THE STRATEGIC MEETING ENGAGEMENT: EXPERIMENTATION AND TRANSFORMING THE U.S. MILITARY

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EXECUTIVE SUMMARY

This project of the Office of Net Assessment was initiated to begin to suggest ideas for conducting experiments on new military capabilities to transform the U.S. military for a new era of warfare. Our methodology has been to assess the series of war games and workshops on the Revolution in Military Affairs conducted during the 1990s. During a series of workshops and studies on experimentation conducted in 1998-1999, three sets of Operational and Organizational Concepts were derived from an analysis of the most promising ideas developed in the games.

The strategic challenge facing the United States is the need to project military power across global distances in the face of a determined opponent who has developed anti-access, asymmetric military capabilities to keep U.S. military forces out of a particular region. Given this strategic problem, we focused our analysis at this stage on one of those concepts, the Strategic Meeting Engagement. Other reports in the Experimentation Project will address Extended Range Aerospace Operations and Maritime Operations.

For the Strategic Meeting Engagement concept, we developed a scenario set in the year 2025 with an opponent roughly modeled on a regionally powerful Iran that attempts to assert its military power to control a wide area of Southwest Asia. In this scenario, Iran has developed a “keep-out” force with cruise and ballistic missiles, and a robust integrated aerospace defense architecture. It has also deployed three large mobile air-land forces: one heavy armored Corps that invades the Caucusus area around the Caspian oil fields, and another heavy armored corps that moves to seize the Saudi peninsula oil infrastructure. A third Corps-sized force, this one more advanced technologically – more mobile, lighter and more lethal – prepares to reinforce the success of either or both invasions.

In response, the U.S. military executes an operational concept called the Strategic Meeting Engagement. The SME is a theater campaign that involves deploying U.S. forces directly from the Continental U.S. into combat -–there is no initial build up or movement-to-contact. The campaign consists of five broad phases:

- Build and maintain Dominant Battlespace Awareness
- Shape Red operations through information and strike operations
- Isolate and seize an initial objective by creating an Air Corridor and an Air Lodgment,
- Defeat key Red Forces in detail by executing “Swarm” tactics
- Transition to subsequent operations such as exploitation, occupation, peace enforcement or redeployment

The specific military capabilities needed by U.S. forces to execute such a campaign were defined and quantified by military experts over the course of three workshops. The source material for this work was the set of RMA oriented war games, work shops, roundtables and seminars sponsored by the Office of Net Assessment during the period 1993 – 1998. Most of these events were co-sponsored with the military services, defense agencies and other OSD offices.

This report suggests three ideas for experiments designed to explore and discover how to conduct a Strategic Meeting Engagement

Joint Air Expeditionary Forces Establish an Air Corridor. This experiment idea involves creating the aerospace forces needed to transport U.S. military power across global distances against an opponent with challenging anti-access forces. A Blue Joint Aerospace Projection Force would be formed out of U.S. Air Force, Navy, Army, Special Operations, and Marine Corps air and space assets and headquartered at Nellis Air Force Base. A Red Aerospace Defense Force would be formed out of Service and Defense Agency capabilities operating out of White Sands Missile Range. Blue Forces would be required to establish various levels of control over the air space between Nellis and simulated deployment sites around Fort Bliss, Texas and Holloman Air Force Base, New Mexico. A key measure of effectiveness for this experiment would be the number of ground combat vehicles that could be delivered to the combat zone.

Joint Air Land Forces Establish an Air Lodgment. U.S. Army, Special Operations and Marine Corps ground forces would be reorganized into small, diffuse units with very few superior headquarters to serve as "Eagle," "Tiger," and "Cobra" force elements. These forces would be based near their present home stations (e.g., Fort Lewis, WA, Fort Campbell, KY, Twenty-Nine Palms, CA) and would conduct field trials of various organizational concepts for initial SME deployment forces near their home station. Once the organizational concepts are mature, the units would then explore operational and technology concepts for deployment into an Air Lodgment experimentation area that would be set up at Fort Hood, TX. Competing Air Transport forces would be organized under Cinc U.S. Transportation Command. One force would be equipped with rotary- and tilt-wing/rotor transports (e.g. Joint Transport Rotorcraft Prototype or modified V-22), the other with fixed-wing aircraft (C-130, C-17, commercial). An opposing air-ground force would be created in the Reserve Components to operated defenses around the lodgment area to represent the kinds of tactical air defenses and rear-area local ground conventional, special operations and militia forces that could be mobilized by an opponent to respond to such incursions. Logistics concepts would also be experimented with in this series. For example, the two competing transport organizations would be tasked to move a brigade rotations' ammunition requirements to the National Training Center from the supplying depots to Fort Irwin on 96 hours' notice. Measures of effectiveness for this set of experiments would include the survivability of the force in the Lodgment and the length of time the supported ground units sustain their logistics requirements.

Swarm Engagement Tactics. The U.S. Army and Marine Corps experimentation units would conduct a series of small-scale exercises designed to discover how to execute the Swarm tactic for defeating the opponents' air-ground forces. The process would begin with engagement-level board games for soldiers and junior leaders to develop various Tactics, Techniques and Procedures with the kinds of hypothetical future systems they would have in 2025. Small units (platoons) would then be equipped with surrogate vehicles, weapons, ISR and C2 systems to provide them with approximations of those key capabilities needed to provide the level of ground agility and mobility needed to execute those TTP. The platoons would then practice conducting dispersed movement across the distances between engagements (about 80 miles as developed in our workshops – this metric would also be subject to analysis in the course of the exercises) expected in Swarm tactical operations. The area between Fort Lewis, WA and Yakima Firing Center would be one recommended location for these trials. Once platoon and larger formations have developed proficiency in movement they would then begin to execute the idea of massing around an enemy force objective for live-fire engagement exercises at Yakima Firing Center. Once the small units develop proficiency in the elements of the Swarm tactic, force level end-to-end exercises would be conducted employing simulated firing of advanced weaponry. These exercises would be opposed by a Red Force created out of Special Operating Forces Opposing Forces which would employ counter-mobility operations and integrated Precision-Strike/Information Warfare capabilities to delay, disrupt and deceive. This Red Force would exploit emerging Attack Operations capabilities derived from ongoing DoD Advanced Technology Demonstration and Advanced Concept Technology Demonstration Programs to provide anticipated future Red capabilities at levels that would be appropriate to the scenario we created for this analysis. A key measure for this stage of experimentation is the ability of the force commander to determine which enemy forces need to be engaged with ground swarm tactics and the lethality of the ground force against them.

Organizing for such an ambitious experimentation enterprise will require significant changes in the current DoD approach to transformation. A high level, perhaps permanent, Joint Experimentation Command, with appropriate authorities and resources, may be required. A measure of political and bureaucratic patience is a prerequisite. History has taught us that a successful revolutionary transformation in a military institution takes on the order of a decade or more.

TABLE OF CONTENTS

INTRODUCTION

Beginning in the early 1990s, the U.S. Department of Defense has been exploring the phenomenon of the emerging Revolution in Military Affairs. In a 1991 study, Andrew Krepinevich concluded that such dramatic changes in the conduct of warfare have provided strategic advantage only when military institutions have been successful in transforming themselves through four sequential, though somewhat overlapping stages: technological breakthrough, development of new operational and organizational concepts to exploit the new technology, experimentation to explore and discover how to employ new military capabilities, and transformation of the force designs and structures for employment of military power. Throughout the 1990s, especially since the end of the Persian Gulf War in 1991, various elements of the U.S. military establishment have conducted studies, analyses, seminars, workshops and war games to try to develop a better and more detailed understanding of this present RMA.

The Experimentation Workshop Methodology

In 1998, exploiting that set of conceptual exercises, the Office of the Secretary of Defense, Director of Net Assessment initiated a series of workshops to develop a better understanding of how to bring non-traditional operational concepts into a time of experimental discovery and exploration. After the fashion of the U.S. Navy in the period between World Wars I and II, we should now attempt to stimulate the movement of the U.S. military beyond the first two stages of an RMA and into the latter two stages.

For this purpose, the Director, Net Assessment proposed six basic questions that need to be addressed in order to provide the basis for an experimentation program:

- What does it take to be better than future opponents?
- How do we do that?
- What are the measures of effectiveness?
- How do we change operational concepts to achieve enhanced capabilities?
- How do we organize military units to conduct such operations?
- What kinds of systems do we need?

Military development programs and requirements processes continuously seek answers to these timeless questions. The Net Assessment inquiry into experimentation used these questions to focus the development of ideas for experimentation programs. This report provides some initial answers to these questions in the context of a well-developed operational concept for a future war fighting campaign, the Strategic Meeting Engagement. This report also presents some advice on how to construct an experimentation program to explore and discover how the United States might create the military capabilities needed to conduct such a campaign. These findings are intended to provide some initial ideas for those who are implementing experimentation programs in the U.S. Department of Defense.

The project used an initial seminar workshop to identify promising operational concepts worthy of experimentation. Subsequent workshops developed one of the operational concepts, the Strategic Meeting Engagement, in enough detail, including the postulation of the kinds of opposing force it might face (a future, hostile Iran, as an example) to begin serious experimentation planning. Specifically, the workshop participants identified the salient features of the Strategic Meeting Engagement operational concept. These concept features are the focus of the suggestions for approaches to experiments.

We know from the inter-war experience (see the case studies in Appendix B) that successful military innovation requires an effective combination of technological advances, changes in organizational structure, and the development of new, revolutionary operational concepts. We also know from other studies (see the Annotated Bibliography in Appendix C) that such innovations are most effective when they arise from within the body of established military professionals, although it often takes a bureaucratic revolution to carry out a Revolution in Military Affairs. While we may not understand all the potentially revolutionary warfighting concepts of the future, we do have a well-developed understanding of the basic elements of the emerging changes in warfare.

The Strategic Demand for New Operational Concepts

The strategic need to prepare for warfighting of a very different kind is well recognized by the U.S. military. The 1997 Quadrennial Defense Review acknowledged the emergence of a Revolution in Military Affairs. The National Defense Panel laid out a path for future modernization of U.S. military forces to produce a dramatic change in capabilities, and recommended some directions for experimentation. The Chairman's Joint Vision 2010 lays out the basic conceptual principles for achieving overwhelming capabilities for the next decade. The fundamental strategic problem for the United States in the coming decades will be how to project power against determined opponents who have developed comprehensive strategies and capabilities to deny access to U.S. forces.

The United States will not soon again enjoy the kind of basing infrastructure it had during the Cold War. In the future, deployed forces will probably base far from the battleground, and the U.S. military may have to deploy directly from the continental United States into combat on the march or on the fly. In the most stressful scenarios the U.S. will have to project military power more than 8,000 miles away in the face of an enemy who has developed powerful anti-access capabilities. Most such opponents will enjoy the time advantage inherent in their own geographic proximity to the area of operations.

Potential opponents are already developing responses to the demonstrated successes of U.S. military power in the 1991 Persian Gulf War. In a few cases they are acquiring their own long range precision strike weapons and integrated command, control, communications, computer, intelligence, surveillance and reconnaissance (C4ISR) networks as a way to keep our military forces out of their region entirely. Several third world states have openly sought to obtain weapons of mass destruction, along with ballistic and cruise missiles for their delivery, as a way to defeat U.S. power projection forces. Even non-state actors are exploring information warfare and space operations to find asymmetries that might give them an advantage in a future military confrontation with the United States.

The Opponent's Military Capabilities

Consistent with the broad trend in future warfare suggested at the beginning of this report, we posited an opponent that, by 2025, was able to exploit certain elements of the Revolution in Military Affairs for themselves and apply them to its own strategic situation. Thus, the Iran that we developed as a powerful regional competitor had impressive "keep out" forces and, to a somewhat lesser degree of development, a regional "anti-access" force of its own.

