M, a system that is proliferating, can fire many types of rockets such as the 9M55K which carries 72 unguided fin-stabilized high-explosive fragmentation sub-munitions, the 9M55K1 which carries five parachute-retarded MOTIV–3F top-attack anti-armor sub-munitions, the 9M55K4 which carries 25 anti-tank mines, the 9M55F an unitary warhead with a charge of 95,5 kg of high explosive, the 9M55S a fuel air explosive munition, and the 9M55K5 with 646 shaped charge fragmentation sub-munitions that are dispensed over the target. The BM–30 Smerch-M 9A52–2 can fire rockets with a maximum range of 90 km. http://www.armyrecognition.com/russia—russian—army—vehicles—system—artillery—uk/9a52–2—smerch-m—bm-30—multiple—rocket—launcher—system—technical—data—sheet—information—description—u.html

[12] Dave Majumdar, "Russia's Deadly S–500 Air-Defense System: Ready for War at 660,000 Feet," The National Interest, 3 May 2016. http://nationalinterest.org/blog/russias-deadly-s-500-air-defense-system-ready-war-660000–16028. The dramatic improvements in the massive processing of signals to find patterns and filter out noise have dramatically improved the precision and capability of radar. The algorithms that enabled NASA to exploit microwaves for exploration of the moon also apply to IADS.

[13] As demonstrated by the failed RAH–66 Comanche, it is impossible to develop a rotor-driven manned craft with sufficiently reduced radar, IR, visible and acoustic signatures to avoid destruction in the mid-to-high intensity warfighting environment. http://nation.time.com/2012/05/25/real-lessons-from-an-unreal-helicopter/

[14] Tamir Eshel, "New Russian Army: First Analysis," Defense Update, 9 May 2015. http://defense-update.com/20150509—t14-t15—analysis.html

[15] Paul Hornback, "The Wheel versus Track Dilemma," Armor Magazine, March-April 1998, pages 33–34.

conditions that dispersed mobile warfare creates, maneuver forces must infiltrate a theater of war at points where the enemy's air defenses are weak or nonexistent. These are the points where manned and unmanned aircraft or missiles cannot easily attack them. This means that unless the U.S. Army moves rapidly away from the last two decades' focus on "permissive non-contested operations" in counter-insurgency to higher-end operations in more contested, non-permissive environments future U.S. Army and Air forces will face certain defeat.[16]

SECTION 2 ("ALL ARMS-ALL EFFECTS," SUSTAINMENT AND ARMY FORCE DESIGN)

The technological trends in lethality, accuracy and range outlined in the previous section point to a very different Army from the U.S. Army we have today; an overly light-infantry-centric force equipped for low intensity conflict much like the Marine Corps. In the 21st Century, the nation needs an Army that consists of mainly mobile, armored forces with accurate, devastating firepower designed to operate on land the way ships operate at sea; within the limits of their organic ISR, Strike and Sustainment capabilities. Like individual naval combatants, Army ground maneuver formations must be able to operate independently or rapidly assemble into larger forces.

These desired attributes point to Army forces that are organized, trained and equipped for mobile, dispersed war within an integrated, joint operational framework; an army that consists of self-contained fighting, mission-focused force packages organized around the warfighting functions of modern warfare: maneuver, strike, ISR, and sustainment capabilities. They must be equipped with the Joint C4ISR and organic sustainment to operate inside a joint military command structure that tightly integrates ground maneuver forces with the ISR and Strike capabilities that reside in the aerospace and maritime forces. The resulting formations of 5–6,000 soldiers under the command of brigadier generals with robust staffs are designed to deploy and fight as unreinforced, stand-alone formations and plug directly into a Joint Task Force without intervening division headquarters. With this new, integrative organizational paradigm in place, the 21st Century U.S. Army becomes an operationally flexible grouping of capability-based formations, faster to deploy, easier to transport and maneuver.

Recognizing the potential this organizational construct represents, Senator John McCain, SASC Chairman, and Members included a provision in the FY 17 National Defense Authorization Bill directing the Chairman of the Joint Chiefs to model, assess and report on a new prototype ground combat maneuver formation, the Reconnaissance Strike Group (RSG). The RSG is a *6,000 soldier Reconnaissance Strike Group (RSG); a special purpose organization* designed to *lead change* by exploiting new, but *proven technologies* in a joint, integrated, operational context. In other words, the RSG is a force design that links strategy with concept and capabilities to ensure capability integration and shared technological development across Service lines (RD&A).

The RSG is organized to capitalize on the application of precision "Strike" informed by networked ISR. With the proposed use of the PUMA infantry fighting vehicle (IFV) as a universal platform for all of its weapon systems, radars and logistical support, the RSG is not a fragile force. It employs manned and unmanned aircraft, sensors, radars and air defense systems (NASAMS National Advanced Surface-to-Air Missile System (NASAMS)), forward with ground maneuver elements to provide the coverage needed to exploit the formation's accurate, devastating, direct firepower including 30mm autocannon, spike anti-tank missiles and either 120mm or 130mm smooth bore tank cannon.[17] Along with strategic and tactical mobility, the RSG has the precise striking power of loitering munitions, rocket artillery, and

[16] In his work as Deputy Sectary of Defense, Robert Work, concluded that the density and lethality of future anti-access/anti-denial capabilities raised questions about the viability of Marine light forces in a contested environment. His observations are important because they apply to light-infantry centric forces in general. He observed: "The Navy-Marine team will never contemplate littoral maneuver until an enemy's battle network, capable of firing dense salvos of guided weapons, is suppressed. Consequently, the initial phase of any joint theater-entry operation will require achieving air, sea, undersea, and overall battle-network superiority in the amphibious objective area . . . Thus far we have only argued that some capability to conduct theater-entry operations and littoral maneuver must be retained. But it is fair to ask how much amphibious capacity is needed." Robert Work and F. C. Hoffman, "Hitting the Beach in the 21st Century," U.S. Naval Institute Proceedings 136/11/1 (2010), page 293.

[17] National Advanced Surface-to-Air Missile System (NASAMS) *http://www.raytheon.com/capabilities/products/nasams/*

advanced 120mm mortar systems to conduct its own fire and close air support, as well as, strike operations against enemy concentrations.[18]

The RSG is organized and equipped to fight for information and to rapidly exploit the information its subunits collect. It's designed for integration with, but not dependence on, air strikes for survival and effectiveness. The RSG is a mobile armored force that reflects the understanding that regardless of how well new technologies are networked, they will never provide perfect situational awareness or perfect information; that information is often of fleeting value. The RSG's robust, organic C4ISR integrates the RSG's ground combat capabilities (including the capability to dismount 840 soldiers) within the framework of "All Arms/All Effects" Cross Domain warfare.

These points notwithstanding, the RSG is simply the vanguard for the Army ground force that must emerge to defeat 21st Century threats. Thanks to the marriage of space-based and terrestrial ISR capabilities with the timely dissemination of analyzed intelligence through networks, the near-simultaneous application of Strike and Maneuver forces can be decisive in 21st Century warfare. This recognition suggests that massed, accurate firepower or, STRIKE seeks to facilitate operational maneuver over distance, dislocate enemy C2, crush large concentrations of enemy forces, isolate the battlespace through interdiction and destroy enemy facilities with operational significance.

Army Strike Groups are the inevitable result of the ISR–Strike revolution. Consisting of precision rocket artillery, cruise missiles and, potentially, intermediate range ballistic missiles, Army Strike Groups are ideal for Joint, integrated Strike Operations with aerospace and naval forces. These formations together with RSG-like Battlegroups can and must also play a key role in the methodical destruction of the enemy's integrated air defenses from the tactical to the strategic levels, thus, liberating American aerospace power to conduct unconstrained strike operations throughout the strategic depth of the opponent's area of operations.

The realities of future force projection dictate that logistical support must be embedded at the tactical level as shown in the RSG, as well as, present on the operational level to respond to the needs of the JTF. Today's Army centralizes too much logistical support at the division and corps levels robbing subordinate BCTS of the capacity for independent operations. Today, the active force also depends too heavily on contracted logistical support. Army C4ISR and Combat Support Groups must be designed within a broader, Joint framework to ensure mutual reinforcing dependence, not unneeded redundancy. (See illustration) As my distinguished colleague, Lieutenant General Dave Deptula has stated in previous testimony, "A dollar spent on duplicative capability comes at the expense of essential capacity or capability elsewhere."[19]

For decades, America has underinvested in strategic lift—a calculated choice to accept risk that shortages in lift could be offset by either taking more time to get forces to the theater or by prepositioning equipment in regions of foreseeable conflict. Smart planning and better acquisition strategies that result in formations like the PUMA-based RSG that are designed with intercontinental transportation in mind can help enormously. Vehicles sized to facilitate rapid transportation to forward locations can avoid the need to devise newer airframes or new ships capable of lifting and accommodating heavier vehicles.

Still, it is not enough to simply expect the private sector to step in and transport the bulk of the military to war on a moment's notice. Dedicated airlift and short-notice private sector support must be readily available, because long lead times to ramp up for war are becoming a luxury in the age of missiles with transcontinental ranges. The capability to lift hazardous cargos such as ammunition and explosives, as well as heavy outsized cargo that cannot easily be lifted using commercial equipment along with investment in transportation support systems to off-load military cargo in unimproved locations is vital.

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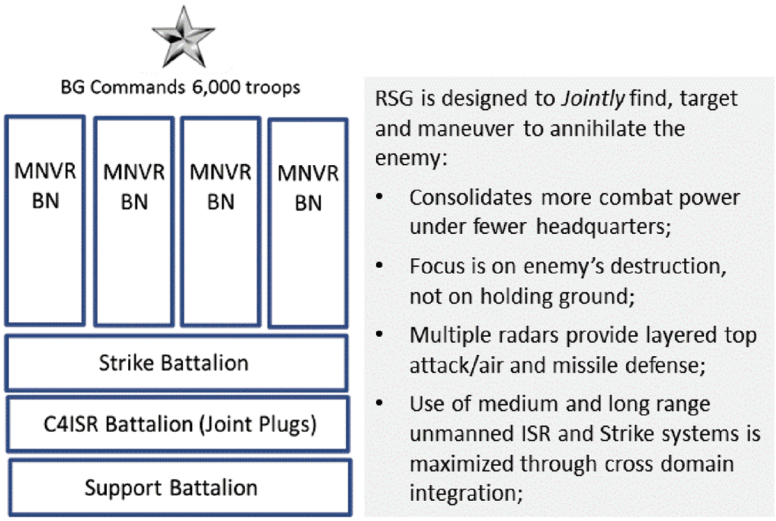
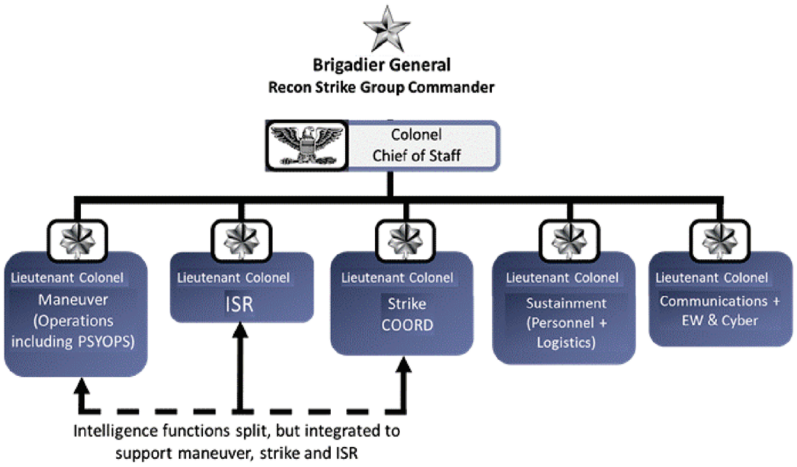
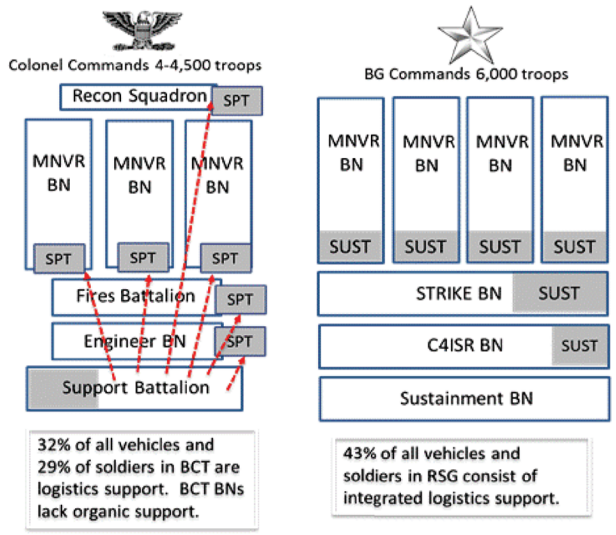
[18] AMOS®. "Advanced Mortar System," (BAE Systems Hagglunds AB). A double barreled breech-auto-loading 120 mm mortar turret mounted. System operates autonomously with direct and indirect fire capability together with Multiple Rounds out to 10 km. One RSG contains 60 '120mm Mortar' variants (System Fielded). MLRS (Lockheed Martin Missiles and Fire Control). The weapon can fire guided and unguided projectiles from 42 to 300 km. (System fielded). One RSG contains 12 MLRS launchers/systems variants. TARES (Tactical Advanced Recce Strike) is a UCAV with a 200 km range and endurance time of four hours. It autonomously searches for, identifies and engages targets. Up to 24 TARES can be flown simultaneously. System is tested ready for fielding. One RSG contains 24 TARES launcher variants. *http://www.army-technology.com/projects/taifun/*

[19] Quoted by Walter Pincus, "Senate Armed Services Committee tackles Inter-service rivalries—finally," *Washington Post,* 9 November 2015.