In order to keep the U.S. from penetrating their airspace, future air defenses for Iran are robust, integrated, and technologically advanced. They will by then have developed sophisticated counter-stealth techniques and technologies and sufficient numbers of systems to shoot down a substantial proportion of incoming long-range and precision platforms and munitions launched by the U.S. Adding to the defensive capability, the Iranians introduced mobility to many of their key military assets, rendering the attack challenge even more difficult for U.S. strike forces. Their approach is not to defeat every incoming munition, rather, it is to have a high enough probability to destroy sufficient numbers to give the U.S. a genuine attrition battle in the aerospace dimension. In some ways their operational concept resembles the 1970s and 1980s Soviet concept for air war in the European theater.

Their anti-access concept relies on a capacity to strike at longer range with precision cruise missiles – up to 2500 km – and ballistic missiles, some capable of carrying nuclear warheads. In addition, they have modernized some portion of their ground forces with an ability to conduct offensive operations well beyond their own borders within the region. A key to this capability is their development of a distributed, redundant logistics architecture that relies on new transportation infrastructure within Iran and mobile transportation assets for theater and tactical operations.

Other major advances were made by the Iranians in command, control, communications, intelligence, surveillance, and reconnaissance technologies. They were thus able to make significant leaps from where they were in the 1990s in Battle Management and Information Warfare operational capabilities. Although their sophistication in training and readiness never reached that of US forces in the 1990s, they were able to conduct large-scale combined arms air-ground exercises across theater distances by 2025.

The Strategic Meeting Engagement

To accomplish US military objectives against such a force (more details about the specific situation presented to workshop participants are provided below in the section on "The Scenario") the participants were asked to develop a detailed and quantified assessment of the military capabilities that would be needed by US forces in broad accordance with the notion of a Strategic Meeting Engagement.

In current military doctrine, "movement to contact" is an offensive operation conducted to establish or regain contact with the enemy. In the new era of warfare, movement to contact becomes unnecessary because battlespace awareness capabilities provide the necessary knowledge of the enemy's locations. In fact, the Strategic Meeting Engagement compresses the deployment to battle, the movement to contact, and the classic operational level meeting engagement into a single, integrated campaign across strategic distances from the continental United States. Its fundamental purpose is to introduce ground forces early into a strategic conflict with a major regional power or peer competitor.

The Strategic Meeting Engagement integrates Long Range Precision Strike, Information Warfare, Dominating Maneuver and Space Warfare into a single integrated operational campaign that could be decisive against a major regional competitor or peer competitor of the future. This concept may be necessary when circumstances preclude the exclusive use of long-range precision fires. It may be that the components of the enemy's critical points simply cannot be remotely targeted because of physical or geographic limitations of U.S. long-range precision weapons. Perhaps the critical targets to be destroyed are so located as to make even the most precise weapon not usable under the circumstances. The nature of the targets may simply not be physical and thus precision strikes would not have the desired effects. Or there just may be so many targets that we will not have sufficient munitions or time to service them all in order to complete the campaign when needed. The SME overcomes these difficulties by inserting ground forces into the enemy country to engage the enemy in close combat and defeat his forces in detail.

The SME operational concept is described below. Additional details of the scenario, force designs, force structure and systems capabilities for the hypothetical future forces envisioned in such a campaign were developed over the course of five years of war gaming and are available at the Office of Net Assessment. These concepts emerged through a number of seminar war games and model runs (see Appendix D). These games included Dominating Maneuver (Army) Games I, IV, and V (and some Janus model runs of Game IV concepts); USMC RMA Game I; USAF Alternative Air Force Games I, II, and Extended Range Operations Game; and Navy Future Operations and Concepts Games.

The idea of the Strategic Meeting Engagement is that, given Long Range Precision Strike and Long Range Power Projection capabilities, enabled by information superiority, the placement of ground forces in superior positions can become decisive.

Since there is no necessary “movement to contact” or intermediate staging to begin such a campaign, the combat phase of traditional operations can be the first set of engagements. In turn, these initial engagements can be so rapid and lethal that they become decisive. The positioning of forces in the course of the meeting engagement – a Dominating Maneuver – initiates military operations opening the campaign. The opponent may well recognize that he is out-maneuvered and might seek to avoid battle. If he does accept the fight, he will be defeated in detail by hundreds of small engagements, precisely placed against his critical points, in a tactic resembling a "swarm" (swarm tactics will be explained in detail later).

Critical Military Capabilities and Tasks

A theater Commander-in-Chief would execute the Strategic Meeting Engagement in perhaps five distinct phases, or tasks. The first phase would establish the necessary command, control, communications, computers, intelligence, surveillance, and reconnaissance capabilities to achieve Dominant Battlespace Awareness for U.S. forces. The second phase would involve long range precision strikes and offensive information operations to shape enemy courses of action in the directions desired by the friendly CinC. The third phase would establish the air corridor and air lodgment. Phase four is the conduct of close combat operations by ground forces to defeat the Red force objectives. Phase five is the preparation for subsequent operations to exploit or re-deploy. The quantified capabilities shown for each task in Table 1 below represents the integration of expert opinion among the participants in our workshops.

TABLE 1. Critical Military Capabilities With Associated Tasks Required To Conduct The Strategic Meeting Engagement

Task 1: Build and Maintain Dominant Battlespace Awareness

TASK ELEMENT	CAPABILITIES
Define the Battlespace	• 800-1200 x 1500-2000 x 3-20nm
Construct Digital Map of Battlespace	• Better than 0.1 in accuracy representation of topography, hydrography, vegetation, trafficability, man-made objects • 72 hour meteorological forecast for air/ground ops • provided to all troops within 1 hour of initial alert • updated continuously
Locate Potential Targets	• 100% of tens of thousands of targets 100% of the time
Identify	• 100% of 5000 targets vs. non-targets
Track	• 20% of key targets continuously, 100% on demand
Classify	• 50% armor vs. light, 100% of organizational and nodal structures
Assess	• Determine key elements of Red center of gravity within 5 minutes
Predict Red Course of Action	• Determine possible COAs with 95% certainty • Select probable COAs with 75% certainty
Establish Blue Situational Awareness	• 100% of all elements 100% of the time
Maintain C2	• Control hundreds of small maneuver units and thousands of individual elements (soldiers, systems, nodes, links)

Task 2: Shape Red Operations

TASK ELEMENT	CAPABILITIES
Create "no detect" zones to cover initial entry	• Up to 3 each 100 x 500 x 30 nm for up to 6 hours
Conduct offensive IW operations in objective area to prevent Red from deducing Blue scheme of maneuver	• Deceive Red ID/Track Sensors as to actual Blue locations for 30% of the force • Blind Red ID/Track Sensors for 25% of the force • Delay sensor-to-shooter links for minimum of 5 minutes • Maintain for up to 12 hours
Conduct precision strikes so Red must execute COA predicted by Blue	• Kill 75% of Red "keep out" shooters • Emplace barriers to eliminate alternative COAs

Task 3: Isolate and Seize Initial Objective

TASK ELEMENT	CAPABILITIES
Plan and Rehearse En Route	• Complete METT-T/COA analysis/OPORD process in parallel from highest echelon to lowest in 30 minutes total
Deploy Division Equivalent Combat Power from CONUS before Red Forces Arrive from In-Theater	• Deploy to Employ within 96 hours • Establish Air Corridor: 8 legs, each 50nm x 100nm • Establish Air Lodgment: 8 sites, each 200km diameter
Position Forces to Affect COG Decisively	• Determine which COG elements to strike and which ones to close with to direct fire range (15km) • Position force elements within 5 minutes of arriving within direct fire range

Task 4: Defeat Red Force

TASK ELEMENT	CAPABILITIES
Strike Targets	• Up to 5000 targets
Employ Tactical Swarm	• Autonomous systems/crew engagements • Attack position to fire position (5km) in 2 minutes • Fire position to logistics position (35km) in 15 minutes • Log position to next attack position (5km) in 2 minutes • All terrain and weather
Close with and Destroy 5000 Force Elements	• 15km direct fire range • $P_k > 0.99$ • Rate of fire and ground speed 6x Red system in 1 x 5 engagements • Evade incoming precision fires – move 1km in 20 seconds

Task 5: Transition to Subsequent Operations

TASK ELEMENT	CAPABILITIES
Sustain Initial Forces	• Self-sustaining for 10 days in all classes
Protect Initial Forces	• B/C MD throughout battlespace
Execute Battle Hand-Off to Follow-On Forces	• Seamless interoperability with legacy and allied forces
Prepare to Conduct Subsequent Operations	• Reconstitute force with up to 30% casualties within 24 hours

Organizational and Technological Concepts

The Strategic Meeting Engagement is a future oriented operational concept which requires organizational designs and systems derived from technologies which are not present in today's military forces. In order to understand how the operational concept works, some of the more advanced technological and organizational components of the concept must be explained. The following paragraphs will discuss the key systems concepts, the basic organizational concepts – the Eagle, Tiger, and Cobra Forces – and the new capabilities provided by future long range air assets, forward deployed naval forces, and global transport systems. We will then be prepared to examine the SME scenario.

Key Advanced Systems Concepts

The Strategic Meeting Engagement is built around certain platforms that enable the force to deliver the required military capabilities. Those platforms deemed essential to the conduct of the SME are described here. They do not represent fully developed systems concepts, or preliminary requirements statements for future systems, or trends in technology development. They are notional systems, developed in the course of war games and workshops, and they are intended to illustrate the kinds of capabilities that would be needed to execute the SME. Participants in the studies generally believed that these systems could be built, and that no fundamental scientific breakthroughs would be required to field them. However, further detailed technology study would be necessary to develop the requirements for these systems and to design and engineer them.

AFAV: Advanced Fast Attack Vehicle
- Small (<.25 tons) ground platform for C4ISR functions
- Electric gun and missile armaments for self-protection
- Connectivity to precision strike architecture

A2CV: Advanced Air Combat Vehicle
- Large capacity, high speed, VTOL
- Unrefueled range of 1500km, 400+kph speed
- Weapons or cargo (50 troops or one ACV)

ACV: Advanced Combat Vehicle
- 10-15 tons Gross Vehicle Weight
- 120kph road speed, 75kph cross country speed
- Electric Gun and Missile armaments capable of 15 km direct or indirect fire range
- Zero on-board fossil fuel required

UACDV: Unmanned Advanced Combat Delivery Vehicle
- Used for point-of-use delivery
- 50,000 lb. payload capacity
- Take-off and land from unimproved sites
- Air-drops supply modules using GPS-guided parafoils
- 1500nm range

TAV: Trans-Atmospheric Vehicle

- Provides global recon, satellite deployment or strike anywhere in the world in < 2hrs
- Vertical take-off, horizontal landing
- Capable of 6 missions per day surge
- Sustained capability of 3 missions per day for 30 days
- Deploys PGMs during trans-atmospheric phase of flight
- Payload of 25,000 lbs to LEO, 10,000 to polar orbit

STARWACS: Battle Management Aircraft

- 767 widebody airframe
- Combines capabilities of JSTARS and AWACS in a single platform

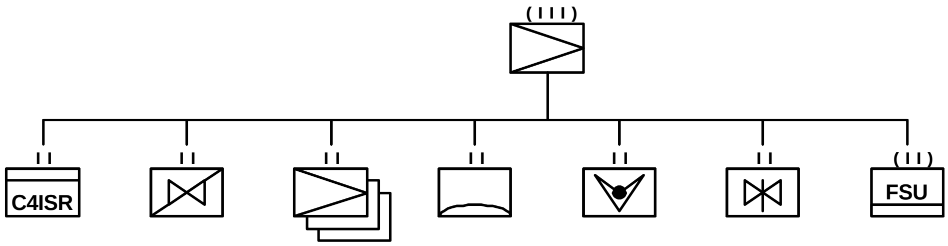
Basic Organizational Concepts

The basic building blocks of the ground force organization for the SME are in a set of three maneuver units, which have been labeled Eagle, Tiger, and Cobra Forces. These Forces have no direct equivalents in the current U.S. ground forces, because they were explicitly designed and equipped for innovative "strategic maneuver" operations like the SME. They are functionally organized units that deploy and operate in a dispersed manner. Although smaller and lighter than traditional units, they are capable of engaging the enemy decisively as soon as they enter the battlespace.