In sum, to terminate future conflicts on terms that favor the United States and avoid long, destructive wars of attrition, the U.S. armed forces must combine the concentration of massive firepower across service lines with the near-simultaneous attack of ground maneuver forces in time and space to achieve decisive effects against opposing forces. Integrating ground maneuver forces into the larger ISR–Strike complex that already exists in U.S. aerospace and naval forces is critical to this outcome. Organizing Army forces into Lego-like mission-capable force packages on the RSG model and investing in the right mix of air and sea lift are indispensable to future force projection.

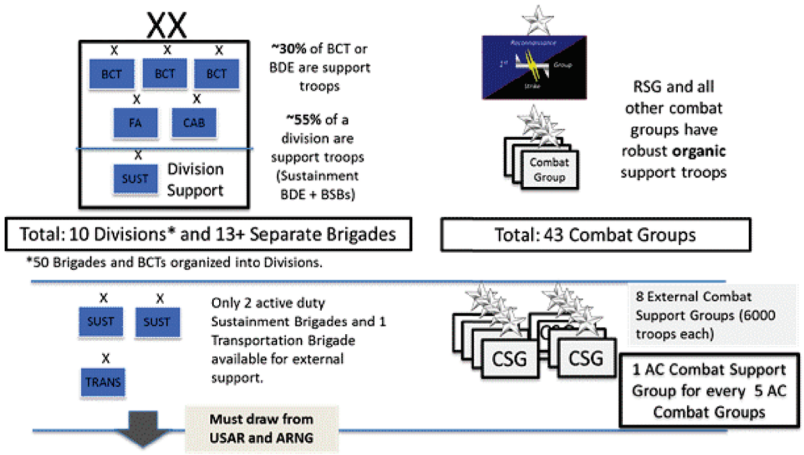






✓ RSG Sustainment Battalion is a "Stand Alone" unit unlike the BCT's Brigade Support Battalion (BSB).
✓ RSG integrates more sustainment troops (2,426 Soldiers) than an entire Brigade Support BN (1,357 Soldiers).

Logistics Comparisons: Current Army Compared with a Reorganized Army



SECTION 3 (INTEGRATED, JOINT COMMAND AND CONTROL IN EXPEDITIONARY WARFARE)

As noted in the Section 2, the Army's organizational constructs of the past—corps, divisions and brigades—with their roots in WW II are the wrong constructs for 21st Century Warfare. This observation applies with equal force to command overhead.

> In the 1944–45 advance from Normandy to the Rhine, General Montgomery's headquarters controlled only two armies, which in turn had only two and three corps respectively, and the corps operated only two to three divisions—sometimes, even, only one. The ratio of headquarters was no more

> economic in the U.S. Army until a late stage. On top of both was Eisenhower's H.Q.—reputedly comprising some 30,000 officers and men. The abundance of headquarters was one reason why the advance to victory was so protracted, despite mobile instruments and exhausted opponents.[20]

A discussion of the massive C2 overhead inside the Services and the Combatant Commands is beyond the scope of this testimony, but a flattening of the echelons of C2 is long overdue. In future conflicts and crises, there will be no time for a "pick-up game." By the time the United States gets its operational construct and "C2" act in order, China, Russia, Iran (or any other future great power or coalition of powers) will defeat United States forces.

Adding maneuver and sustainment to the ISR–Strike framework is vital step joint interoperability cannot be created on the fly. Without unity of command, there is no unity of effort. Effective integration is the key to unity of command. Unity of effort, speed of decision, and action demand integrated command structures midway between the strategic and tactical levels that create and maintain a coherent picture of operations. The challenge is to integrate the diverse military capabilities from the aerospace and maritime forces with the Army's ground maneuver forces as seamlessly as possible when Army forces are committed as part of a Joint Task Force.

Because command and control of geographically dispersed armed forces requires "brain to brain" as well as "box to box" connectivity, C2 structures on the operational level must involve trained professionals from all of the services. Shared battle space awareness is both technical and intellectual. Within the operational framework of ISR–Strike-Maneuver-Sustainment, the planning and execution of operations become routinely integrated through multi-service command and control—common mission purposes. The outcome is a regionally focused standing Joint Force Headquarters capable of commanding whatever mission-capable force packages are assigned to it.

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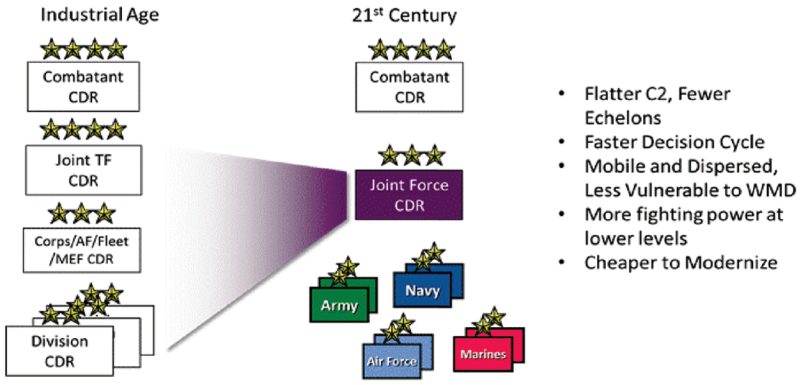
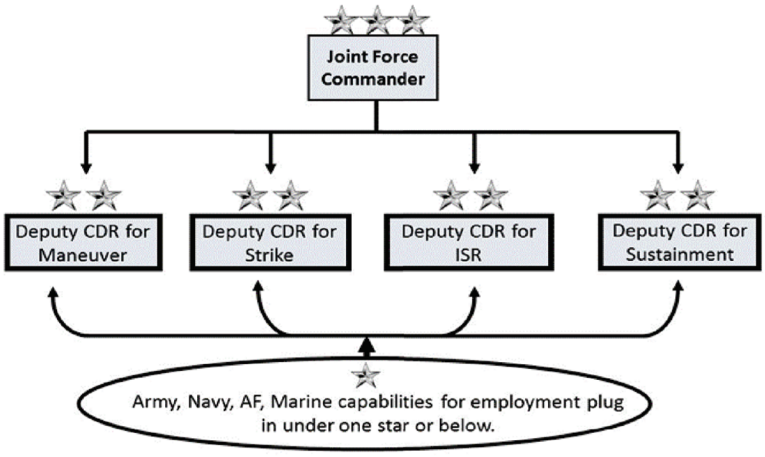
[20] B. H. Liddell Hart, *Defence of the West,* (New York, NY: William Morrow & CO., 1950), page 244. Forrest Pogue puts the number of officers and soldiers assigned to Eisenhower's HQ at 16,000. The difference lies in which supporting elements are included in the count. Forrest Pogue, *The Supreme Command,* (Washington, DC: Center of Military History, 1954), pages. 533–535.



✓ Develop template for JFCs across regional unified commands. Consider stand up of initial 3 star Joint Force Headquarters (JFC) at Joint Base Lewis-McChord.
✓ Flag officers for JFC are drawn from all services.



A Regionally Focused Joint Force Command Structure.
These are modular HQTRS.

To briefly sum up, the ISR–Strike-Maneuver-Sustainment Framework is not just about "things." It's about integrating existing and future capabilities within an agile operational framework guided by human understanding. The goal is to create a *coherent view of warfare,* (not just operations) across service lines. The JFC concept moves the armed forces beyond the last minute lash up of single-service headquarters, or the ad hoc coordination of individual federal agencies and service-based elements of integration.

SUMMARY AND RECOMMENDATIONS

Today and in the future, the United States' military response to future regional wars depends on our general purpose, non-nuclear capabilities. The United States needs powerful forces-in-being (professional ready, deployable, air, land and sea) that are prepared to win the first fight, because we may not get the chance to win a second. The last fourteen years severely eroded the United States' military-technological edge and operational flexibility—particularly those of the U.S. Army. The focus on irregular warfare—suppressing weak, insurgent opponents without armies,

air forces or air defenses let alone naval power—must end. At a strength of 500,000 or less, the active U.S. Army cannot preserve its vital warfighting forces and still maintain large light infantry-centric and paramilitary forces for counterinsurgency and nation building in the Eastern hemisphere.

Members of the Air-Land Committee must apply Peter Drucker's private sector advice to National Defense: "If you want something new, you have to stop doing something old."[21] To survive and prevail in twenty-first-century close combat the vast majority of soldiers should be mounted in tracked armored platforms equipped with accurate, devastating firepower and tightly integrated with ISR and Strike capabilities in all of the services.[22]

Finally, a flattening of the American military command structure is equally critical. The multiplicity of higher headquarters in the chain of command not only slows decision making and increases friction, it drains the fighting formations of too many capable soldiers. These points suggest two critical recommendations:

1. Urge the Chairman of the Joint Chiefs and the incoming Secretary of the Army to accelerate the RSG's evaluation and provide funding for rapid prototyping of PUMA platforms to produce an experimental RSG maneuver battalion set as soon as possible;
2. Direct the CJCS to stand up an experimental 3 star Joint Force Headquarters on the model presented in this testimony with the goal of developing a template for Joint Force Commands inside the regional unified commands. The Joint Base Lewis-McChord should be considered for the testing and evaluation of the proposed JFC C2 structure.

Senator COTTON. Thank you, Colonel Macgregor.

Mr. Scharre?

STATEMENT OF PAUL SCHARRE, SENIOR FELLOW AND DIRECTOR, FUTURE OF WARFARE INITIATIVE, CENTER FOR A NEW AMERICAN SECURITY

Mr. SCHARRE. Thank you, Senator Cotton, Ranking Member King, and distinguished Senators. Thank you for inviting me to testify today.

The United States has fallen behind in adapting to challenges from other nations. Russia and China have developed anti-access/area denial capabilities that threaten traditional forms of United States power projection. If the United States is to remain relevant as a global power, we must adapt to these challenges.

Cuts under the Budget Control Act have harmed military readiness and delayed urgently needed modernization. In addition to a sustained increase in defense spending above BCA levels, the Department of Defense needs a predictable and stable budget in order to plan future activities.

With additional resources, DOD should prioritize restoring readiness by funding maintenance and training and modernizing the force to adapt to emerging challenges. U.S. Forces cannot be considered ready if they are prepared for the wrong threats. U.S. Forces must adapt their capabilities and concepts of operation to meet the threats posed by adversaries. Greater capacity alone cannot meet these challenges.

DOD should pursue a disciplined modernization strategy that focuses investments on high pay-off capabilities, that can deliver the most value in countering A2/AD challenges. This approach should leverage existing programs where possible in order to maximize the

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[21] Peter Drucker, *Management Challenges for the 21st Century,* (New York, NY: Harper Business, 1998), page 32.

[22] For a good assessment of the lethality that confronts U.S. and allied ground forces, see Ron Tira, "Breaking the Amoeba's Bones," *Strategic Assessment,* Jaffee Center for Security Studies, Tel Aviv University, autumn 2006. *http://www.tau.ac.il/jcss/sa/v9n3p3Tira.html*

efficient use of scarce resources. DOD should also capitalize on emerging technologies, such as robotics and automation, to increase operational effectiveness and reduce costs.

The Air Force must adapt to adversary investments in air defenses, ballistic and cruise missiles, and mobile assets. To do this, U.S. aircraft must be able to project power over long distances, penetrate and survive in contested areas, deliver high volume fires, and persist in order to track mobile and relocatable targets. These aircraft also need robust, secure communications in order to operate as a distributed network.

Key investments include procuring the B–21 bomber at the maximum rate once it enters production so it is fielded in sufficient quantities for future conflicts; leveraging work on the B–21 to more affordably upgrade existing B–2 bombers, building an optionally manned version so they can operate beyond human endurance limits to conduct persistent surveillance and strike missions against mobile targets inside enemy territory; investing in an aerial layer network to build robust, secure communications in the event of satellite disruption; procure additional quantities of next generation munitions; developing new munitions including a longer range air-to-air missile and air-launched swarming drones; continuing investments in electronic warfare and direct energy weapons; and upgrading existing non-stealthy aircraft, such as F–15's, F–16's, and MQ–9 Reapers to augment the fifth generation aircraft with additional munitions.

The Air Force should also improve the cost effectiveness of day-to-day counterterrorism operations by investing in a fleet of low-cost light attack aircraft.

The Air Force should also upgrade its MQ–9 Reaper fleet with extended range, multi-aircraft control, and automated information processing to improve cost effectiveness.

The Army must similarly adapt investing in new capabilities and ways of warfighting to respond to these challenges. The Army must be prepared to face a diverse array of threats, but Russia should be the pacing threat for Army modernization.

Key Army initiatives include increasing the number of Active Duty Army brigade combat teams; upgrading ground vehicles with active protection systems; investing in long-range precision fires, electronic warfare, and protected communications; upgrading Paladins with hyper velocity projectiles for ballistic and cruise missile defense; experimenting with new concepts for air and ground robotic teammates; and investing in human enhancement technologies to improve soldier performance.

The Army should also improve its ability to conduct day-to-day advising activities without disrupting the readiness of brigade combat teams by investing in new advise and assist brigades to resource this mission.

These investments would improve the military's ability to project power into contested areas. But Congress must also help DOD address the underlying conditions that caused these threats to remain unaddressed. It was not because of a lack of funding or too much focus on counterinsurgency. From 2001 to 2008, DOD received a massive influx in defense spending. Not all of it went to the wars in Iraq and Afghanistan. Yet, we remain ill-postured today for

these emerging threats because of bureaucratic inertia, acquisition mismanagement, and a lack of strategic agility. Congress must help DOD address these institutional challenges as well.

Thank you for having me.

[The prepared statement of Mr. Scharre follows:]

PREPARED STATEMENT BY PAUL SCHARRE

ADAPTING THE FORCE TO EMERGING CHALLENGES

Chairman Cotton, Ranking Member King, and distinguished Senators, thank you for inviting me to testify today.

We are at a time of both risk and opportunity for the U.S. armed forces. Budget cuts instituted under the 2011 Budget Control Act have harmed military readiness and delayed urgently-needed modernization. The United States has fallen behind in adapting to challenges from other nations. Russia and China have developed a suite of capabilities, broadly labeled "anti-access / area denial" (A2/AD), that threaten traditional forms of United States power projection. In order to remain relevant as a global power, the United States must adapt to these challenges. At the same time, the United States must also find more cost-effective means of conducting day-to-day operations, such as countering terrorism and providing a stabilizing presence in key regions around the globe.

To accomplish these and other high-priority missions, such as defending the Homeland from ballistic missile attacks from rogue nations, the U.S. military must continue to evolve and adapt. Congress, working with the Trump Administration, has an opportunity to reverse the harmful budgetary cuts under the Budget Control Act (BCA). In addition to a sustained increase in defense spending above BCA levels, the Department of Defense (DOD) needs a predictable and stable budget in order to plan future activities.

With additional resources, DOD should prioritize (1) restoring readiness by funding maintenance and training and (2) modernizing the force to adapt to emerging challenges. U.S. forces cannot be considered "ready" if they are prepared for the wrong threats. United States forces must be trained, equipped, and postured to meet the challenges posed by China, Russia, Iran, North Korea, and violent extremism. Greater capacity alone cannot meet these challenges. The force must evolve its capabilities and operational concepts.

DOD should pursue a disciplined modernization strategy that focuses investments on high-payoff capabilities that can deliver the most value in countering A2/AD challenges. This approach should leverage existing programs wherever possible in order to maximize the efficient use of scarce resources. DOD should also capitalize on emerging technologies such as robotics and automation to increase operational effectiveness and decrease costs.[1] Finally, DOD should improve its ability to conduct day-to-day activities, such as countering terrorism, in a cost-effective manner by investing in a "high-low mix" of forces: a small number of highly capable assets for countering sophisticated adversaries and larger numbers of lower cost assets for routine operations.

The remainder of this testimony will outline key initiatives DOD should pursue to adapt the Air Force and Army to these challenges.

AIR FORCE—STRATEGIC ENVIRONMENT AND KEY INVESTMENT PRIORITIES

Adversary investments in advanced integrated air defense systems, ballistic and cruise missiles to target U.S. bases, and mobile and relocatable assets require the U.S. Air Force to adapt. U.S. aircraft must be able to project power over long distances, penetrate and survive in contested areas, deliver high volume fires, and persist in order to track mobile and relocatable targets. These forces need robust, secure communications links to operate as a distributed network.[2]

DOD has taken steps towards developing a global surveillance and strike capability that meets these ends, but more could be done to ensure DOD attention and

[1] For more on the cost-saving advantages of robotic systems, see Paul Scharre and Daniel Burg, "The $100 Billion Question: The Cost Case for Naval Uninhabited Combat Aircraft," Center for a New American Security, Washington, DC, August 2015, *https://www.cnas.org/publications/reports/the-100-billion-question.*

[2] See also David Ochmanek, "Restoring the Power Projection Capabilities of the U.S. Armed Forces," Testimony before the Senate Armed Services Committee, February 16, 2017, *http://www.armed-services.senate.gov/imo/media/doc/Ochmanek—02–16–17.pdf.*

investments are focused on the most high-priority areas. Key focus areas for the Air Force include:

- *Long-range penetrating strike:* The B–21 bomber, currently in development, will provide DOD with the ability to deliver high-volume fires in contested environments over long distances. Even medium-scale conflicts, like the opening phases of the 2003 Iraq War, require tens of thousands of weapons on targets.[3] Congress should work with the Administration to ensure that once the bomber enters production, procurement proceeds at the maximum rate in order to field this capability in sufficiently quantities for future conflicts. In the interim, the Air Force should leverage work underway on the B–21 to upgrade existing B–2 bombers, with a focus on increasing operational availability, survivability, lethality, and connectivity.
- *Persistent surveillance and strike:* In addition to delivering high volume fires, U.S. aircraft must have the ability to persist within contested areas in order to find, fix, and finish enemy mobile and relocatable targets. Stealthy uninhabited (unmanned) combat aircraft are the only way to do this from long range. Refuelable uninhabited aircraft could achieve ultra-long endurance, far exceeding the limits of human pilots.[4] While the Air Force has invested in a large fleet of non-stealthy uninhabited aircraft for counter-terrorism missions and a smaller number of stealthy uninhabited aircraft for reconnaissance,[5] it has yet to acquire a stealthy uninhabited combat air system (UCAS) for operations in contested environments. This is the most significant capability gap the Air Force faces today. Fortunately, the Air Force has a ready-made option to affordably develop this capability. The Air Force has stated that it is preserving the option of developing an "optionally manned" version of the B–21 in the future.[6] Congress should ensure the Air Force exercises that option and develops an optionally manned version that could be used for uninhabited, long endurance persistent surveillance and strike missions.
- *Robust, secure networks:* U.S. forces will be most effective when they are connected via secure, robust networks for communications and position, navigation, and timing (PNT). DOD should capitalize on the rapidly maturing commercial space market to lower satellite launch costs. DOD should also invest in an aerial layer network to increase redundancy, provide a resilient backup against satellite disruption, and diminish the advantages to adversaries of attacking U.S. satellites. This aerial layer could affordably be developed by placing communications and PNT relay nodes on stealthy UCAS so that they provide their own self-healing network in contested areas and on existing non-stealthy uninhabited aircraft for communications relay outside of contested areas.
- *Next-generation fires and effects:* The Air Force must continue to upgrade and increase its quantities of munitions to ensure they are sufficiently lethal, survivable, and acquired in sufficiently high capacity to operate against future threats. This includes procuring larger quantities of munitions such as the Joint Air-to-Surface Standoff Missile–Extended Range (JASSM–ER) and Long-Range Anti-Ship Missile (LRASM) and developing a new longer range air-to-air missile. The Air Force has led the way on developing small air-launched swarming air vehicles, which could be used for jamming, decoys, reconnaissance, battle damage assessment, and strike, and the Air Force should move swiftly to operationalize this technology.
- *Directed energy weapons:* High-energy lasers have the potential to provide a breakthrough capability that radically "changes the game" in aerial warfare because of their deep magazines. Provided they have sufficient power and cooling, high-energy lasers could continue engaging targets indefinitely, intercepting incoming missiles and providing offensive effects.[8] Coupled with long-endurance uninhabited aircraft, high-energy lasers could potentially provide persistent,

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[3] Micah Zenko, "Comparing the Islamic State Air War With History," July 6, 2015.

[4] Paul Scharre, "The Value of Endurance," Center for a New American Security, November 12, 2015, *https://www.cnas.org/publications/blog/infographic-the-value-of-endurance.*

[5] U.S. Air Force, "RQ–170 Sentinel," December 10, 2009, *http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104547/rq-170-sentinel.aspx.*

[6] Dave Majumdar, "USAF leader confirms manned decision for new bomber," FlightGlobal.com, April 23, 2013, *https://www.flightglobal.com/news/articles/usaf-leader-confirms-manned-decision-for-new-bomber-385037/.*

[7] For more on swarming concepts, see Paul Scharre, "Robotics on the Battlefield Part II: The Coming Swarm," Center for a New American Security, October, 2014, *https://www.cnas.org/publications/reports/robotics-on-thebattlefield-part-ii-the-coming-swarm.*

cost-effective defenses against cruise and ballistic missile attacks. The Air Force should continue to mature this important technology.

- *Lower-cost delivery systems:* The Air Force will need a way to affordably deliver large quantities of munitions. In addition to procuring long-range stealthy penetrating platforms, the Air Force should maximize the use of existing aircraft (e.g., B–1, B–52, F–15, F–16, and MQ–9) as delivery vehicles for standoff weapons, decoys, and swarming air vehicles. Operating in concert with stealthy aircraft, this high-low mix of platforms could help augment the magazine depth of U.S. forces. The Air Force should upgrade these platforms with the necessary communications, survivability improvements, and other capabilities to optimize their value against sophisticated adversaries.

Even as the Air Force pursues these capabilities to respond to adversary A2/AD challenges, it must also look for more cost-effective ways to counter less capable adversaries, such as the Islamic State. The Air Force should invest in a fleet of low-cost, light attack aircraft to conduct counter-terrorism, close air support, and other missions in permissive air environments. The Air Force should also optimize its MQ–9 Reaper fleet by investing in extended range, multi-aircraft control, and automated information processing, exploitation, and dissemination in order to improve operational cost-effectiveness.

ARMY—STRATEGIC ENVIRONMENT AND KEY INVESTMENT PRIORITIES

The Army must similarly adapt, investing in new capabilities and concepts of operation to respond to emerging challenges. The Army must be prepared to face a diverse array of potential threats, from sophisticated states such as Russia to non-state actors such as the Islamic State and potentially "hybrid" actors in between. Russia should be the "pacing threat" for Army modernization—the threat archetype that represents the most sophisticated potential adversary in terms of capabilities, technology, and organization. This does not mean that all other threats are "lesser included" cases. Indeed, the U.S. experience in Iraq and Afghanistan demonstrated that ground forces optimized to fight a conventional war against a state actor may be woefully unprepared for counterinsurgency or irregular warfare. The Army must be prepared to fight across the full spectrum of potential adversaries, which may require special-purpose capabilities, doctrine, training, and organizations to counter certain threats. Both states and non-state actors alike are innovating in ways that challenge the U.S. Army and could potentially dramatically change ground warfare in the coming years.