Eagle Force

The Eagle Force operates in the battlespace like a brilliant, mobile ground sensor system. By utilizing advanced sensors and organic mobility to remain in nearly constant motion, the Eagle Force provides continuous Reconnaissance, Intelligence, Surveillance, and Target Acquisition (RISTA) connectivity as well as seeking and destroying selected enemy targets in its AOR. The Eagle Force is highly agile, optimized for C-17 or A2CV lift, and can self-deploy anywhere in the world on very short notice (given sufficient priority for in-flight refueling). The Eagle Force carries its own strike assets (weaponized UAVs) as it operates beyond the range of most fire support.

Eagle Force Table of Organization and Equipment



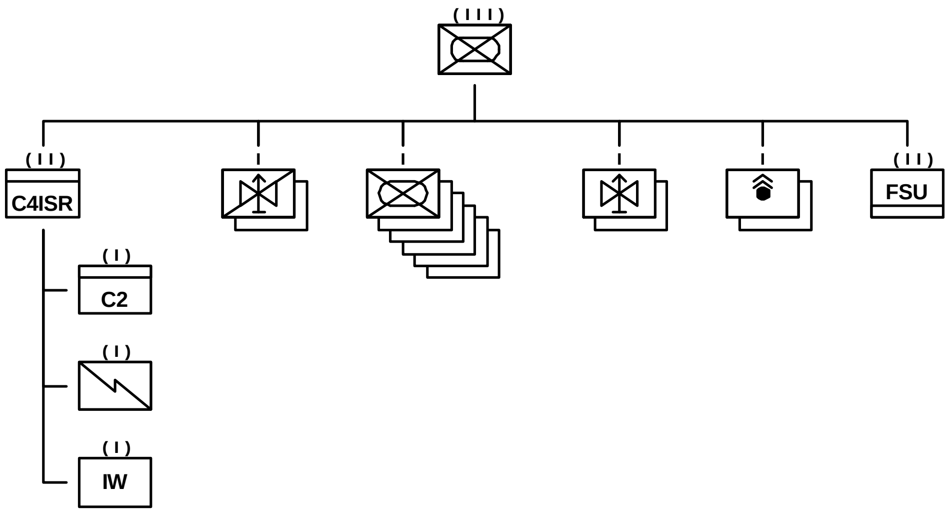
Eagle Force (x1)	Sub units	Total Equipment
	1 C4ISR Squadron	**24 Multi-mission VLO HALE UAV (RISTA, ECM/ELINT, comms)** **12 LUH-66 liaison/utility helo**
	1 Air Cavalry Squadron	**24 RAH-66 helo** **6 Multi-Mission Tactical UAV**
	3 Hunter Squadrons	**Each Sqn:** **108 AFAV** **54 EFOG-M (AT)** **54 RISTA sensor suites**
	1 FAAD Bn	**18 Avenger trailers** **18 EFOG-M (CA)** **9 sensors**
	1 Weaponized UAV Bn	**24 VLO HALE UAV (DPICM, BAT, WAM, FOGM sub-munitions)**
	1 Transport Aviation Bn	**48 CV-X (A2CV)**
	1 Forward Support Unit (FSU)	**48 CV-X (A2CV)**

Tiger Force

The Tiger force is a highly mobile ground maneuver unit of approximately regimental size, capable of deploying from CONUS directly into combat (with additional non-organic airlift) and accomplishing missions currently assigned to division-sized units. Although the Tiger Force lacks the mass and robustness of a current heavy division, the Tiger Force is more deployable, maneuverable, and agile. It is designed to exploit the "swarm" tactics described later in this document.

The Tiger Force is organized around the capabilities of the Advanced Combat Vehicle (ACV), a notional fighting vehicle capable of operating well outside the performance envelope of any current or projected ground combat vehicle. The Tiger Force has a novel force design, which eliminates the battalion and division echelons, and which is enabled by superior tactical agility, increased connectivity, superior battlespace awareness, and the range and lethality of organic systems. The Tiger Force contains organic Information Warfare elements equipped with a variety of futuristic systems designed to attack and/or deceive the enemy and defend friendly information systems.

Tiger Force Table of Organization and Equipment



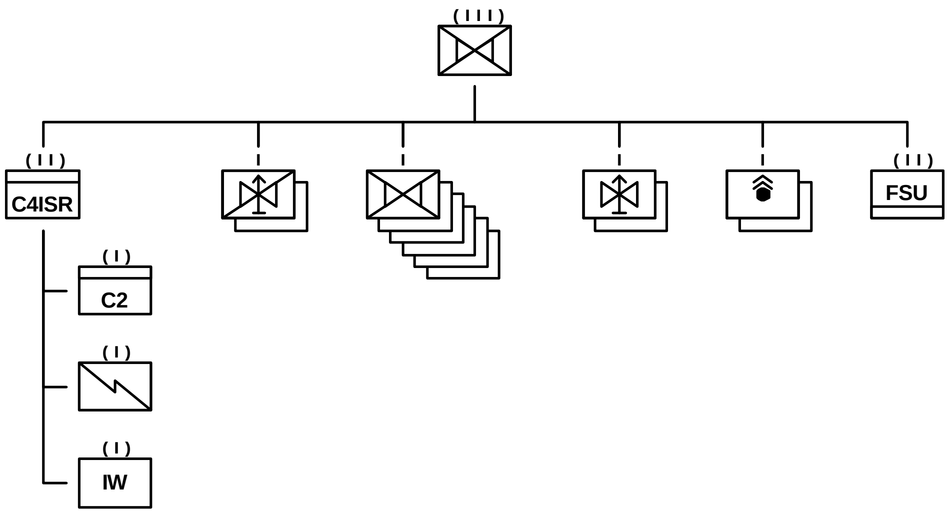
Tiger Force	Sub Units	Total Equipment
	1 HQ unit (C4ISR)	**18 Multi-mission VLO HALE UAV (RISTA, ECM/ELINT, comms) 50 Robot Scouts**
	2 Recon/Attack Avn Elements	**Each: 12 RAH-66 helo**
	6 Ground Maneuver Elements	**Each: 2 C2 ACV 4 MBT ACV 8 AIFV ACV (E-FOGM) 2 Stinger ACV**
	2 Attack Aviation Elements	**Each: 12 AV-X (A2CV)**
	2 Long Range Strike Elements	**Each: 12 ER-MLRS (DPICM, WAM sub-munitions)**
	1 Transport Aviation Bn	**48 CV-X (A2CV)**
	1 Forward Support Unit (FSU)	**48 CV-X (A2CV)**

Cobra Force

The Cobra Force is designed to conduct aerial maneuver in much the same way that the Tiger Force conducts ground-based maneuver. Cobra Forces are regiment-sized, highly agile, and have similar logistics, combat support, C4I, and IO/IW elements to those of Tiger Forces. Unlike Tiger Forces, Cobra Forces can deploy from CONUS directly into combat *with organic airlift*. Cobra Forces operate in close coordination with Tiger Forces and exploit the "swarm" tactics described later in this document.

The Cobra Force is organized around the capabilities of the Advanced Air Combat Vehicle (A2CV), a notional aviation fighting platform capable of operating well outside the performance envelope of any current or projected Army aviation system. The Cobra Force has a novel force design, which eliminates the battalion and division echelons, and which is enabled by increased connectivity, superior battlespace awareness, and the range and lethality of organic systems. The Cobra Force contains organic Information Warfare elements equipped with a variety of futuristic systems designed to attack and/or deceive the enemy and defend friendly information systems.

Cobra Force Table of Organization and Equipment



Cobra Force	Sub Units	Total Equipment
	1 HQ unit (C4ISR)	**18 Multi-mission VLO HALE UAV (RISTA, ECM/ELINT, comms) 50 Robot Rat Scouts**
	2 Recon/Attack Aviation Elements	**Each: 12 RAH-66 helo**
	6 Air Maneuver Assault Elements	**Each: 12 CV-X (A2CV) assault aircraft with E-FOGM 12 Javelin**
	2 Attack Aviation Elements	**Each: 12 AV-X (A2CV)**
	2 Long Range Strike Elements	**Each: 12 ER-HIMARS (DPICM, WAM sub-munitions)**
	1 Transport Aviation Element	**48 CV-X (A2CV)**
	1 Forward Support Unit (FSU)	**48 CV-X (A2CV)**

The Tiger, Cobra and Eagle Forces will conduct the SME on the ground. Getting them to the theater, supporting and protecting them once there will be the responsibility largely of aerospace and maritime forces that will also need new capabilities. Some of those new capabilities are described here.

Other Systems Concepts

Long Range Air Assets

A large number of air and space platforms would launch from CONUS and/or peripheral bases at the first sign of hostilities. These systems will comprise the primary anti-spearhead force. Space-based sensors and, if available, ISR UAVs already in-theater will provide targeting information to B-2s, long-range UCAVs, and UAV Tenders armed with multiple short-range UCAVs. These platforms will penetrate contested airspace to find and attack mobile ground elements (e.g., tanks, infantry fighting vehicles, self-propelled artillery, air defense batteries, and transport trucks) with relatively short-range, precision-guided weapons.

Blue forces would establish local air superiority over friendly territory to enable follow-on air and ground forces. Blue air superiority over enemy territory would generally be local and maintained for only short periods of time for attack operations. Striking forces would either not require air superiority or need it for only short periods. For example, VLO aircraft, cruise missiles, and UAVs would use stealth for their very localized air superiority, while weapons delivered from space [e.g., transatmospheric vehicles (TAV) and space-based lasers (SBL)] would not require air superiority, but would require a measure of space control.

As part of their initial operations, the B-2s and UCAVs would seed terrain through which the enemy ground force elements could be expected to transit with “smart mines” in order to slow down their advance, emphasizing deployment in “choke point” areas that typically channel ground force movement. If sufficient B-2s/UCAVs were available, they could be assigned to dispense unattended ground sensors (UGS) to better track enemy vehicles and add detail to the battlespace picture shared by all the components in the fight.

If “peripheral bases” outside the range of the bulk of the adversary’s long range precision strike assets were available, the B-2s, UCAVs, and UAV Tenders could recover to them. Otherwise, they would have to return to the closest U.S.-operated airbase. Assuming support services were available, recovering to peripheral bases could help maximize the sortie rates of these critical assets.

Depending upon the capability of the enemy air defenses and the danger posed by the advance of enemy forces, nonstealthy B-1 and B-52 long-range bomber aircraft could support anti-spearhead operations, such as dropping air-scatterable mines or PGMs along with the B-2 force. They could also support C4ISR building operations such as dropping unattended ground sensors.