The Army must shift from a force primarily trained for counterinsurgency warfare towards one prepared to deter and defeat aggression against a major state competitor. Key initiatives include:

- Increasing the number of active duty armored brigade combat teams (BCTs);
- Upgrading ground vehicles with active protection systems (APS) to intercept precision-guided anti-armor weapons;
- Investing in long-range precision fires, electronic warfare, and protected communications;
- Upgrading Paladin 155mm howitzers with hyper velocity projectiles (HVPs) and targeting capabilities for ballistic and cruise missile defense;[9] and
- Experimenting with new operational concepts leveraging air and ground robotic teammates.

At the same time that the Army is upgrading its forces to keep pace with adversaries, it must prepare for potentially dramatic changes in the character of ground combat.

- *Threat from enemy air attack:* For decades, the Army has been able to rely upon U.S. air superiority to eliminate the threat from enemy aircraft such that U.S. ground forces have not faced threats from the air. That era is ending. In a Russia conflict, U.S. ground forces would have to fight within range of Russian air defenses and aircraft before those threats are eliminated. That means that U.S. ground forces would be operating within the A2/AD "bubble." The Army must adapt its capabilities and concepts of operation to cope with a contested airspace. The Army must increase its investment in air defenses and reduce the signature of U.S. ground forces through camouflage, concealment, and deception. U.S. ground forces also face the threats of air attack from non-state actors

[9] Sam LaGrone, "Pentagon: New Rounds for Old Guns Could Change Missile Defense for Navy, Army," USNI News, July 18, 2016.

equipped with low-cost commercially available drones. While these low-cost drones are not a threat to U.S. fighter aircraft, they are a threat to ground forces and U.S. fighters are improperly matched to counter this threat. The Army will need to invest in countermeasures to detect, target, and destroy swarms of small commercial drones.

- *Air-ground robotic systems:* Other nations are investing in military-specific ground and air robotic vehicles and using them in novel ways. Russia has been developing a fleet of ground robotic vehicles, including some that are armed, and has employed uninhabited aircraft as forward observers for artillery in the Ukraine. Robotic systems can be used to increase standoff from threats, field larger numbers of forces on the battlefield, persist beyond the limits of human endurance, and enable new concepts of operation such as attritable swarming formations. The result could be new doctrine and ways of fighting on par with the invention of the blitzkrieg. While the Army has been at the forefront of integrating uninhabited aircraft into its force, partnering uninhabited Gray Eagle aircraft with inhabited Apache helicopters, the Army significantly lags other nations in ground robotics. The Army will be woefully unprepared for future conflicts if it misses out on the opportunity provided by robotic systems. The Army should increase its investment in ground robotics, including armed systems, and experiment with robotic teammates in mixed manned-unmanned formations.
- *Precision-guided infantry weapons:* One of the most innovative transformations in warfare over the past several decades was the invention of precision-guided weapons. Warfare at the level of infantry combat has remained, however, largely a realm of unguided weapons. With the exception of night vision, infantry tactics have changed little since World War II. The continued miniaturization of electronics means that precision-guided weapons are filtering down to the level of the individual soldier, however. A range of new weapons, from smart munitions to intelligent rifles to small drones, are placing precision-guided weapons into the hands of the individual soldier.[10] A future in which individual soldiers can target each other with precision at long ranges would change infantry combat in ways not seen since the invention of the machine gun. While some of these systems have been developed by the Army, others come from the commercial sector and will be widely available. The Army should experiment with new ways of fighting with and defending against these technologies in order to prepare for changes to come.

Even as the Army prepares for these potential changes in warfare, the Army must also conduct a wide range of day-to-day peacetime activities, including advising and assisting partner forces. The Army's current model for resourcing these missions is to pull individual soldiers from Brigade Combat Team (BCTs), an approach that is inefficient and undermines readiness. In order to help restore readiness, the Army should invest in Advise and Assist Brigades (AABs) that would provide a pool of qualified advisors to resource these missions without disrupting BCT readiness.

Finally, the Army should take advantage of emerging technologies that have the potential to directly improve the capabilities of individual soldiers. These include:

- Increasing soldier protection against blast-induced brain injury through improved helmet design;
- Investing in human enhancement technologies, such as transcranial direct current stimulation (tDCS)[11] and pharmaceutical enhancements to improve alertness and cognitive performance, such as modafinil;[12] and

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[10] For more on these changes to ground warfare, see Paul Scharre, "Uncertain Ground: Emerging Challenges in Land Warfare," Center for a New American Security, December 2015, *https://www.cnas.org/publications/reports/uncertain-ground-emerging-challenges-in-land-warfare.*

[11] Jeremy Nelson, R. Andy McKinley, Edward Golob, Joel Warm, and Raja Parasuraman, "Enhancing vigilance in operators with prefrontal cortex transcranial direct stimulation (tDCS)" *NeuroImage* 85 no. 3 (January 2014), 909917. Justin Nelson, Richard McKinley, Chandler Phillips, Lindsey McIntire, Chuck Goodyear, Aerial Kreiner, and Lanie Monforton, "The Effects of Transcranial Direct Current Stimulation (tDCS) on Multitasking Throughput Capacity, *Frontiers in Human Neuroscience,* (2016).

[12] Arthur Estrada et al., "A comparison of the efficacy of modafinil and dextroamphetamine as alertness promoting agents in aviators performing extended operations," *United States Army Aeromedical Research Laboratory,* Report No. 2011–05, December 2010, 4. Amanda Kelley et al., "Cognition-enhancing drugs and their appropriateness for aviation and ground troops: a meta-analysis," *United States Army Aeromedical Research Laboratory,* Report No. 2011–06, December 2010, 4. Amanda Kelley, Catherine Webb, Jeremy Athy, Sanita Ley, and Steven Gaydos, "Cognition enhancement by modafinil: a meta-analysis." *Aviation, Space, and Environmental Medicine,* 83 no. 7 (July 2012), 685–690.

- Maturing exoskeleton and exosuit technologies to improve soldier mobility and protection.

INCREASING STRATEGIC AGILITY

These investments can help evolve and adapt the force to confront a range of emerging challenges. Ultimately, however, DOD must become more agile so that it is better suited as an institution to rapidly adapt to adversary innovation. So long as DOD procures major weapon systems in timelines measured in decades, it will continually be shooting behind a moving target. Institutional innovations like the Army's Rapid Capabilities Office will be essential to improving DOD's strategic agility. Congressional support for this and other efforts is critical to sustaining America's military edge in the years to come.

Senator COTTON. Thank you, Mr. Scharre. Thank you, gentlemen, for your testimony.

Colonel Macgregor, you spoke of the differences in the kinds of wars we fought or saw fought around the world at the turn of the last century, the Philippine war, the Russia-Japan war, World War I, and how sometimes the wrong lessons were taken or we imagined a future war would look like the recent past war.

What is your vision for war and combat between great powers in the 21st Century? What can we expect to be different? What should we expect to be the same?

Mr. MACGREGOR. Obviously, people are looking carefully today and the Russians and the Chinese, but as Senator King pointed out, many of the capabilities they are developing are going to find a home in places like Iran, potentially Pakistan, India, and many other countries over time.

Russian military development right now is based on the work of a man named Gareyev. He is a former Russian general. His first name is Makhmut. He is an interesting man. He is still alive. He is actually a Tartar who was russified, and he was one of General Ogarkov's brain trust members back in the 1970s, 1980s, and 1990s. He foresaw a war that resembles in many ways what I wrote about in the statement. He anticipated the arrival of precision, not just in the United States, but eventually in Russian hands as elsewhere, the impact of microcircuitry, computational power, and that this precision paradigm would essentially obviate the need for nuclear weapons but would suddenly make conventional munitions and capabilities infinitely more capable.

So what we see now emerging in Russia and what I think we are going to see emerging around the world increasingly are categories of weapons like the rocket artillery that carries a variety of different warheads, that can launch for 90 or 100 kilometers with great precision on very short notice, loitering munitions. These are essentially unmanned aerial vehicles, for all intents and purposes another form of cruise missile. These loitering munitions will fly for hours. They will fly day or night using various kinds of acquisition. They will look for and find targets on the ground, and then fly directly into those targets. As soon as a target is identified and they attack it, that will be followed up by rocket artillery.

At the same time, we are dealing with these integrated air defenses that, once again, thanks to the computational power that once was our monopoly and is now also in Russian hands, presents us with a very serious threat to any form of air power, but specifically air power that flies low and slow, to the point where many of the aircraft in the Army and the Marine Corps, if they were used

in a place like eastern Ukraine, would be shot instantly out of the sky.

So what we have got now I think is a different kind of battlefield from anything we have seen before. We have to be prepared to disperse on it because if we present a concentration, we become a lucrative target. We cannot simply hold ground, dig in, and fight back because if we are static for any length of time, the persistence surveillance will find us and attack us. If we are not armored, flesh and bone is not going to survive very long because virtually everything exists to kill the individual human being who is not protected. So we need protected mobility, but that mobility, to be effective, needs to be armored, needs to be tracked for reasons of physics to provide adequate protection, to provide stable platforms for all of the various weapon systems that now need to be incorporated into future formations much beyond this thing we call the brigade combat team.

So that future battlefield is going to be confusing. It is going to be very lethal. It is going to demand greater dispersion. We are going to see that battlefield empty quite a bit even more so than we have seen over the last 50 years. We are going to have to find new ways to sustain ourselves. We are going to have to have more support integrated at lower levels that allows for greater dispersion, new forms of command and control that integrate capabilities across service lines very quickly, without hesitation because our inability to make decisions quickly in this setting with all of the capabilities at our disposal could be fatal. So that is in broad terms the picture that I see, sir.

Senator COTTON. General Deptula, would you care to offer any comments on Colonel Macgregor's vision for all arms warfare?

Mr. DEPTULA. Yes, sir. I think Colonel Macgregor outlined some specifics. I would tell you that the nature of future warfare is going to depend on the particular situation and scenario. Clearly the situation that might exist in the conflict in the South China Sea is very different than the specifics of one that Doug just spoke about that might occur in Central Europe.

However, I can postulate some changes in the character of those conflicts from those in the past.

First, information, always prized, is going to become the dominant factor in the battlespace. Who has the greatest situational awareness is going to win.

Second, electronic warfare is no longer going to be just an enabling capability. It will be a survival requirement. The proliferation of high-end electronics has made offensive cyber operations in electronic warfare the modern military equalizer. We see some of that going on today without full-scale warfare.

As you pointed out, Mr. Chairman, area denial will become the norm, not the exception in the future. The conditions of a major theater war will be very different from the experience of the members the U.S. Military has today. It is an interesting fact that over 85 percent of the Active Duty U.S. Military has joined since 9/11/2001. So their experience is primarily in the counterinsurgency and counterterrorism environments of Iraq and Afghanistan. You went through some of the challenges, heavy opposing artillery or armor, barrages of theater ballistic missiles, the rear areas under attack,

surface-to-air missiles ranging hundreds of miles, smart mines, quiet submarines, and so on and so forth. Remotely piloted aircraft that we have become used to relying on today, non-survival, non-stealthy, are going to start falling from the sky like rain. So we need to be able to anticipate those kinds of characteristics.

Because of these factors, warfare in the future will by necessity become more disaggregated, a word that Doug mentioned, than in the past. So we better get used to fighting effectively in a much more decentralized and degraded set of conditions than what we have become used to over the last 15 years.

We also need to reverse the culture of "mother, may I" force application and empower our warfighters with execution authority. Senior commanders need to provide guidance regarding desired effects of the campaign and then empower the warfighters to fight.

Senator COTTON. Thank you, General.

Senator King?

Senator KING. It is hard to know where to start.

All of our discussion is about kinetics essentially. Russia, I would argue, has achieved an extraordinary success in the last several years if they set out to destabilize the West and undermine Western democratic values. We do not know what the outcome of the election is going to be in the Netherlands today. They are active now in France and Germany. They were clearly active in our elections here. Somebody once said—I think it was after September 11th, one of the conclusions was our response was a failure of imagination. We have to use our imagination to realize that if they set out to destabilize Western values, they have done it without firing a shot, and that has got to be part of our strategy. That is simply a comment.

One of the things that concerns me—and we all sort of take this for granted—is the heightened levels of communication and capacity to integrate. General Deptula, you mentioned that. If our strategy is based upon seamless communications, what happens when the wires are cut? I was heartened to learn that at the Naval Academy I think just this year they started teaching celestial navigation again after a 20-year lapse because everybody assumed GPS was the answer. How do we deal with the problem of cyber or electronic warfare that blinds us, the electronic equivalent of J.E.B. Stuart being off chasing boots instead of being Lee's eyes and ears. General Deptula?

Mr. DEPTULA. Yes, sir. Those are excellent points. As you noted in our discussion earlier, I am a big advocate of linking our forces together to use information as an advantage. Obviously, we have to be prepared, however, for adversary attacks that degrade the perfect exchange of information because regardless of where technology goes, there will always be the unexpected. The fog of warfare is not going to be blown away by technology. It will always be present.

So, therefore, ensconced in this whole notion of seamless, ubiquitous sharing of information must be, again, the ability to operate in conjunction with the commander's overall strategic intent even if you are disconnected from different elements of this combat cloud that I have advocated. So we have to make the ability to operate

in degraded structures part of the norm, part of our training processes.

I am very concerned that over the last 15 years—and this is what I alluded to in my opening remarks—we have gotten so used to modern telecommunications providing connectivity. What happens when that goes away. This is what I mean by we also have to reverse this whole notion of "mother, may I" warfare. So commander's intent need to be understood by all the warfighting elements so that if they are disconnected, until we are able to reestablish connectivity, they can still fight and contribute to the overall mission commander's objectives.

Senator KING. Colonel, do you want to comment?

Mr. MACGREGOR. A couple of things. First of all, as we look at this proposed formation that we would like to build using rapid prototyping, leveraging existing technologies, existing platforms, not inventing new things or expecting someone to break the laws of physics in the process, as we look at this, we can do a lot of things today with communications that exist that we are not using, for instance, in the United States Army. We have access to something called WiMax, fourth generation telecommunications. If we were to adopt that and encrypt it, breaking that system would take a super computer 1,000 years. So one of the solutions to the cyber threat is good encryption. But to do that effectively, we need to look at new technologies that we can rapidly integrate today on the ground that will make a huge difference.

Senator KING. The word "rapidly" does not apply very much to our organization of our military. That is a term you do not hear very often.

Mr. MACGREGOR. Well, I do not disagree with you, but that is a self-inflicted wound in most cases.

One of the things that we looked at when we developed this reconnaissance strike group—we looked at what the Germans did in the late 1920s and early 1930s. They set up a group of people independent of the conventional army, and they were told to look at all the new technologies of warfare and how they would organize those technologies and soldiers and airmen differently. The result of that was that by 1935, you had five new armored divisions emerge with new battle groups inside of them that looked nothing like anyone had ever seen in history. It also produced the Stuka dive bomber and the idea of air-ground coordination and close integration between the air and the ground, which was revolutionary and frankly a strategic advantage over everyone that the Germans fought for many years.

Senator KING. But it is interesting you pointed out that this innovation came from a group outside of the military.

Mr. MACGREGOR. Yes.

Senator KING. My note said organizations are rarely reformed or restructured——

Mr. MACGREGOR. Exactly right. That is why the idea behind the reconnaissance strike group is that you do not build this inside the Army. You take it outside of the Army. It has to have the participation of all the services.

The Army historically has built its formations in isolation from the other services. That is impossible today. First of all, we cannot

afford it. Secondly, we need to leverage what already works in the other services. We need an Air Force officer, a naval officer to stand there and say, wait a minute. Before you buy X, before you invest in this, be aware of what we have already got that actually works right now in the Air Force and in the Navy. That can be rapidly integrated to fill that capability shortfall.

The same thing is true with weapons, rockets, missiles, all of these kinds of things, but also organizational constructs. What are you building the construct to do? We today have a 1942 construct called the brigade combat team. That is the regimental combat team from 1942. It is still organized around the same old functions that we have been organizing for decades. Those functions do not necessarily vanish, but they are not necessarily the right functions anymore because today we have the capability to detect an enemy, target an enemy, attack an enemy much earlier than we ever did before. Today formations on land need to look a lot more like ships at sea because we have the capability within these formations to build an ISR-strike construct that can be linked to larger constructs in the other services. So the RSG [Reconnaissance Strike Group] needs to be a special purpose organization.

I am sure you are familiar with Mr. Christensen's book, "The Innovator's Dilemma." In his book, he points out that many, many corporations have squandered the impact of new technologies, new organizations, new management techniques because they tried to push them in the existing organization, which of course worked tirelessly to destroy it.

Senator KING. The mouse was invented at Xerox Park. It was developed by Apple.

Mr. MACGREGOR. Right. No matter what anybody says, Peter Drucker was right. He said if you want to stop doing something old, you have got to start doing something new. People always cling to what is obsolete. People are comfortable with what they know. They are not comfortable with the unknown.

The RSG is the march into the unknown because if we do this properly and we prototype the platforms and we use new communications technology, we involve the Air Force and the Navy, we are going to discover what we do not need anymore, things that we can shed. We do not need to spend money on things that no longer have much utility.

On the other hand, we could also discover what it is that we need that we do not have. But we will only do that when we do, as the Germans did, put these things into the hands of soldiers, sergeants, lieutenants, and captains, majors, lieutenant colonels and say tell us what this does. Show us how this works. Then they will come back and tell you what the answer is. That answer may or may not be popular with the status quo, but it is the answer we have to find.

Senator KING. Thank you.

Senator COTTON. Senator Warren?

Senator WARREN. Thank you, Mr. Chairman, and thank you all for being here.

I would like to start by asking a question about the future of our ground forces. The Army went into Iraq in 2003 with absolutely unmatched capabilities and then quickly became bogged down fac-

ing a determined adversary that effectively used low-grade technology to harm our troops.

In recent years, senior Army officers have cautioned against the myth that advanced technology will win wars. While I think most people would agree that technology alone will not win wars, I think we turn away from technology at our peril. In fact, potential adversaries such as Russia and China are rapidly capitalizing on and integrating new technology in their ground forces.

So that is what I wanted to ask about, and if I could start with you, Mr. Scharre. Could you name the three technologies that are in development that you think have the greatest potential impact on ground warfare in, say, the next 5 to 10 years and how it is that we should be thinking about developing and integrating them?

Mr. SCHARRE. Absolutely, Senator. Thank you.

I think there are some very clear things that we can look at, what Russia has been modernizing its forces and the way they have been employing them in the Ukraine. We can see places our Army is falling behind. Electronic warfare, protected communications on the move, long-range precision fires would be at the top of that list. There are other areas like active protection systems for ground vehicles that the Army looks like they are moving forward on, integrating those. There are other places like integrating more robotic and unmanned systems that the Army has been really, I think, doing a pretty innovative job with their aviation fleet towards pairing them with Apache helicopters. But I think those are some of the key things where—and those technical skill sets, the electronic warfare, communications, and particularly long-range fires— those are the places where the Army has fallen behind.

Senator WARREN. That is very helpful.

General Deptula, can I ask you to weigh in on that?

Mr. DEPTULA. Yes, Senator.

The first one that comes to mind, the greater incorporation of remotely operated ground vehicles. We have seen the benefits of remotely operating airborne vehicles, also known as drones, unmanned aerial vehicles, whatever you would like to call them. But unmanned ground vehicles is certainly an area of potential, as is directed energy both from an offensive perspective and a defensive perspective.

Senator WARREN. Could you say a little more about that?

Mr. DEPTULA. Directed energy?

Senator WARREN. Yes.

Mr. DEPTULA. If you look at the potential of directed energy to assist in air defenses, we are still challenged by the attenuation of directed energy beams inside the atmosphere, but there still have been very successful applications in close-in, short distances.

The second piece on the offensive front is the use of microwaves as a nonlethal means to render an adversary or people as they approach in a close environment.

So those are two that I would highlight.

Senator WARREN. That is very interesting.

Colonel Macgregor, could I ask you the same question?

Mr. MACGREGOR. Senator, I think the capabilities that we need, the technologies we need exist as opposed to the requirement for development.

I am much more skeptical of the near-term realization of weapons from lasers. I think the problems with the atmosphere, the problems with powering lasers are just enormous. We are having a number of problems. We have worked on this airborne laser for years and years and years. It has not worked. I would not expect much from that for a very long time.

Robotics, at least on the ground, is very—they are very problematic. It is not a matter of better algorithms. A man really has to control it, has to maneuver it. They are relatively easily destroyed by enemy fire. We found that in Afghanistan when we sent them into caves. We found that in Iraq. So I think there are lots of expectations of micro-robots that are unrealistic. Everything requires infrastructure. Everything requires a human being. There is no artificial intelligence. There are better algorithms, but real artificial intelligence, to quote one physicist, is an analogous to a medieval sculptor trying to reengineer or reverse engineer a jet aircraft today. We are a very long way from that sort of——

Senator WARREN. Sir, actually I understand your point about what you think will not work. Are you telling me you have nothing on your list for development in the next 5 to 10 years?

Mr. MACGREGOR. When I look at development, first what I want to do is take what is there that we know works and rapidly prototype it, integrate it, and employ it as opposed to speculating. First of all, I am not a physicist.

Senator WARREN. So I take that as a no.

Mr. MACGREGOR. Yes. I really do not want to walk down that road because at this point the things that we need we can get now at relatively little expense, and we can find out what they can or cannot do. Based on that, I think then we can establish where we might want to go in the future with other things. I mean, to sit here and say do we need a new tank, for instance, I would argue that we need new gun systems, new platforms. The platforms need to be modular. The platforms need to be more fuel efficient. Could we do with a bigger, better gun, in many cases, yes. We have a 130 millimeter tank gun right now that exists. For an 8 percent increase in the caliber of the gun, you get a 50 percent increase in the striking power.

Senator WARREN. Okay. I get your point that there are places where you think we can make changes at the margins.

Mr. MACGREGOR. No, no, no, no. These are profound changes, Senator.

Senator WARREN. I just have to say I am concerned that if we believe that the lesson out of the Iraq war is that technology and new technology will not be important in future combat——

Mr. MACGREGOR. No. I did not say that.

Senator WARREN. I am sorry. That is what I hear you say.

Mr. MACGREGOR. No, not at all. Absolutely not. In fact, we spent some time at the beginning talking about the fact that comparatively speaking, that was a low-tech environment because it required a different kind of soldiering in order to be successful, and people operated under extremely restricted rules of engagement that made a huge difference to the effectiveness of the force.

You mentioned that we were unmatched in 2003, and I would tell you that is absolutely not true. We had tanks with turbine en-

gines in them that had perhaps, at the most, 7 to 8 hours of fuel capacity.

Senator WARREN. Are you telling me that the Iraqis had better technology in 2003?

Mr. MACGREGOR. No. What I am telling you is that we were not unmatched. We were already at a point since 1991 of having effectively stagnated. We had not moved forward. We had not prototyped equipment.

Senator WARREN. We were up against an enemy that we had far superior technology.

Mr. MACGREGOR. Yes, but that enemy was quickly brushed aside. No. You are talking about the problems that ensued when the decisions were made—policy decisions—to dismantle the government, liquidate the army, and then govern a Muslim Arab country with European Christians and Americans who had no chance of success in that endeavor. They were sabotaged on day one. We had 500 years of history and experience with that when we went in there. I was on Active Duty at the time.

Senator WARREN. I think there are a lot of people who were injured in that conflict by low-grade technology——

Mr. MACGREGOR. Sure.

Senator WARREN.—that was matched against our very high-grade technology in ways that surprised many both in the military and in civilian life.

Why do we not leave it there and I will ask about the UAVs [Unmanned Aerial Vehicles]? Because I have a question about how they have changed, how we think about their combat.

In 2001, we went to Afghanistan with a small number of drones. All a drone could do at that point was take a picture. Today the U.S. Military has over 7,000, many of which are armed with missiles. Many are involved in strikes on ground targets.

Deputy Secretary Bob Work has spoken at length about integrating manned and unmanned systems. In a recent episode of 60 Minutes,? Dr. Will Roper from the Defense Department's Strategic Capabilities Office actually demonstrated how more than 100 tiny drones could operate autonomously as a swarm after being released from the back of a Navy fighter jet.