Forward Deployed Naval Forces

Relatively low signature naval combatants such as arsenal ships and converted Trident boats (SSGNs) carrying large numbers of extended-range PGMs would support Blue operations. Submerged platforms would exploit their inherent stealthiness to penetrate beneath the enemy's sea denial barrier to within about one hundred kilometers of the enemy coast. From these positions, submerged forces would launch cruise missiles configured to loiter for several hours over suspected enemy departure and landing zones, striking enemy transport aircraft immediately upon their take-off or landing. Cued with the requisite targeting information, submerged forces operating in the littoral could also attack fixed- and rotary-wing transports while they are on/off-loading troops and equipment, or lead elements of the ground advance. Attacks would employ short-time-of-flight PGMs such as NTACMS (the Naval version of the Army's ATACMS) or hypersonic variants of the Tomahawk land-attack cruise missile.

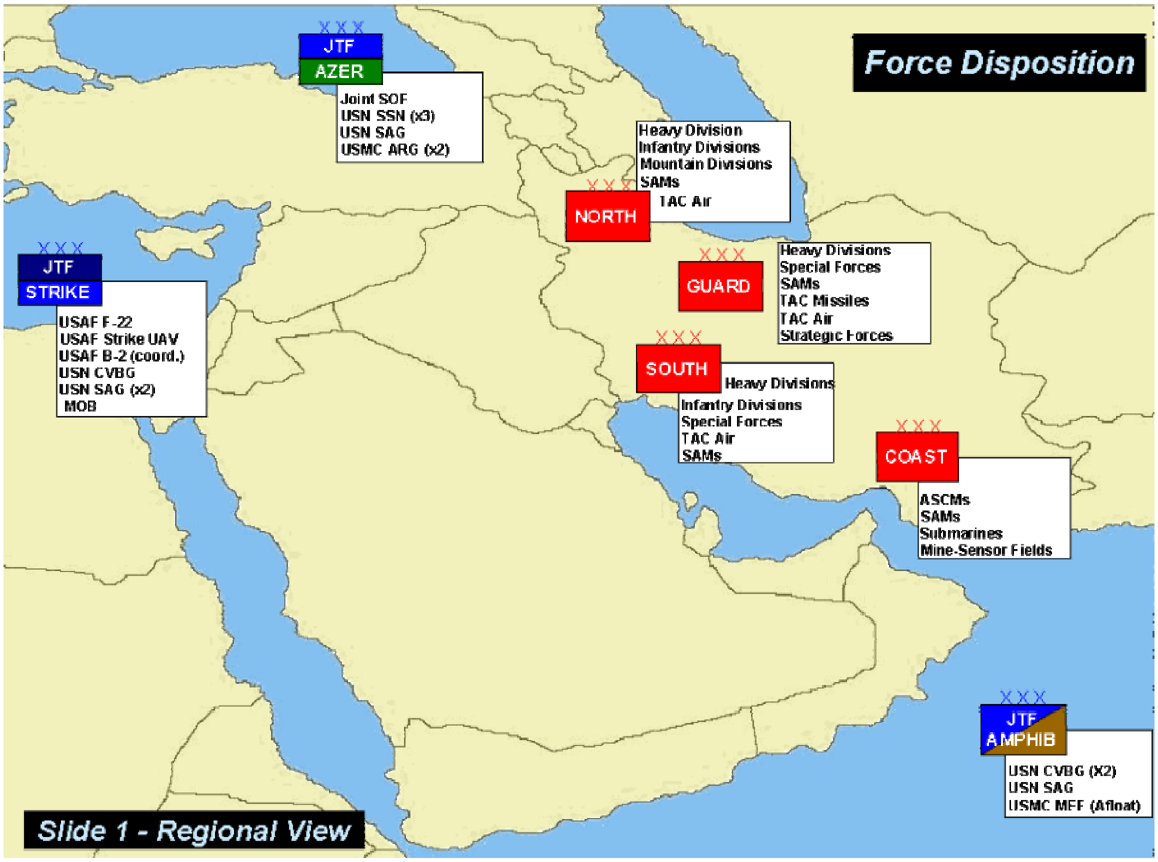
Global Transport Systems Concepts

C-17X Heavy Transport Aircraft: The C-17X can carry 20% more weight and 20% more cargo by volume than the current C-17.

KC-135X Tanker Aircraft: The KC-135X is a modified commercial aircraft with 20% greater range and payload than the KC-135R.

Advanced Fast Sealift Ship: The Advanced Fast Sealift Ship enjoys a 25% greater capacity and speed than current Fast Sealift Ships. The Advanced Fast Sealift Ship is equipped with an air self-protection suite.

Mobile Offshore Base (MOB): A Mobile Offshore Base (MOB) is a self-propelled, floating prepositioned base approximately 1 mile long by 400 feet wide that is deployed to an area of national defense interest. Flight, maintenance, supply and other forward logistics naval support operations are conducted from the MOB. The MOB can accept cargo from Air Force C-17s and MSC Container ships, and can store 10 million gallons of fuel and 3 million square feet of cargo in reconfigurable internal compartments. The MOB can also house up to 3,000 troops and discharge resources to the shore via a variety of landing craft.



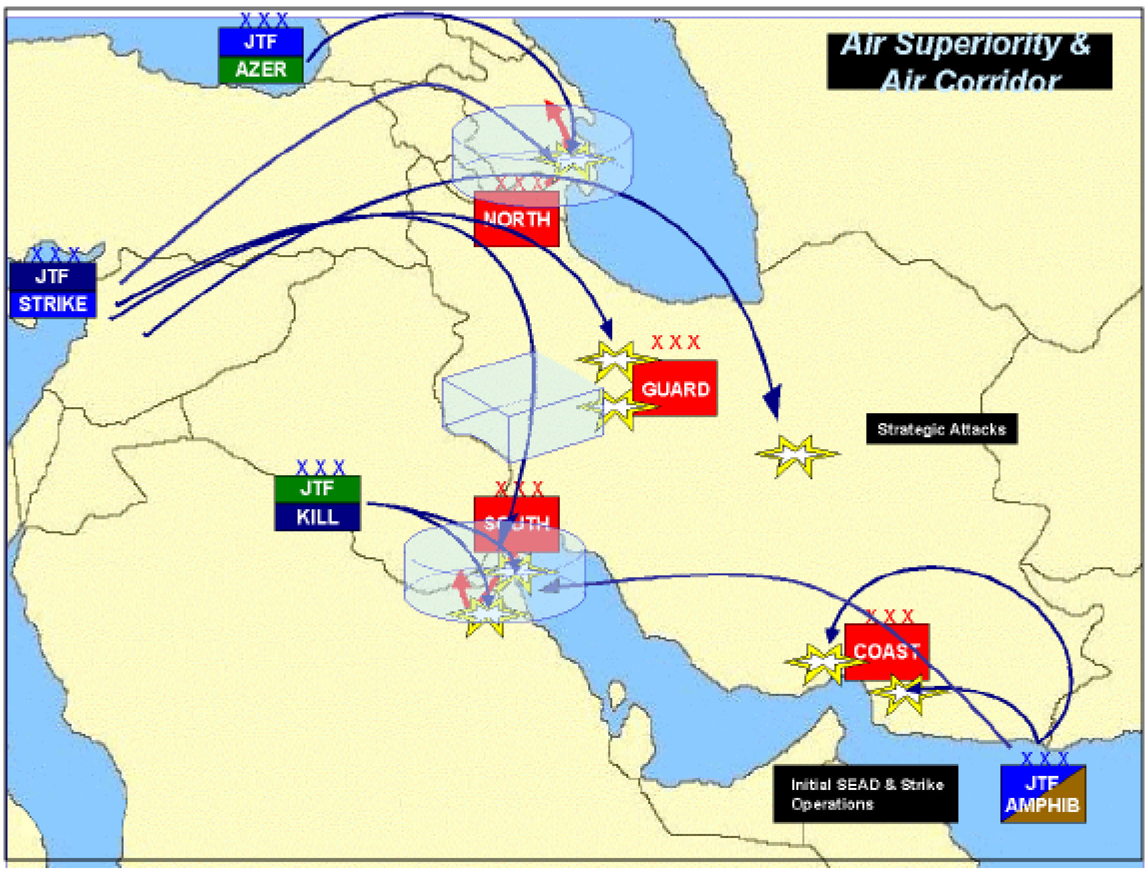
Scenario

The scenario imagines a peer or near-peer competitor (in the following example, a near-peer Iran). In this scenario, Iran possesses a robust “Long Range Precision Strike” (LRPS) capability to effect a “keep-out” strategy, and can see most of our deployed and deploying assets. Iran also has a limited space denial capability. Enemy force design is asymmetric, consisting of a combination of tactically mobile, mechanized forces and ubiquitous reserves and militia. These forces enable Iran to project power beyond its borders under cover of its significant long-range strike capability. The enemy also enjoys initial advantages in geography and time. Iran has already begun final preparations to commence attack toward its key theater objectives, and operates on internal lines of communications.

Iran initially places U.S. forces at significant spatial and temporal disadvantage. Iran’s Northern Corps seeks to seize oil resources and infrastructure in the vicinity of Baku, and threatens to control all of the Caspian oil production. Simultaneously the Southern Corps advances towards the major oil fields and infrastructure of the Saudi Peninsula. Successful completion of these operations would allow Iran to dominate a significant fraction of the world’s oil resources. Meanwhile, Iran’s best force – the Guard Corps – is poised to exploit or reinforce in either direction, though they intend to attack South. The terrain is rugged and will slow mounted operations in the north and south, but

Iran retains its spatial and temporal advantage vis-à-vis US forces who must arrive from CONUS.

U.S. early warning prevents the adversary from having total strategic surprise, and the NCA has time to decide to put U.S. forces on a heightened state of readiness and to execute certain preparatory actions. During the initial period of heightening tensions, the U.S. began repositioning space forces and maritime forces and deploying some tactical air forces into the larger theater. One MOB is positioned in the eastern Mediterranean. These elements form the foundation for JTFs STRIKE, AZER, and AMPHIB. JTF KILL consists of CONUS-based RMA Forces (Eagle, Tiger, and Cobra) plus tactical aircraft and UAVs that will deploy to the theater during the course of the operation.



Air Superiority

Kinetic energy weapons from space, cruise missiles, and other long-range precision guided weapons (PGMs) are highly effective against known, relatively static targets. However, attacking the Iranian ground forces advancing towards Baku and Kuwait eventually requires a constant presence in the air. Maneuvering enemy surface forces are easier to find, but present what may be fleeting targets. Hence, the requirement for the presence of some firing mechanisms near the advancing force. Space-based C4ISR systems can be used to target these ground forces, but airborne ISR and C2 systems (UAVs, STARWACS, and AAWACS) are also required in sufficient numbers for timely C2 and targeting. This, in turn, requires local air superiority for an extended period of time. These areas of sustained local air superiority allow the attacking force freedom of maneuver within a designated airspace.