Now, these UAVs were developed in Massachusetts at MIT's [Michigan Institute of Technology] Lincoln Laboratory, and the tests showed they will some day be able to patrol air space, penetrate enemy defenses, or even serve as decoys for our manned aircraft. That, obviously, helps protect our pilots. In short, they have the potential to revolutionize what air combat looks like.

So if I could ask you about this. What types of capabilities do you think that the Air Force should be focusing on when it comes to these unmanned aerial systems. General Deptula, would you like to start?

Mr. DEPTULA. Sure.

The subject is one that is personal because yours truly was a director of the air operations center in October, actually October 7th, 2001, when we first employed a lethal weapon off a remotely piloted aircraft in combat. Then I had the good fortune of overseeing the increase in investment in numbers in remotely piloted aircraft

in the first decade of the 21st Century, increasing the use of those aircraft in the Air Force by over 500 percent.

Senator WARREN. So I found the man to ask the question.

Mr. DEPTULA. So I am a fan.

We need to continue to exploit the advantages that the persistence of remotely piloted aircraft provide. Today I will tell you that is probably the biggest single advantage because they give us the opportunity to watch a particular area of interest and then to determine what the appropriate course of action is. Contrary to some of the popular mythology that these are very inaccurate vehicles, they actually provide the United States an advantage in the context of providing the greatest ethical oversight before weapons employment is considered because of this persistence and ability to operate over time and the most precise means of employing force at a distance.

You mentioned the issue of swarming. In addition to swarming, the Air Force is also pursuing the concept of loyal wingmen where you use unmanned aerial vehicles in a variety of different modes to act as weapons drones, if you will, or mules carrying additional weapons for aircraft like F–35, F–22 where those information sensor shooters can then control a series of unmanned aircraft to amplify the effect of being in any particular area.

So it is a wide open area that needs continual investment and exploitation.

Senator WARREN. With the chairman's permission, may I ask the other two?

Colonel Macgregor, would you like to weigh in on that?

Mr. MACGREGOR. I agree with General Deptula. The only thing that I would point out is that unmanned systems can be shot down just as readily as manned aircraft.

Senator WARREN. I do not think he suggested otherwise.

Mr. MACGREGOR. No, but I think people miss that point. There is a tendency to assume that the unmanned system will be more survivable and be less vulnerable and that the answer is to have more of them. Certainly having many of them is very, very important, and in the RSG, we built those into the system for that very reason. But the point is they are still vulnerable, and they are not unmanned because there are huge numbers of people on the ground that are required in order to maneuver them and employ them effectively. But persistent surveillance is critical, and whatever you can do to achieve that is key to victory.

Senator WARREN. Mr. Scharre, would you like to add anything? My question is where is that the Air Force should be focusing at this point in dealing with the unmanned aerial vehicles?

Mr. SCHARRE. Thank you, Senator.

I think that this vision that General Deptula outlined about an idea of a loyal wingman combat aircraft that could operate alongside F–22's, F–35's, the new B–21 in contested areas is actually the biggest capability gap the Air Force faces today. The Air Force is not developing that aircraft. Now it is absolutely essential because of this ability to have greater persistence. So it is not just a whizbang technology. The problem is that in an anti-access environment, we are fighting from very long ranges. Enemy missiles, ballistic and cruise missiles put all our airbases at risk. We have to

fly from very long distances, and there are just fundamental limits of what a human can do in a cockpit and remain combat effective.

Now we can put up a refuelable stealthy combat aircraft. They can stay up for hours, days at a time. We have seen non-stealthy aircraft stay up for 80 hours. So we have a large fleet of non-stealthy aircraft that would not survive in these environments. The Air Force has invested in a very small number of stealthy reconnaissance aircraft, but it does not right now have a stealthy combat aircraft, which is really the biggest gap they need to fill.

Senator WARREN. All right. That was very helpful. Thank you very much.

Thank you, Mr. Chairman.

Senator COTTON. We have spoken a lot about technology today, but one point that keeps occurring is the human element of warfare.

Colonel Macgregor, do you foresee a time in the future when we will ever fight in a fashion in which the war does not end up with infantrymen on the ground in the mud?

Mr. MACGREGOR. Near term, no. We will still have to put human beings at risk. Even if you mount most of your infantry inside armored vehicles, inevitably they are going to dismount at some point. We can extend their capability using various kinds of unmanned systems, whether they are drones or ground robotic vehicles. But these things can extend human potential. They cannot necessarily substitute for it. They cannot replace human judgment, human reasoning, human understanding. That is really the point I was trying to make on artificial intelligence. We have to be very careful of our assumptions about how far we can go with that.

Senator COTTON. General Deptula?

Mr. DEPTULA. If we want to be able to accomplish as a Nation our national security objectives, we have to be able to exploit the capabilities resident in each one of our services, Army, Navy, Air Force, and Marines, Coast Guard. But how we employ our forces should not be dictated by a predetermined, formulaic solution. So, no. Every conflict is not going to end up with an infantryman standing on top of his adversary with his boot on his neck and a bayonet at his throat. Examples I would provide to you are the manner—let me go back a step because this goes back to my statement.

To be effective in the future, we need to apply the right force at the right place at the right time. It is not always going to be a predetermined fashion. That is the beauty of jointness is each joint task force commander has at his or her disposal service components that they can then mix and match to apply to the particular contingency at hand. So when you look at how we did in Operation Desert Storm, surface forces were not used for the first 39 days of a 43-day operation. If you look at Operation Allied Force, U.S. ground forces were not used at all. If you look at Operation Enduring Freedom, we accomplished U.S. national security objectives by the 31st of December, 2001 with a small number of special operations and other government agency folks acting as ISR [Intelligence Surveillance & Reconnaissance] centers on the ground providing information to aircraft using precision weapons in the air.

So my point is we have to be very careful about we are always going to use infantry. That is the only caution. We should always have that option available to be able to tailor the use of our expert forces when and where they are needed.

Senator COTTON. Mr. Scharre?

Mr. SCHARRE. So thank you, Senator.

I admit that perhaps I am biased as a former infantryman. But I think, obviously, wars are different, and there have been some examples like the Kosovo air campaign. We did not put in ground troops. But can I envision a world where we do not have to use ground troops in the future? It is very hard for me to envision that for the simple reason that we are going to care about the political outcomes on the ground. That is going to motivate why we going to war. We got stuck in Iraq and Afghanistan because we cared about the political outcomes of those countries afterwards.

So the unfortunate thing is that as much as the Military has been able to invest in new technology to improve its capabilities, as Senator Warren mentioned, we really have not been able to change that at the level of the infantry soldier. So in World War II, the three most dangerous jobs in the U.S. Military were in bombers, submarines, and the infantry. We were able to leverage technology in these other areas for things like stealthy submarines, stealth bombers.

But the infantry is as dangerous as it has ever been. Part of that is the fundamental limitations of a human being and what that person can carry. It never changed since Roman times. Every time we give more protection to a soldier on the ground, we give them more body armor. We are weighing them down. We are slowing them. There is no way out of that trap. Technology cannot fix this today.

But there are some things that we can do in the near term and long term to change this to make infantry more survivable for those soldiers that are on the ground.

One is better helmet protection. Traumatic brain injury (TBI), is the signature wound of these conflicts. Experimental modeling and tests have shown that there are ways to design better helmets that could protect soldiers against brain injury. We do not currently have a requirement to do that. That is, I think, a big gap in the U.S. Army, that we should establish a requirement to better protect soldiers from brain injury.

Two, exoskeletons. That is further down the road, but the Army does not have an active program to develop this. There is technology now on the horizon that we can see that might be able to get to a place where soldiers could carry more, be more mobile, have better protection.

Three, robotic teammates. We have seen some of these demonstrated in things like the BigDog and AlphaDog system that are viable.

The last one is human enhancement technologies, things like transcranial direct current stimulation, pharmaceuticals like modafinil that could increase alertness and cognition for soldiers and other service members to improve their capabilities and their survivability.

Senator COTTON. Colonel Macgregor, in the old days, the Army used to say there were five elements of combat power and leadership was the most dynamic element because it infused the other four. Do they still say that in the Army?

Mr. MACGREGOR. As far as I know, we still exalt leadership as a critical combat power source, yes.

Senator COTTON. Given the changing face of war in the future and the fact that we in the old days—and by old days, I mean about 10 or 12 years ago—the Army used to refer to C2 (command and control). Then it went to C3 [command, control, computers]. Then it went to C4 [command, control, computers, cyber], and then it went to C4ISR [command, control, computers, cyber, intelligence, surveillance, reconnaissance], maybe on something else now with more acronyms. What differences would you expect to see in ground combat leaders of the future as compared to ground combat leaders of the last 25 years?

Mr. MACGREGOR. We have been on the road to increasingly greater dispersion of capability and combat power on the ground. That inevitably puts enormous responsibility and pressure on the leadership at the lowest level. If you are going to man a front of, say, 80 miles and cover that into a depth of another 60 or 70 miles and you are only going to have 6,000 men mounted in various kinds of vehicles with the kind of ISR-strike capability that we have been discussing, then the individual who is somewhere on mile 62, who is in charge of perhaps one or two vehicles, has to be able to make decisions and think. He has to understand the intent of the operation. He has to know what his commander wants him to accomplish. He has to know what the battle is supposed to look like, in other words, on the basis of what the commander's mission is and the mission that he has been assigned. He cannot depend upon micromanagement. He cannot assume that a lieutenant, a captain, a major, lieutenant colonel is going to show up and tell him exactly what to do.

I think this has been true for a long time. The Army has resisted because they fear failure, and their concern is that someone at a low level will make a decision that will cause failure at higher levels. But the nature of this future battlefield that we have been discussing makes that unavoidable. The nature of how you cultivate, identify, for that matter, recruit people has got to change.

One of the things that was very clear from the study that I have been through over the last several years in Margin of Victory is that, frankly, the more intelligent the soldier, the better the soldier and the more effective the unit. So you want someone who is highly intelligent, who can grasp what it is that you are expecting him to do, and then can make decisions within that framework that are going to be successful.

Senator COTTON. In that future, the old joke about military intelligence being an oxymoron may no longer obtain?

Mr. MACGREGOR. No, sir, absolutely not.

Senator COTTON. Thank you.

Senator King?

Senator KING. Well, as confirmation of what you just said, I suspect one of the most intelligent people ever to serve in the United States armed forces was Joshua Lawrence Chamberlain of Maine

who spoke 10 languages, was a college professor, and one of the most successful leaders, of course, at the battle of Gettysburg. Being from Maine, I cannot resist making that observation.

Colonel, you have talked several times about the RSG. Give me a succinct differential between the brigade combat force and the RSG. What is the difference? How do we identify one from the other?

Mr. MACGREGOR. Well, first of all, sir, your BCT [Brigade Combat Team], depending upon whether it is infantry or armor—again, that is the World War II construct—numbers somewhere between 3,500 up to perhaps 4,200 or 4,300. So some are going to be armored. Some will be light infantry. They are commanded by a full colonel. He has a lieutenant colonel as an executive officer, and he has a staff of captains.

Senator KING. He or she, Colonel. He or she. That is not a question. That is a statement. You keep saying he.

Mr. MACGREGOR. Yes. Well, I fully expect that if you go into close combat and fight the kinds of people that we are fighting, I would be surprised to see large numbers of women forward in the battle zone. History may prove me wrong, but that is my expectation based upon the last 5,000 years of history.

The bottom line is that this is an organization that is designed for linear warfare. You line up your brigade combat teams under a division headquarters. The brigade combat teams are, in turn, supported by divisional assets brigades, and then you move forward and fight in that fashion.

The reconnaissance strike group is 6,000 men commanded by a brigadier general. He has a staff of lieutenant colonels. The lieutenant colonels are organized, unsurprisingly, not as G–1, G–2, G–3, G–4, as we have seen in the past, but around ISR, strike, maneuver, sustainment, information, cyber, intelligence, and so forth. This formation then is designed to operate intimately with the aerospace community, the aerospace power that we have so that they are effectively, if you will, joined at the hip both technologically and in terms of——

Senator KING. That is not true of a modern BCT?

Mr. MACGREGOR. No, absolutely not. It does not have the ability to plug straight into a joint task force, straight into the United States Air Force. What the Air Force does is they will send someone down there as a liaison officer so that the brigade combat team, as it has for decades back into the Second World War, can call for fire support. We are now talking about a seamless integration where that reconnaissance strike group that has rocket artillery, it has loitering munitions, it has automatic mortars can actually also reinforce and magnify aerospace power, the striking power of your aircraft, manned and unmanned.

Senator KING. General, you have talked in your prepared testimony about cloud combat. Is this a similar concept? Again, I am trying to get a fix on what these concepts are.

Mr. DEPTULA. Yes, sir, it is because what Colonel Macgregor is talking about really boils down to information exchange, both in terms of being aware of what is going on in the vicinity and then being able to capitalize on either the forces that are part of the re-

connaissance strike group or air forces that are operating in the vicinity.

Senator KING. Is the current structure that you have the Air Force as a command structure and you have the Army as—are you suggesting there should be some—I think you are suggesting closer integration. At what point do they become one fighting force? Is this sort of Goldwater-Nichols 2.0 on the ground? Is that what you are suggesting?

Mr. DEPTULA. Not necessarily on the ground. It is, again, conceptually how we bring forces together to fight. Today in a surprise situation, the first time the airmen and the soldiers, sailors, and marines see each other who are going to participate in that operation is when they are at the point of embarkation to be able to get together and fight. What we are talking about is creating structures that inherently rely on one another for advantage and to begin the training process well before one deploys to fight.

Senator KING. You talk about training because we think of training as the Army has their training and the Air Force has their training. Is there any integrated training of our forces at Fort Benning or——

Mr. DEPTULA. Today there is. Yes, sir. But they are very, very specific at a tactical level. So you have joint terminal attack controllers working with surface units learning how to control aircraft. Well, that is a very tactical level activity. But in the context of training for and preparing for the employment of air and land and naval activities in the context of an operational challenge, not so much.

Senator KING. This is, after all, a legislative hearing. It is fascinating. But my question is, do any of you have suggestions of where we go from here in terms of law, things that should be in the National Defense Authorization Act, for example, that would change structures, change training systems? Do you have suggestions for us as legislators to implement some of the changes that you think are important?

Mr. MACGREGOR. Yes, sir. At the end of my statement, I have two critical recommendations which try to address exactly your question.

Going back to the special purpose organization called the reconnaissance strike group, effectively it is a test bed that can then provide us with a road map 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.

The first recommendation is urge the Chairman of the Joint Chiefs and the Secretary of Defense to accelerate this modeling and simulation of the RSG. We already conducted a modeling and simulation exercise with this formation with all of its capabilities. We are very confident of its performance. It was not high fidelity. We are going to get a better, more high fidelity modeling and simulation. But while we are doing that, we need some money so that we can take platforms—and the platform that I think is the best available right now is the German PUMA—and put different kinds of systems on that platform and begin to build a battalion set that

then becomes the experimental force that will tell us what we want in the future.

The second part of this is to look at integrative command structures. In the statement, I give you a straw man for what I call the joint force command structure. These are structures at the three-star level that are designed to replace your standing corps, Marine expeditionary forces, air forces, and so forth. Now instead you have an integrated structure organized around ISR, strike, maneuver, and sustainment, and we need to stand one up using officers from the various services and put it together and decide what we think it can and cannot do. In other words, in parallel with the formation that we are trying to build on the ground for all arms-all effects joint warfare, we need the command and control structure to develop simultaneously so that we end up in 3, 4, 5, 6, 7, 8 years with the solutions that you are asking for.

How fast we get there depends upon how much emphasis we put on this, how much resolve is included, how much you as the civilian leadership demand from the uniformed leadership because, again, as you pointed out earlier, when you begin to talk about integrative force structures that come at the expense of what we think of today as single service force structures and single service headquarters that provide lots of jobs for generals in the Army, Navy, Air Force, and Marines, and admirals, it is very threatening because you are talking about an operational command structure that is different from what we have now. They are not sure where they fit in. Again, these are the things that you have to do as civilians for us. We cannot do it for ourselves.

Senator KING. Mr. Scharre, your thoughts about what do you want us to go back and think about in terms of changing the rules, structures, legislation that would help to better prepare us for this new kind of warfare?

Mr. SCHARRE. Thank you, Senator. Yes, I do have some suggestions along those lines.

First, I cannot let this slide. I do think, Colonel Macgregor, the last 15 years of war have proven you wrong that we have had women prove themselves in combat. I have fought alongside some of them.

To your question, Senator, I think the biggest thing that I think history shows is valuable in situations like this is experimentation. So I do not know what a new organizing construct would look like, but I do think that there are enough emerging technologies to suggest, whether it is cyber, electronic warfare, robotics, that the Army should task a unit to go and experiment with these things and figure out how do we fight with this. This is what the Army did between World War I and World War II. The Army conducted a series of experiments called the Louisiana Maneuvers to figure out how to use tanks. Now, the biggest problem is the Army did not start that until 1940. I mean, the Army thought about tanks before, but they really did not kick off those large scale maneuvers until very late in the game.

I think if we can get ahead of that curve now and start doing those experiments, then we can go figure it out, figure out how do we use these things, how do we use robotics, how do we use other technologies, how do we use artificial intelligence and automation

to manage command and control problems, how do we fight without communications if we do not have it. How we fight in cyber makes us very vulnerable, and everything that is electronic goes down. So you got to break out the compass.

I think that organizational concept is really key to figuring out those innovative solutions.

Senator KING. General, do you have thoughts on this?

Mr. DEPTULA. Well, I will not elaborate too much except to say this is all about leadership, and it is also about the service and the joint leadership supporting these kinds of activities. I do not think it needs to be legislated, although encouragement certainly would help to kind of break out of the current operating paradigm and to encourage experimentation.

We have had, over the last several years, folks talk about bold thinking and innovation. But although there are exceptions, we have not seen a whole lot of that going on in the Department of Defense lately.

Senator COTTON. General Deptula, is it fair to say that you were somewhat involved in the air campaign in the Gulf War in 1990 and 1991?

Mr. DEPTULA. Yes, sir.

Senator COTTON. How important are the lessons learned from the Gulf War for our adversaries' modernization plans over the last 25 years, in particular China and Russia?

Mr. DEPTULA. That is a wonderful question, Mr. Chairman.

They actually learned the lessons that we delivered out of Operation Desert Storm. What they learned is not to give the United States the time to deploy and build up force structure in theater. They learned not to give the United States air forces—little A, little F—from all the service components the advantage of being able to operate over them because when that happens, we dominate. They have worked very, very hard over the years to come up with tools and techniques and strategies to deny us that advantage, which has resulted in the whole notion of A2/AD, or anti-access/area denial, strategies. They continue to work on those efforts. So our adversaries paid attention to what we did and they are committed to ensuring, to the best of their ability, that we are not able to achieve those advantages in the future.

Senator COTTON. Is it fair to say that they spent the last 25 years trying to ensure that what happened to Iraq in 1991 would never happen to them?

Mr. DEPTULA. Yes, sir.

Senator COTTON. For the life of our country, we have mostly thought away games, especially in the last 100 years. Do you anticipate that we will continue to fight away games in the old world in the future?

Mr. DEPTULA. Yes, I do expect that we will be fighting away games because, quite frankly, that is a premise of our national security strategy that I would tell you there are two critical tenets that have remained ensconced in that strategy regardless of the administration in power. The first one is that U.S. Military forces will be employed and engaged around the world during peacetime and attempt to shape and stabilize the different regions to prevent warfare. The second one is if we do have to fight, we will be prepared

to do so in more than one conflict simultaneously in an expeditionary fashion away from U.S. shores.

Now, that does not mean that we should not be prepared for the information age warfare, which we have already seen being perpetrated upon us in the realm of cyber attacks, cyber warfare, not to mention the obvious attacks that were pretty imaginative in the context of what happened on 9/11.

Senator COTTON. Well, given that, we will then continue to be heavily dependent on space and undersea fiber optic cables in particular, as we have discussed here, our great reliance on information operations. Is that right?

Mr. DEPTULA. Yes, sir.

Senator COTTON. Colonel Macgregor, you wanted to add something?

Mr. MACGREGOR. Sir, I would just add one thing. There is a nexus of terrorism and criminality in the Caribbean Basin that we ignore at great peril to the United States. Mexico is effectively a failed state in most respects. If you turn to the United Nations statistics on criminality and organized crime, right now Mexico, El Salvador, much of Central America is frankly more dangerous and more problematic than Iraq by far.

The problem for us with Mexico, ever since we finally had a border with Mexico, has been its tendency over the years to ally itself with whoever was our enemy. We have intervened in Mexico as a result several times. We intervened in 1873, intervened again in 1915 and 1916 in response to the Mexican revolution. Again, there have seen a series of revolutions, chaos in that country.

So my concern is that when we look at what we would call general purpose forces fighting major wars, certainly those will be overseas, but we have to reckon with the high probability that we could have a second front in Mexico and the Caribbean Basin that will involve U.S. naval air power and ground forces.

Senator COTTON. No doubt about that as was true in the Cold War as well in Central America and Grenada and the threats from Cuba.

Putting aside the conversation we have had is mostly focused on that kind of major war against peer and near-peer adversaries in the old world, taking into account those potential threats from the nexus of terrorism and international criminal networks to our south, how would that inform your decisions about the forces of the future?

Mr. MACGREGOR. Well, first of all, if you are looking at it from an Army perspective—and I think you have to—we have to truly be able to secure that border on very short notice. We need coastal naval forces that can protect our littoral waters I would argue more than we have today. That may involve a new set of ISR sensors. Some of you will remember that during the Cold War, we had the Acoustic Breeze up and down both coasts that alerted us to Soviet submarines. We may have to look at things like that for our coastal waters as well, different kinds of technologies.

Do we want to actually go into these countries? Not if we can avoid it, but we may have to execute punitive operations if we identify serious threats that could be arrayed against us. The problem right now is that something like a cruise missile is easily launched

from a location without much warning. The location could be identified, but by the time you arrive, the cruise missile is launched and the people that launched it may be gone. We will probably face some of that. I am not saying exclusively in Mexico. There are other places in the Caribbean from which that could also be done. We have to think about how we will respond to those things.

Then you have to have a more agile and flexible force structure. That is not necessarily going to require a mobile armored force, but that may require an air mobile force of some kind and it may require a different kind of light infantry force that is designed to go in, execute an operation, and get out quickly from the land, from the sea, from the air, whatever it turns out to be.

This is why the problem that we have I think to a large extent is the tendency to move towards the one-size-fits-all. We have to maintain forces with a variety of capabilities. So we are looking at different kinds of mission-focused capability packages. Those are the things that we need to begin building now for the future. We cannot wait. The old force package with its roots in 1942 is not the answer for the future.

Senator COTTON. Thank you.

I want to return to one discrete item you had said earlier, Colonel Macgregor, about how the future vehicles in the Army for reasons of physics will exclusively have to be tracked vehicles as a matter of physics. Is that because of the weight of the armor those vehicles will require?

Mr. MACGREGOR. Not necessarily. The difference between, say, an 8-wheeled vehicle and a tracked armored vehicle very straightforwardly is the following. The track distributes the weight very evenly across a large area. For instance, a 70-ton M1A1 tank exerts about the same ground pressure per square inch that I at 6 foot 2 and 220 pounds do. That means that your off-road mobility is exceptionally good. It also means that you have a very stable platform for a large weapon or an automatic cannon, whatever else.

Finally, if you go back and look at the recent Israeli experience in 2007, 2008 in southern Lebanon, they immediately went in on roads into that region. Then they suddenly found that the roads were obviously picketed by the enemy. They began losing equipment and people, so they had to get off the road. The problem with getting off the road in southern Lebanon is it is very rocky and difficult terrain. It is not convenient flat desert. They very quickly discovered that the only vehicle that could navigate that terrain, that could resupply forces, that could survive whatever was thrown at it was the Merkava tank. The Israelis, as a result, when they look at their combat formations, whether they are moving infantry or whether it is a tradition tank force, everything that they send into enemy territory is initially tracked.

The wheeled vehicle, on the other hand, touches the ground at eight points. It exerts a ground pressure of 30 to 40 pounds per square inch or higher, depending upon how heavy that vehicle is. It has very poor off-road mobility. It is not a good platform for advanced weaponry, and its survivability is poor because, again, you cannot distribute the weight in a way that provides the shell with extreme survivability in the event of a blast. So if you have a

choice, you are going to opt for tracked armor if you know you are moving into enemy territory.