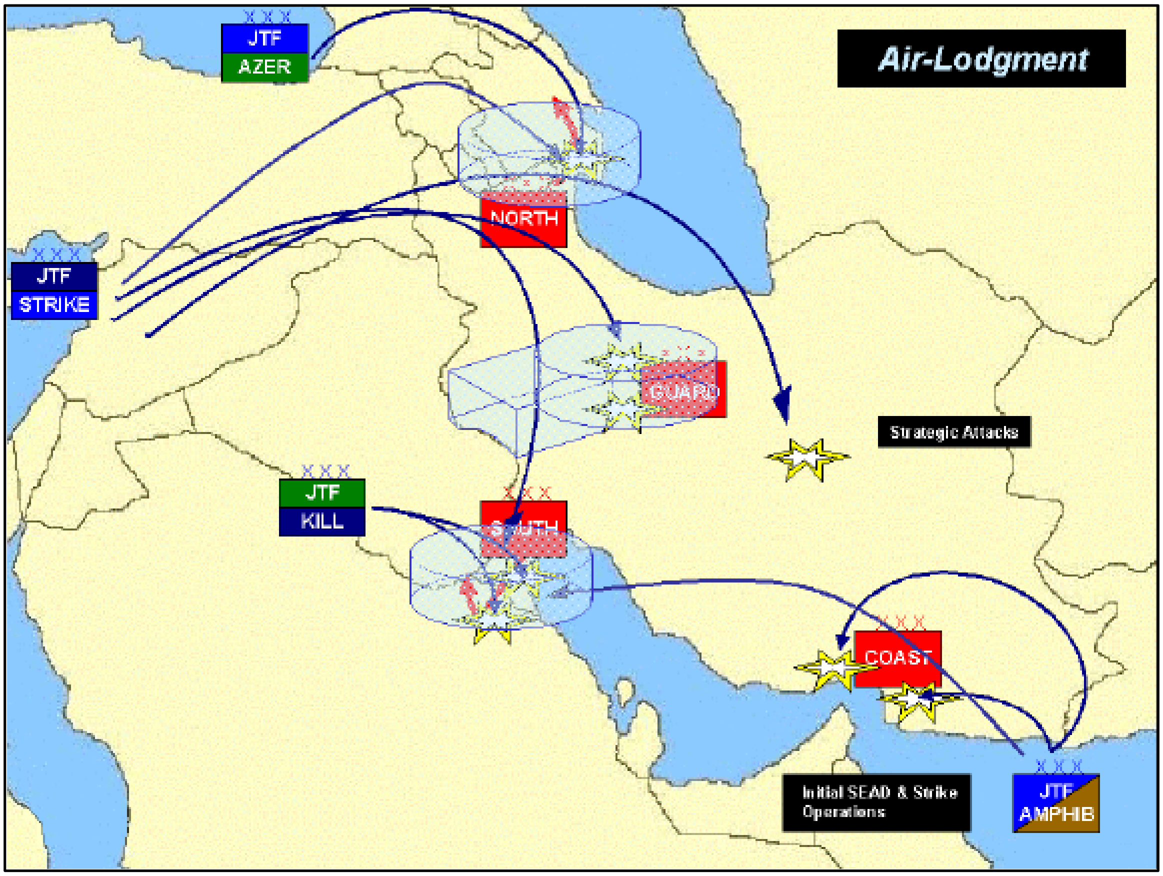
Although air superiority (and eventually air supremacy) throughout the theater is normally the goal, the ability to do so over a country with the size and force capability of a 2025 Iran is difficult and may take quite a while. Therefore, establishing an "air lodgment" over a smaller designated area within Iran is more reasonably achieved for the purpose of allowing air and surface forces to operate at will.

Strikes continue against high priority targets (e.g., C2) from air, space, and sea-based forces. JTF KILL ground and air forces begin to arrive in dispersed positions in Saudi Arabia, and participate in the blocking strikes on South Corps. However, JTF KILL is not optimally positioned or adequately resourced to execute a "roll-back" operation at this stage.

Air Corridor

Once the decision to establish an air lodgment is made, the air and space effort focuses on creating a corridor to a proposed lodgment area where attacking ground and rotary wing or rotorcraft forces will initially deploy. If the right forces are available this could occur almost simultaneously with the creation of the air lodgment itself. Long range precision strikes would continue from B-2s, air and sea launched cruise missiles, carrier-based aircraft, TAVs, and UAVs (both long-range UAVs and shorter-range versions launched from UAV tenders). Attacks would focus on Iranian integrated air defense system (IADS) command centers (and associated C2 networks), air defense forces, and offensive air and missile forces. Many of these targets probably have been taken down earlier based on JFC priorities. However, now the concentration is specifically on those remaining Red air and missile forces that could directly affect operations in the corridor and air lodgment area. Of particular interest are SAMs and air-to-air systems that could target friendly air forces. Note that these attacks are not limited to the vicinity of the corridor and lodgment areas. The range of the Iranian systems requires these strikes to be conducted throughout the country. Accompanying these lethal attacks are information operations (IO) to include electronic countermeasures (ECM) using UAVs and the information architecture assault teams.

Simultaneously with the long range precision strikes, counterair, multi-role, and ECM UAVs set up continuous orbits to protect the approximately 100nm wide and 800nm deep corridor from air and surface-based interceptors. Meanwhile, SBLs continue to attack the remaining early warning/air defense radars. The UAVs used here are a mix of long- and short-range assets with UAV tenders providing the re-supply and sustainment of the short-legged systems. These UAVs can be complemented by F-22s and both land- and sea-based JSFs if available. AAWACS and the airborne laser (ABL), protected by UAVs and/or fighters, are brought into the corridor and are used to expand the counterair effort to the lodgment itself.



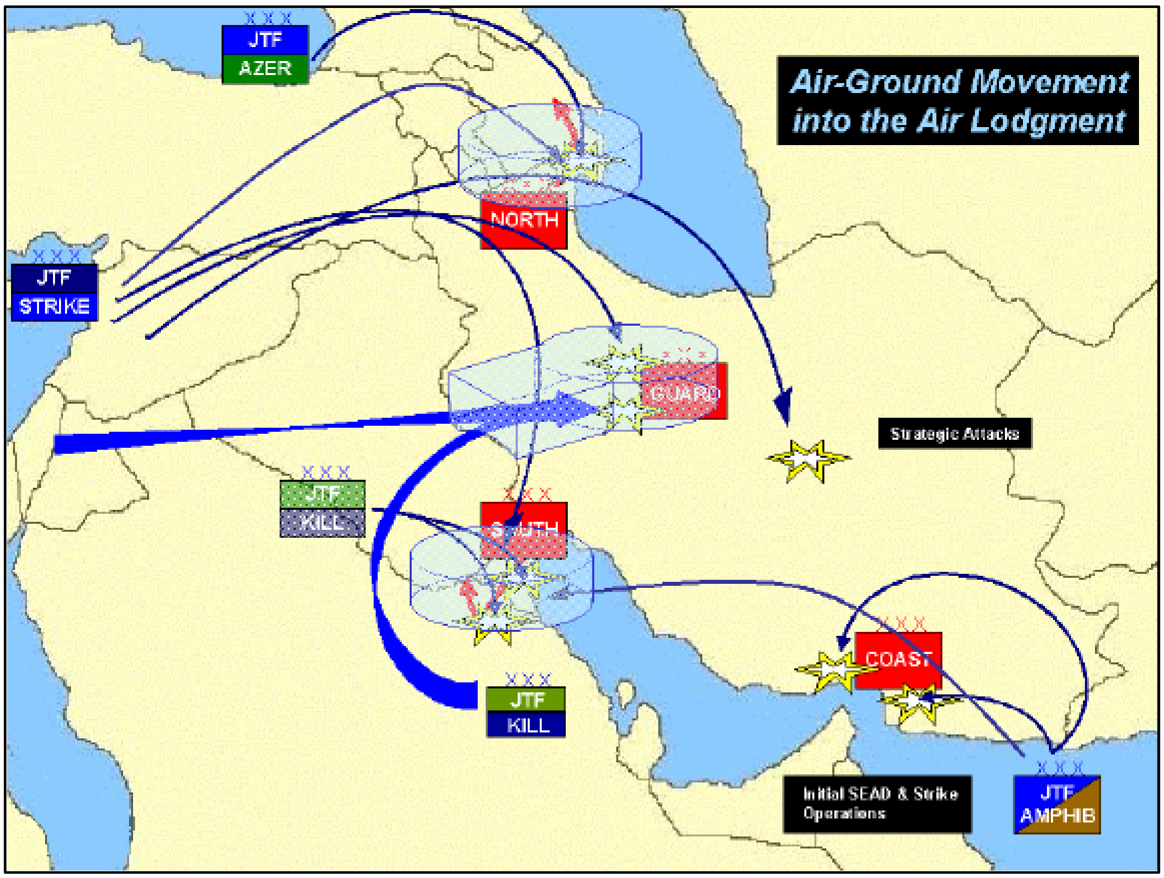
Air Lodgment

Initially, establishing the air lodgment (approximately 200km diameter) flows directly from the establishment of the air corridor. A combination of long range precision strike forces, space-based forces, UAVs, etc., will maintain air superiority within a geographical area in Iran. This will require a continuous presence of UAVs, fighters, bombers, SBL, ABL, and AAWACS using VLO/LO and/or ECM to mask and protect the forces. However, not all of these various systems have to be there all at once. A mix, based on threat, forces available, and objectives determines the friendly force structure at any given time.

The air lodgment is not complete until it is safe for the introduction of JTF KILL's ground forces. This requires further action against Red surface-to-surface and air-to-surface forces. The anti-ballistic missile UAVs concentrate on the areas that could most likely launch the short- and medium-range ballistic missiles at the air lodgment area while the SBL concentrates on the medium- and long-range missiles. The counterair UAVs and fighters are also used defensively against cruise missiles fired into the air lodgment area. To make the air lodgment complete, the STARWACS is introduced (protected, of course) along with more communication and ISR UAVs to support the surface force. Additional air forces can now be brought into the lodgment area to support the ground force with precision fires by either remaining on station (e.g., UAVs) or providing long-range standoff systems responsive to the surface force. The air lodgment is now realized and ready for the insertion of the Eagle Force.

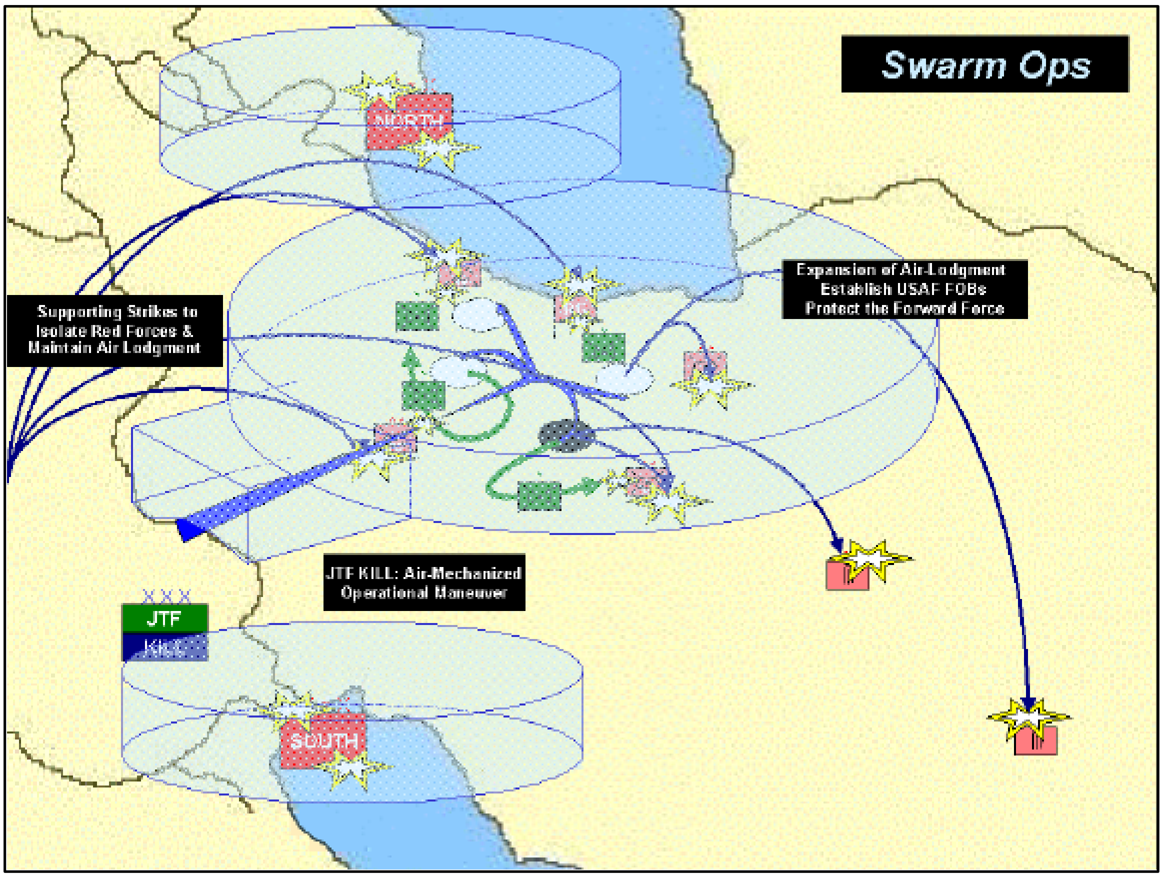
JTF AMPHIB begins preparation of follow-on maneuvers, pursuant to the success of the meeting engagement by striking Iran's defensive deployments in the vicinity of the Strait of Hormuz and continues strikes against the South Corps (along with JTFs STRIKE and KILL). JTFs AZER and STRIKE continue blocking strikes to prevent North Corps from reaching its objectives.

The first ground force into the air lodgment is JTF KILL's Eagle Force.



Following the Eagle Force through the air corridor and into the air lodgment, the main body of JTF KILL's maneuver forces consists of ground elements (Tiger Forces) and aerial elements (Cobra Forces). Tigers and Cobras move through the air lodgment area and commence the major maneuver of the meeting engagement. Undertaken in conjunction with continuing strikes on the Guard Corps from both JTF KILL and JTF STRIKE, this part of the meeting engagement should cripple the Guard Corps by disintegrating its C2, IO and Maneuver Divisions in a series of violent, short fights of 30 minutes or less. (The capability to conduct such short fights is desired of systems that will perform the Strategic Meeting Engagement (see Table 1 Task 4). Like the other capabilities listed in Table 1, this capability has been refined over five years of wargaming, and quantification of this capability was discussed in detail at the second and third experimentation workshops.) This phase of the operation commences when the air lodgment is established and lasts for a period of approximately three days. Upon conclusion, major U.S. maneuver and fires elements are positioned in the vicinity of Tehran threatening the capital.

The major impact of this maneuver, in addition to destroying the effectiveness of the Guard Corps, is the expected turning of the attacks in the North and South. Confronted with a threat to their rear, North and South Corps turn most of their forces around on their attack axes and face the new threat. Halting strikes continue on those elements of the two attacking corps that persist in advancing.

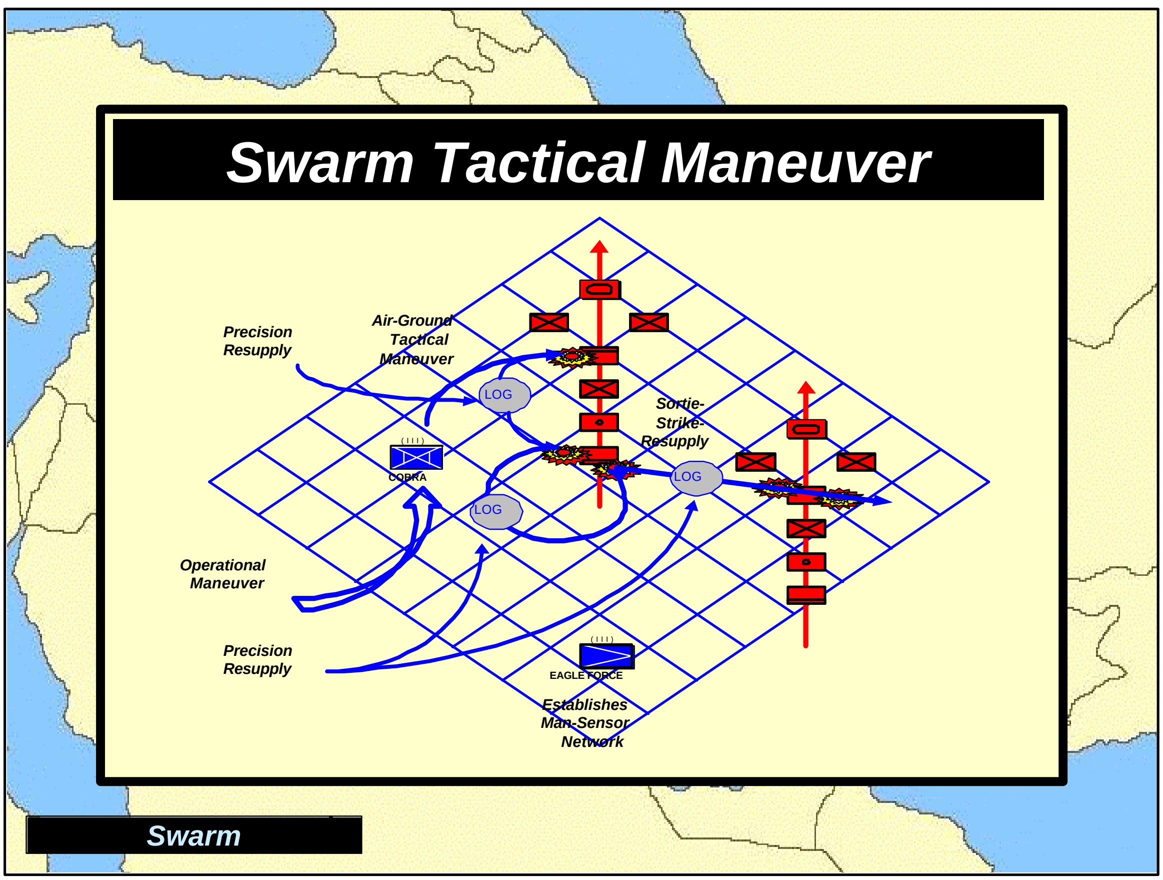


Swarm Operations

The size of the air lodgment varies according to the objectives of the surface forces and their requirement to maneuver. For this scenario, the air lodgment expands to approximately a 350nm radius. This allows for the insertion of additional Cobra and Tiger Forces.

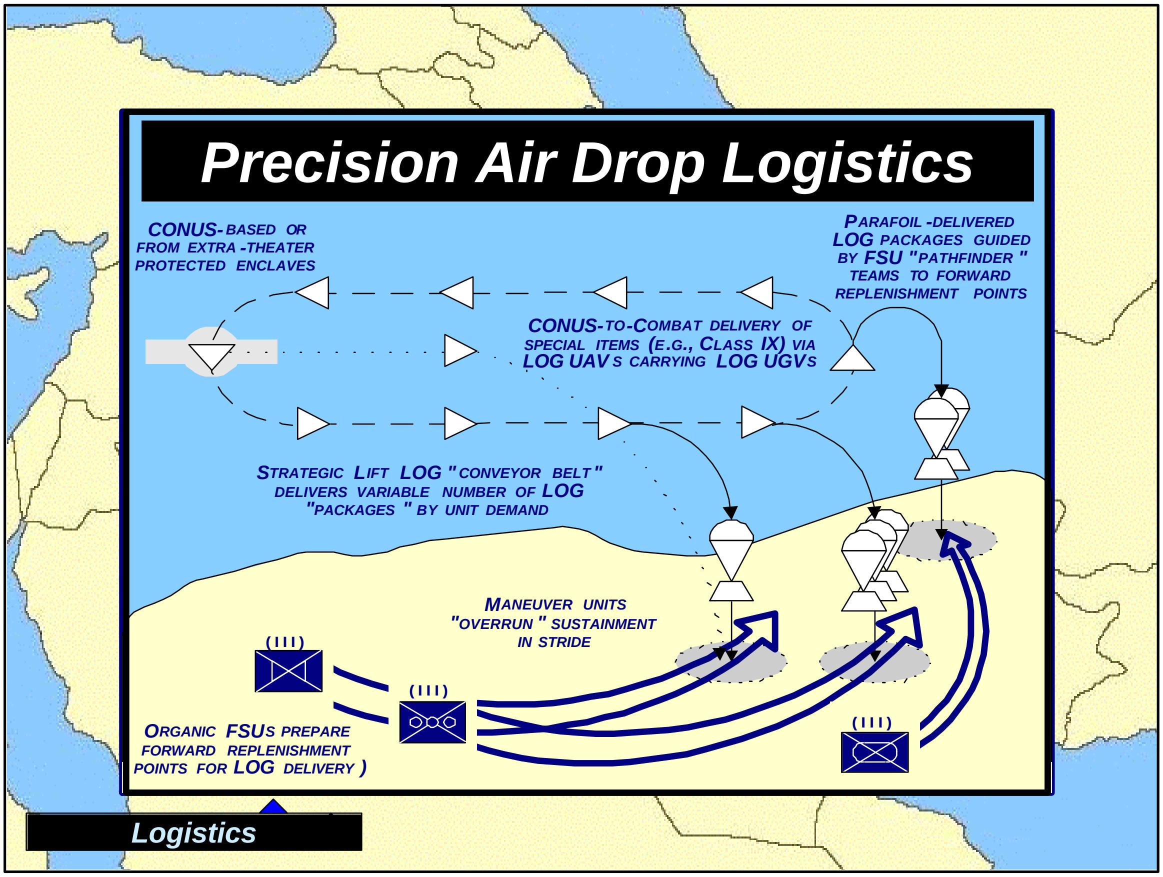
Looking down at the tactical level at what was just described largely at the operational level, air-mechanized elements operate within the expanding air lodgment in what is described as a tactical swarm. Individual elements operate with a basic commander's concept of the operation, fairly simple operating rules, and extremely precise battlespace awareness. Swarming maneuver elements attack enemy units from all directions in conjunction with their own organic fires and strikes provided by higher echelons. Precision logistics are provided to units in stride as they maneuver. (Following charts provide an abstracted view of these maneuver schemes.)

Supporting air and long range precision strikes are used here to complete destruction of the Guard Corps, protect the air lodgment, maintain the air corridor, and reinforce the maneuvering units of the swarm. The airbridge into the air lodgment is crucial to the success of this version of the Strategic Meeting Engagement. A Strategic Meeting Engagement might be conducted without such an elaborate air lodgment, but air maneuver units provide the crucial underpinning to any version of this type of operation. Additionally, the ability to network fires in a comprehensive and joint fashion throughout the battlespace allows accomplishment of the initial phases of a campaign with minimal entry forces in the battlespace.



The Swarm as Tactical Maneuver

Swarm operations entail operating in a demassed manner, attacking enemy forces from all directions at once, massing as necessary and then rapidly demassing to continue "swarming" over the enemy. In the graphic, the grid represents the integrated sensor network established by the Eagle Force tied with other assets. Air and ground maneuvering elements enter the battlespace moving immediately to attack enemy elements. They sortie from the attack into another attack, overrunning prepositioned caches of supplies en route to the following attack. Air and ground maneuver units are capable of air operational and tactical maneuver with organic assets.



Logistical Concepts

The Strategic Meeting Engagement concept relies heavily on the idea of transient resupply. Small caches are placed throughout the battlespace and periodically relocated. Sometimes units and sub-units maneuver to the caches on their way to their next engagement, and sometimes the caches come to the units as they disengage from a sortie. However, the operational pause required to fill up at such a cache could on occasion be too long and could present too much of a burden and a vulnerability. An alternative involves precision airdrops in the following manner. Tactical units, when deployed in de-massed fashion to theater, land on top of small pre-positioned caches that are tailored to the tactical situation and delivered by strategic lift in front of the units to keep them operating initially. Thereafter, high-flying transport aircraft and stealthy cargo UAVs loiter over the battlespace with a number of standardized resupply modules. Maneuvering combat units relay information to these airlifters, directing them to offload a module (e.g., via guided parafoil) to specific coordinates on the ground. Tactical logistics elements arrive at the drop point, unload the module, and facilitate the unit's resupply.