Is that helpful, sir?

Senator COTTON. Yes. Thank you.

Senator King?

Senator KING. Mr. Scharre, what if any are our advantages today? In the past, we have always had advantages whether it was our industrial might, our technology, our leadership, the training and bravery of our people. What do you see as advantages?

What I see is that the advantages that we have had have narrowed over the last 15 or 20 years.

Talk to me about what are our advantages at this point vis-a-vis our near peers and others.

Mr. SCHARRE. Sure.

I think one of the most striking advantages that comes up frequently frankly is our people being better trained, better educated, a volunteer force. I think it is absolutely true. The disconcerting thing about that is it is easier for others to then close the gap. So all our pilots, submariners, our infantrymen are better trained than adversaries. Absolutely. But it also means that dollar for dollar for training investments, they can get closer to us. Right? It is harder for us to continue to improve.

I think looking forward, one area of the United States has a tremendous advantage in—and something we have not talked much about today—is the artificial intelligence revolution. Now, if we are talking about things like Cylons. We are not seeing that. Right? Science fiction AI [artificial intelligence]. But we are seeing an explosion in artificial intelligence in the private sector driven by companies like Google, Facebook, Apple, IBM, doing things like self-driving cars, managing your taxes, medical diagnoses. Really the United States' private sector is leading that charge. Other countries are nowhere near. One of the really down sides here is it is not coming from the traditional defense sector. DOD has put up a lot of walls to working with those companies.

Senator KING. What do you mean by that? DOD has put up walls about working with those——

Mr. SCHARRE. Just the regulations that are in place make it very difficult for companies that are not traditional defense companies to work with DOD. The profit margins are not there. There are regulations and red tape to work with our acquisition and requirements system. I have certainly heard from people like venture capitalists say that they will not let their companies they give their money to work with DOD because they are going to get sucked into a 5-year requirements process that, at the end of the day, will not give them a product that they can build that they can take to market. The profit margins will not be there for them.

Senator KING. That is a terrifying statement because what you are saying is the hotbed of technological development in this country is largely out of bounds for the Department of Defense.

Mr. SCHARRE. Yes.

Senator KING. That is a shocking statement that we have got to do something about.

Mr. SCHARRE. I think Secretary Carter had made efforts to try to improve this with some of his outreach to Silicon Valley, things

like DIUx [Defense Innovation Unit Experimental]. I think there is a lot of work still to be done here because ultimately it is not about Silicon Valley does not know where the Pentagon is. That is not the problem. It is about addressing these pain points in our acquisition and requirements system to try to find ways to make it easier for others to work us.

A case study on this was, a couple of years ago, Google bought out Boston Dynamics, a very cutting edge company that was doing very interesting things in robotics primarily for DARPA [Defense Advanced Research Projects Agency]. They said afterwards that they would finish the government contracts and they would not do any further work with the government because it is simply just not in their business interest to do so. So I think that is something we need to work at, just being a better customer on the government side.

Senator KING. General?

Mr. DEPTULA. I just want to pile on a bit here with an example, which is always useful. There was a small company who had a very innovative idea who went to DARPA to try to get on contract, and after 2 years, they finally got on contract. But as you are very well familiar, the Moore's Law's cycle is 18 months. By the time they got them on contract, they were already off doing something else.

So these are fundamental structural issues which I would like to go back and revisit my comment on where Congress could be involved with legislation. I know it has been said a thousand times over the last 20 years—maybe more—we have to fix our acquisition process.

Senator KING. You mean to say that a 125-page spec for a new handgun maybe excessive. Is that——

Mr. DEPTULA. Yes, sir. Absolutely.

I mean, Silicon Valley does not want to do business with the Department of Defense. I point to the example I just gave: waiting 2 years to get put on contract because of the bureaucratic, Byzantine processes that exist.

Senator KING. Of course, the problem is even if they get the contract, the development process is so long that the product is obsolete almost by definition the day it enters service.

Mr. DEPTULA. Yes, sir. What would your impression be if you went to an auto dealership to order a car, and they said, okay, great, it will be ready in 15 years?

Senator KING. Actually the current figure for a new aircraft is 23 years.

Mr. DEPTULA. I am trying to be optimistic.

[Laughter.]

Senator KING. Colonel?

Mr. MACGREGOR. Sir, let me add something to this that is very important. In my statement, I talk about the use of the PUMA infantry fighting vehicle, which is a German vehicle built by KMW in Germany, Krauss-Maffei Wegmann. The PUMA is very interesting because it is brand new from bottom to top. It was designed in the space of 3 to 4 years really by a team of 12 scientists, engineers, and former Active Duty Army officers. They built it for 750 million euro. We had something called the future combat system that many of you may remember. We worked on that for almost a

decade, perhaps 8 or 9 years, not quite a decade. We spent $20 billion. We had 5,000 technicians, engineers, and scientists involved, and we produced nothing.

Now, the reason I bring up the PUMA is that the PUMA is a leap-ahead, and we are not looking at it. We looked at it in FCS [Future Combat System], and everyone judged it at the time privately to effectively fill the requirement for the future combat system.

Senator KING. So why do we not buy the design and build them here?

Mr. MACGREGOR. Well, you can. The Germans would be happy to come over here and set up the factories, bring in their advanced technology, their manufacturing processes, and hire American labor. But the Army has resisted this because historically the Army purchases its equipment from two sources: General Dynamics and BAE Systems, which used to be called UDLP [United Defense]. Unfortunately, those two firms have evolved over the last 15 to 20 years to mimic their client, in other words, to give the client what the client has wanted. The client has not been interested in anything new. That is one of the reasons that you have equipment from the 1970s which you can upgrade, but it is absolutely not going to measure up to the brand new equipment that is emerging in Germany or, for that matter, in Russia and increasingly in China and other countries.

So we have to go overseas at this point. We have to look at prototypes that are first-rate and look at their utility for us, whether or not we want them and whether or not we can build them here. We really need to do that because otherwise, exactly what General Deptula said and what you did, the answer will be in 20 years we will have something for you and you need to pay us X number of billion dollars immediately to begin work on that.

Senator KING. Clearly work on procurement is an important issue. The process itself—thank you for that.

Senator COTTON. Senator Cruz?

Senator CRUZ. Thank you, Mr. Chairman.

Gentlemen, welcome. Thank you for being here and for your testimony. Thank you for your service.

Earlier this year, General Milley and General Neller approved a white paper discussing the concept of multiple-domain battle. The Army's concept describes a, quote, flexible means to present multiple dilemmas to an enemy and create temporary windows of localized control to seize, retain, and exploit the initiative.

Last month, Admiral Harris spoke about the potential for integration of Army's land-based missile defense systems into the Navy's defense networks in the Pacific.

How do each of you think we can make this concept of multi-domain battle into a successful reality? What do you see as the gaps or shortfalls in doing so? General?

Mr. DEPTULA. Senator, thanks for the question. It is a good one.

I would like to make sure everyone is aware of the fact that the Air Force first began investing in multi-domain battle on 18 September 1947 when it was born, when they became a separate service because that is what the Air Force does, and that is to create

effects in multiple domains. So it is great to see the Army and the Marine Corps catching up.

Recently General Goldfein introduced—the Chief of Staff of the Air Force introduced—a multi-domain command and control program as a priority to effectively tie these multi-domain battle capabilities together faster and more effectively.

What I would tell you in the modern era is the United States and its allies need to increasingly seek to attain desired military effects through the prudent use of information. So every asset that is out there—this is the whole notion of this combat cloud thing. It is just not about networks. It is about achieving the ubiquitous and seamless sharing of information by viewing each of the combat vehicles that we use to put together concepts of operation for their independent use and treat them as information nodes in this whole notion of an ISR, strike, sustainment complex. So that is where we need to do the work. We need to do the work conceptually to capitalize on what we already have by enabling the rapid exchange of information among all these elements.

A case in point. You know, there has been a lot of discussion. You all are very aware of the discussions on the Hill and elsewhere. Most of them focus on the acquisition and programmatic aspects of F–22 and F–35. But very few realize that these aircrafts are not F's. We got to think about them differently. They are not just fighters. They are F–B-E–A-R–C-E–A-W–A-C–S 22's and 35's. They are flying sensor shooters or more properly sensor effectors. We need to start thinking that way about those PUMAs that Colonel Macgregor talks about, about our deployed fleets of ships. You start thinking about an F–35 as a sensor effector that can penetrate contested airspace and relay information to an Aegis class cruiser who then has knowledge of a ballistic missile launch that it, using its own sensors, could not detect and then be able to intercept very rapidly. So that is the kind of direction we need to be moving our forces in the future.

Senator CRUZ. Colonel?

Mr. MACGREGOR. Sir, the answer is twofold. First, a new organization for combat. Armies consist of formations. Numbers are very misleading. You can have 600,000 men and a totally ineffective force because there is no force until you take the men, the people in uniform, assimilate them into an organizational construct with technology, train them, and then finally move them to the point where you want to use them.

So, first of all, you have got to look at the formations that you have, and they are going to have to be different for the future. They are going to have to bring different capabilities to the fight from what we do today. Then you have to have an integratve command structure that reaches from the bottom to the top and back down again. In other words, it flows in two directions that does what Dave said but has to become multi-service because, quite frankly, in future warfare, to the average soldier who is fighting somewhere, it is irrelevant to him whether the man with three stars, who is ultimately his joint task force commander, is in Navy, Air Force, Marine, or Army uniform. Frankly, it does not make any difference to him whether it is a man or a woman. He is not interested in that. He is fighting a fight at his level that he is trying

to survive. Whether or not he does, of course, has to do with how all of these capabilities are integrated across service lines. So making that integration work quickly and seamlessly means you need a different command structure from what we have.

That is why in the statement I provided, there are two recommendations. One has to do with a new formation, which should explore the capabilities that we need, that will produce a different kind of formation from what we have now, and then secondly, stand up an integrative command structure as an experiment. Use a straw man. Bring in the various services. Figure out what that has to look like. Those two things need to happen. That is the practical path to realize what is written in that multi-domain battle paper.

Senator CRUZ. Mr. Scharre?

Mr. SCHARRE. So as General Deptula mentioned, in the early 20th century we saw warfare expand into air and also undersea with submarines. Today we are in a similar place. We are seeing space becoming contested in a way that we have never seen before. We rely on it for not only communications and surveillance but also our global position navigation and autonomy through the GPS system. So all of our precision weapons—many of them might depend on this, and our communications depends on this because of timing. So that is something that is at risk. We are seeing now the creation of cyberspace, an artificial domain that has vulnerabilities for basically anything that is electronic, even if it is off network possibly. Then we are seeing increasingly the electromagnetic spectrum become increasingly important. So we use the electromagnetic spectrum to find the enemy, to hide from the enemy, for communications, and we need it potentially for things like microwave weapons to disrupt electronics directly that the enemy has.

So when you think about fighting in all of these domains, a multi-domain battle is very appealing because now we think, well, how do we integrate that. There are a couple, I think, uncertainties going forward. One is what are the sort of cross-domain effects of these things. So how vulnerable are we from cyber attack? How much do we need to be concerned about resiliency of operating, being able to turn the switch off of our electronics and fight offline? How resilient are our networks? Are we going to have robust communications, which we want to have those, but will we have them in a contested environment? I think we just fundamentally do not know.

So experimentation is needed. I think one of the biggest challenges going forward is when we think about command and control. How do we think about command and control in this world where we have potentially varying degrees of cyber vulnerability and offense, communications, but also lots of automation, not just robotics but also things like planning tools and automated responses on systems? How do we think about a command and control paradigm for that?

For the Army, I would say a big challenge for implementing that type of a battle is it has to be for the more technical service. It has never been ultimately as technical a service as the Air Force and the Navy, and I think to implement this vision that they have, they are going to have to invest in more engineers, more science and

math, more technical skills to make sure they have the right people to then fight in these kind of domains.

Senator CRUZ. Thank you, gentlemen.

Senator COTTON. gentlemen, thank you all for your time and your testimony today. It has been very informative and insightful.

This hearing is adjourned.

[Whereupon, at 5:19 p.m., the subcommittee was adjourned.]

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