Robot ground vehicles could be included in the airdrop to transport supplies over short distances. The resupply operation takes no more than thirty minutes in any instance. As the modules are standardized rather than tailored to the specific needs of specific units at specific times, not everything dropped is necessarily needed in each case. Leftovers are simply abandoned, or logistics personnel might destroy them in place to prevent enemy forces from exploiting them. The fleet of airlifters that transport the resupply modules flies in a racetrack from CONUS so there are always sufficient supplies loitering near operational forces, awaiting the call for an airdrop.

The concept as articulated has a number of important implications for the design and operation of Dominating Maneuver units. First, logistics elements in each maneuver unit can be dramatically reduced in size. Resupplying tactical units via precision airdrop obviates the need for protection assets (e.g., air defense) for transient enclaves, and reduces the need for large numbers of logistics transporters at the unit level. There will be little logistics infrastructure for any unit to carry. The primary logistics equipment at the unit level will be information systems.

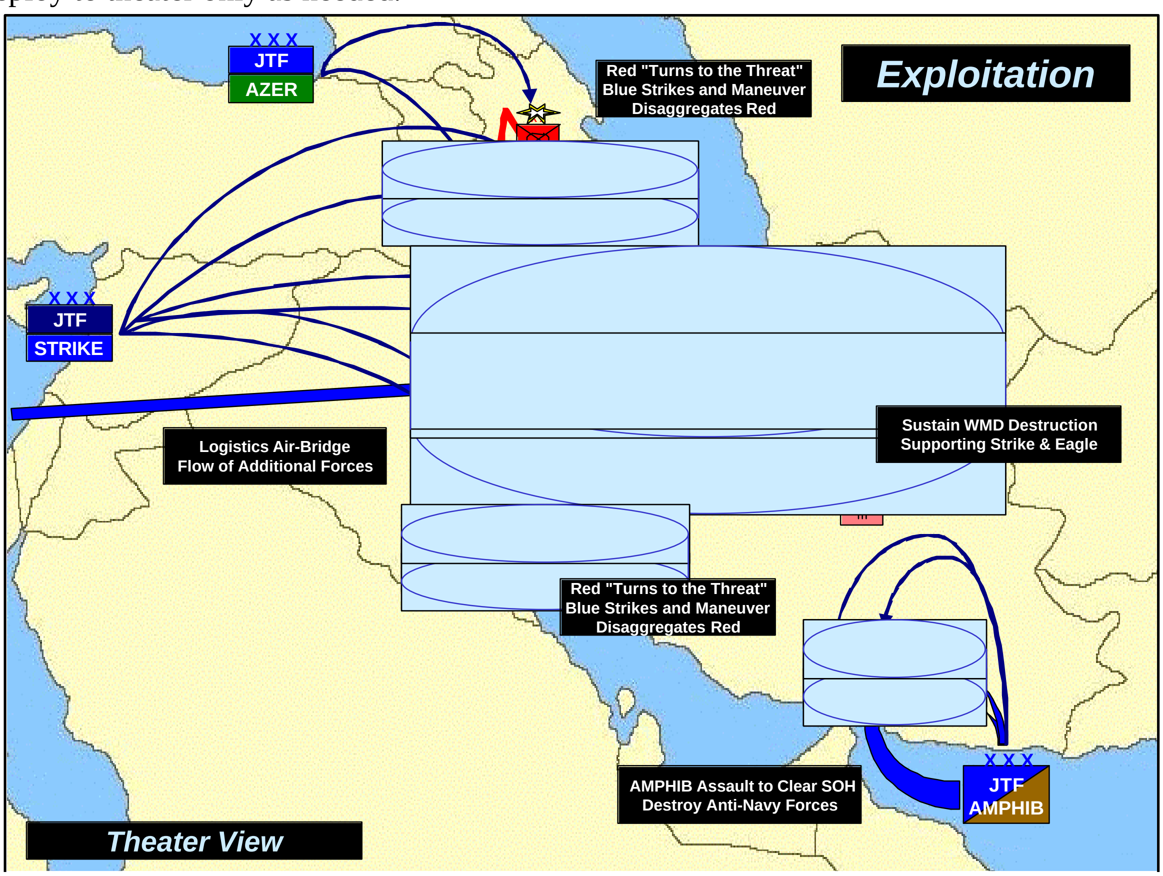
Logistics Organizational Concepts

Operational Level Support: An intermediate Theater Support Command (TSC) acts as a coordinating authority. The TSC moves support from a CONUS-based national provider to the tactical providers, and also provides and coordinates limited functions in theater (e.g., materiel handling, equipment recovery, medevac, etc). The activities of TSC sub-units, some land-based and others operating from seaborne stations, are coordinated much as the operations of supporting units are coordinated today. Some anticipatory demand items (e.g., Class IX) move directly from CONUS to the user in combat, while other classes of supply move to temporary stockpiles at "theater transfer and repackaging points" (TTRP) for rationalization, prioritization, and transport to the tactical units. Given limitations of available lift, only the most critical and time-urgent supplies move directly from CONUS to combat.

Tactical Level Support: Each tactical maneuver formation possesses a tailored Forward Support Unit (FSU) and Rear Support Unit (RSU). Redundancy is built into the support unit concept. FSUs and RSUs are tailored to the specific type of unit they support (i.e., air or ground maneuver forces -- Eagle, Tiger, Cobra), but each is capable of supporting several units of the same type. This enables them to cover gaps created as logistics elements displace from one location to another or suffer combat losses.

FSUs have the same mobility characteristics as the combat elements they support, and a limited self-defense capability. As the combat maneuver units cycle in and out of combat, the FSUs remain nearby and establish transient replenishment enclaves. They provide only the most critical, immediate support functions and services to highly mobile fighting forces. RSUs are operationally controlled by the TSC commander and are in relatively more secure rear areas, collocated with arriving resupply. The RSUs take supplies as they flow into the theater from CONUS, configure mission packages, and move them forward to the FSUs. Only enough supply for each replenishment cycle is moved from the RSU to the FSU. Given that these units do not require the same hyper-mobility characteristics as the maneuver force combat elements (except for intra-theater transportation), RSUs can employ trucks to move from one TTRP to the next. However, a combination of manned and unmanned air and ground delivery vehicles substantially decreases the number of trucks in the battlespace.

One responsibility of a Forward Support Unit in each maneuver organization is to serve as a "pathfinder" for the precision airdrops (e.g., scout future forward replenishing points; coordinate sustainment delivery to sub-units; direct logistics parafoils to the replenishment points; etc). Once the modules are dropped and secured, unit logistics personnel execute a rapid fill-up and facilitate the unit's transition to its next combat sortie. Given this radical departure from the traditional function of forward logistics elements, the FSU could be as small as 300 persons, consisting of an HQ element (for materiel management via information technology), a pathfinder detachment, small detachments to handle Class III and Class V fill-ups, minimal maintenance personnel (conducting only limited component swap-out activities vice detailed repairs), and minimal medical personnel (primarily placing wounded into stabilizing pods and preparing them for evacuation). More importantly, there will be no need for rear support elements attached to each unit (the RSU) to accompany it into combat. The RSU would deploy to theater only as needed.



Exploitation

As the initial air lodgment is expanded, and subsequent air lodgments are established, a sustained offensive information operation is undertaken to deceive and disrupt elements of the North and South Corps. Deception and disruption are accompanied by destructive attacks on select parts of the command and control of these organizations. These elements are systematically bombarded with the effects of the positioning of significant Blue forces in their rear area and in the vicinity of their capital. They receive orders to return to assist the Guard Corps, reinforcing the normal sense of panic resulting from the awareness of enemy units operating across their lines of communications. The remaining cohesion of these units is destroyed by precision strikes as they turn around on themselves and attack through their own formations to face the new threat.

As the two Red Corps maneuver back to dislodge Blue's central position, they are halted and effectively destroyed by joint strikes. At this point the meeting engagement has been completed. A flow of follow-on forces may continue into the battlespace to conduct additional missions. The Eagle Force can be made available to help other forces (Amphibious and Special Operating Forces) assigned to find the remaining missiles and mobile launch facilities and destroy them. Follow-on forces into the air lodgment maneuver to destroy surviving elements of North and South Corps. JTF AMPHIB undertakes operations to clear the Straits of Hormuz.

When the JTF Commander determines that Red has reached his culminating point and his mission has been accomplished he can commence re-deployment operations, depending on guidance from the National Command Authority.

Experimentation for the Strategic Meeting Engagement

Essential Capabilities

One of the critical lessons of the inter-war experimentation period is that new measures of effectiveness must be created in order to have an objective standard against which to judge progress in achieving the new military capabilities. Thus, after much debate and several war games and simulations, the U.S. Navy by 1925 reached the conclusion that what it had to do in order to be successful with carrier warfare was to maximize the number of aircraft it could get into the in single “pulse” operation. This became the MOE against which naval aviation experiments tracked progress. Likewise, the U.S. Army Air Corps, in exploring how to conduct pursuit operations against long range bombers, determined that the key variable was how long it takes to relay messages from an initial determination of range, altitude and heading of incoming bombers to the pilots of interceptor fighters.

It is too early to narrow the range of decisive variables for the current military transformation to one or even two or three. But we can begin to reduce the number of key capabilities to the critical sub-set of capabilities needed for the concepts we have developed. The capabilities needed for conducting the Strategic Meeting Engagement suggest a set of perhaps a dozen candidate measures as judging future experiments.

First, the SME cannot be conducted without first winning **Dominant Battlespace Awareness**. The key capability here, and the one that distinguishes the SME from other transformational concepts such as Long Range Precision Strike, is the need for establishing and maintaining 100% Blue situational awareness. In LRPS operations the key capability is knowing where all the targets are, this is less important for the SME since the objective of the SME is to position forces in places where the enemy *is not*, rather than striking him wherever he *is* as in LRPS.

Next, in order to **Shape Red Operations**, forces conducting the SME must be able to create those “no detect zones” needed to bring the initial force into the theater of operations. It is probably impossible to completely and permanently “blind” enemy sensors. But it should be feasible, and is essential for the success of the SME, to block out enemy detection capabilities in designated corridors of entry during the crucial period of first landings when early arriving forces are most vulnerable. There is as much danger of detection by enemy national assets with consequent counter-strike by long-range missiles and aircraft, as there is from local detection of incoming U.S. forces with responses conducted by area militia and early mobilizing immediate response ground forces.

The truly distinguishing feature of the SME is the requirement to **Isolate and Seize Initial Objective**. Two capabilities are key to achieving this capability. *First, the campaign force must discriminate among the key elements of the Red center of gravity (COG).* The broader part of this capability is identifying those components in the first place. Integrated with this determination must be a rapid decision-making capability for the Blue forces to decide which components of the Red COG are to be attacked through long-range strikes, which are to be dealt with by means of information operations and which ones must be dealt with through close combat ground operations. *The second capability needed here is the ability to deploy those combat forces into the theater from CONUS into combat within 96 hours.* This requirement is driven by the geographic advantage enjoyed by the opponent who is, after all, operating in its own "back yard." Inherent in the 96 hour deployment requirement is the capability of the SME force to provide all of its logistics sustainment requirements for the attack operation with its on-board deployed systems.

Finally, the SME must demonstrate the capability to close with and destroy those forces determined by the commander as unable to be targeted by LRPS or IO. To **Defeat the Red Force** through the *Tactical Swarm* Blue ground systems will have to have advanced mobility and agility characteristics. These will include the ability to travel with high velocity from attack position to fire position (high mobility) and the ability to evade incoming precision fires (high agility). Such vehicles should be evaluated in terms of the trade-space between maximizing agility/mobility and relevant lethality characteristics (direct fire range, rate of fire, and probability of kill.) Protection will be inherent in the mobility and agility of the vehicle as it is integrated into the C4ISR architecture.

Table 2 Critical Military Tasks With Associated Candidate Measures of Effectiveness and Standards of Performance

TASK	CAPABILITY	MEASURES	STANDARDS
Dominant Battlespace Awareness	Blue Real-Time Situational Awareness	• Percent of force positions not known in real-time by JTF Cdr/HQ • Percent of Time an individual force element does not have situational awareness of all other relevant blue force elements, aggregated across all blue force elements	• 0 • 0
Shape Red Operations	Create No Detect Zones	• Number of Red detections of Blue force elements in time for Red to respond with Strike or Attack • Volume of space contained within zone • Duration Zone can be sustained	• 0 • 100 x 500 x 30 nautical miles • 12 hours

Isolate and Seize Initial Objective	• Decide how to attack enemy COG: which elements for Strike, IO and Ground Assault
	• Deploy Combat Forces CONUS to Combat
		• Minimize JTF Commander decision time
		• Minimize Deployment Time
		  • Establish Air Corridor
		  • Establish Air Lodgement
		  • Deploy Ground Elements to Attack Positions
		• Maximize Combat Power
			• 6 hours from notification to deploy to issue OPORD
			• 96 Hours
			• N to N+3
			• N+3 to N+12
			• N+12 to N+96
			• Total No. of Vehicles Delivered

Defeat Red Force	Close With and Destroy Key Red Forces Unreachable by LRPS or IO	• Maximize Ground Vehicle Speed and Agility • Maximize Direct Fire Weapon Lethality	• Sustain 160 kph road cruise speed • Traverse 1 km Rough Terrain in 20 sec. • 15km range • P_k >0.99 • Max Rate of Fire = 30 rounds per minute

The Nature of Experimentation

An *experiment* is any action or process undertaken to discover something not yet known or to demonstrate something known. An experiment may also be something attempted in order to find out whether it will be effective. The imperative for experimentation in the U.S. military is that we do not yet know how to meet the demands for the projection of military power in the face of anti-access strategies of future opponents. We must begin a process of experimentation now to discover how to do it.

Currently, the defense community's efforts to understand future war fighting concepts entail attempts to discern that which is not yet known. There are some promising notional operational concepts, but it is not yet clear which operational concepts will produce a decisive advantage on future battlefields. There is a wide-ranging debate over how to organize to fight in the future, a debate that is concerned with such issues as levels of command and span of control. There is particular uncertainty as to the role of technology and the investment priorities needed to make the operational and organizational concepts feasible. In short, there are some ideas on *what* to do; it is not yet known *how* to do them. The process of experimentation should develop the art of the possible from the array of emerging operational concepts.

The experimentation process must avoid the temptation to move too quickly from discovery to validation. Traditional operational or developmental tests and evaluations cannot yet be conducted because the right concepts, organizations and technologies are not known. Classic force-on-force modeling and simulation tools are not likely to simplify the problems associated with exploratory experimentation because these tools are derived from attrition-based theories of war. Attrition-based theories do not adequately represent the emerging new war-fighting concepts, which depend more on information and mobility effects to achieve the defeat of the opponent.

The experiments will contribute to the understanding of new theories of war and thus to the development of new models and simulations. There will need to be frequent interaction between field and fleet trials, and continued development of the concepts in war games and seminars. We certainly have not exhausted the potential for new war fighting ideas to be developed in the seminar environment. As the more promising new ideas emerge they should be tried out in experimentation programs. War games will also provide a forum for developing the appropriate measures of effectiveness to evaluate new operational concepts. As the analytical process continues, data from field trials can be fed in to war games to test the utility and to refine the reliability of contending measures of effectiveness.

The exploratory form of experimentation will be characterized by trial and error focused on new, non-traditional operational, organizational and technological concepts. Many of the new operational concepts born in the pristine environment of seminars and war games need to be tried out in order to see just how far we can go with them and to figure out how to make them work. As the case studies show (see Appendix B), more often than not, a particular field or fleet trial is likely to fall short of reaching the full capability promised by the operational and organizational concept. But in reaching for that capability, those who conduct the experiments will be inspired with new ideas on how to come closer to achieving the ideal. Just as the U.S. Navy developed carrier warfare and the German Army created the blitzkrieg over two decades of incremental steps along a non-traditional path, the United States can develop new military capabilities through exploratory experiments on power projection against determined opponents. The magnitude of the differences in military capability will not be immediately apparent from one year to the next in such an experimentation program, but over the longer run of a decade or two dramatic and decisive military advantages can emerge.

More importantly, the field and fleet trials will demonstrate practical limits to the ideas developed in war games. War gamers should then take the results of the experiments and refine their concepts even further. For example, in the U.S. Navy's inter-war development of carrier warfare, fleet trials in the Pacific Ocean revealed the tremendous magnitude of the logistics requirements of vast maneuvers across the seas nearly a decade after the first war games. Only in the early 1930s, after ten years of dreaming up long- range maneuvers and assuming away their logistical implications, did the Navy conduct fleet experiments that eventually perfected such techniques as underway replenishment.

Finally, exploratory experiments must be designed so that skilled technical and tactical innovators will have the opportunity and the time to solve the problems associated with new ways of doing things. Since we will not be sure what works and what does not work, we must not to give up too soon on a promising concept. We will have to be willing to accept the lack of success and progress that would otherwise doom an acquisition program so that the people working on the problem can find ways to solve it. Had this not been the approach in the early years of carrier warfare experiments, the mechanics and crews of the first carriers would never have found ways to recover aircraft with cargo nets or arresting cables. Moreover, they might not have been able to ascertain the optimum deck geometry, engine power and technical procedures needed to maximize the numbers of aircraft that the carrier could launch.

A Concept for Conducting Experiments on the Strategic Meeting Engagement

The Strategic Meeting Engagement is an operational concept that might be feasible in the future, and the preceding discussion described the execution of a Strategic Meeting Engagement against a powerful regional opponent. This concept was developed on the basis of a number of seminar war games and other assessments as a mechanism for developing ideas for a program of experimentation aimed at the longer-range future. We can now begin to develop some sample experiments based on this program..

Such a program must recognize that the experiments will necessarily be of an exploratory nature. The goal is to discover what we do not yet know about future military operations. Long after the initial set of exploratory experiments, other programs would validate the designs and doctrines to emerge from the initial years of experimentation. Furthermore, at some point field and fleet trials must be conducted to demonstrate that the operations can be done and to assist the discovery process. Simulations cannot substitute for live experiments, especially when dealing with revolutionary operational concepts for which there are no proven theories from which to gauge the results of simulation. This is not a quest for causality and inference where statistical tests can determine significance. While we are still in the stage of discovery and description of phenomena heuristics are called for, not hypotheses. Disciplined open-ended trial and error methodologies must predominate, not controlled variables and conditions.

The overall objective is to see how a Commander in Chief might make a Strategic Meeting Engagement campaign work by experimenting with the different pieces of the campaign. Workshop three developed some ideas on how to conduct an experimentation program (Table 1 Stage 4). Such a program would consist of five experimental phases. Each phase would correspond with a Tasks of the Strategic Meeting Engagement (Build and Maintain Dominant Battlespace Awareness, Shape Red Operations, Isolate and Seize Initial Objective, Defeat Red Forces, Transition to Subsequent Operations) and would explore particular elements of the campaign. This part of the program might extend over a five-year period. It would be followed by a culminating stage, perhaps of another three to five years, devoted to integrating the separate components of the campaign.

Phase I: Build and Maintain Dominant Battlespace Awareness

The early part of the Strategic Meeting Engagement (SME) is devoted to gaining the informational advantage required to skip the traditional movement to contact. Since force movement and fires will not be employed to force the enemy to reveal his dispositions and intent, U.S. forces will require superior information in order to execute the SME. Dominant Battlespace Awareness (DBA) is the *sine qua non* of the Strategic Meeting Engagement and if friendly forces cannot achieve it, the operation cannot be risked.

Current views of future warfare postulate significant U.S. informational advantages as central elements of new warfare capabilities. The future warfighting visions of the services and the joint community assume the information advantage as a given. For the longer range future anticipated in the SME, we must examine that assumption critically. In fact, it is likely that there will be a fight in the information battlespace. This fight will occur simultaneously with such operations as an SME and will form an integral part of the overall theater campaign.

The kinds of systems and procedures that will be required for such information operations are themselves quite complex technically and sometimes even strategically. Many are highly classified at present. Wargame experiences with Information Warfare show that these complexities are at present very poorly understood. There are few tools or models capable of simplifying information warfare to the level needed to run an effective war game and there is even less available that would be appropriate for field experimentation. Before this component of the SME can be subjected to experimentation, we must perform much more conceptual work on information operations. Hence, consideration of experiments for this phase of the SME in this Report will be deferred until later treatments.

Phase II: Shape Red Operations

In this stage of the Strategic Meeting Engagement Campaign, Blue conducts offensive Information Operations in the Area of Operations to prevent Red from deducing Blue's scheme of maneuver. In close coordination with those Information Operations, Blue also conducts long range precision strikes so that Red must execute the course of action preferred by Blue.

Phase II involves Information Operations that are even more difficult to experiment with than in Phase I because of the explicitly offensive nature of the requirements in this phase. Experimentation with the other aspect of Task 2, Long Range Precision Strikes, is discussed separately in the Extended Range Aerospace Operations project. Hence we will move directly from these preliminary phases to the force-on-force stages of the Strategic Meeting Engagement concept.

Phase III: Isolate and Seize Initial Objective

Force-on-Force Air Expeditionary Force Exercise Series

Task 3 of the SME requires Blue to plan and establish an air corridor for the insertion of maneuver, information and strike forces as well as their accompanying support forces. This is a logical mission task for an Air Expeditionary Force.

The AEF Commander would become the JFACC and within 1 hour of notification would select the assets required for the mission, and would assign missions and tasks to supporting commands located across the CONUS and some overseas. The AEF would have to achieve its first “wheels up” in that first hour and the last departing aircraft would have to arrive in the AO within 12 hours. The AEF would have to establish its logistics, C4ISR and basing network within 72 hours. The Air Corridor would consist of up to 8 legs, each approximately 50nm long, 100nm wide, and up to 90,000 feet in altitude (the total air corridor would thus be about 400nm long and 100nm wide).

In order to experiment with this phase of the SME concept, a Joint Air Expeditionary Force Headquarters could be formed and based at Nellis Air Force Base to play the role of Blue. It would be equipped with surrogate aircraft to conduct the missions envisioned for the future Airborne Laser, Joint Strike Fighter, and follow-on to F-22 air superiority aircraft envisioned in the war games. Space capabilities necessary for the operation would be simulated by the Air Force Space and Missile Command. CINCUSSPACECOM would serve as the overall controlling headquarters for the experiment. Blue would be required to fly from Nellis Air Force Base to Fort Bliss Texas, transiting instrumented portions of White Sands Missile Range en route.

The Red forces would be played by a Joint Aerospace Defense Force created for this purpose. The recently formed mobile SCUD force created for exploitation by the Director of Operational Test and Evaluation would be employed as well as US aerospace defense systems staging out of the Air Defense Center at Fort Bliss to play the roles of anticipated Iranian aerospace defense capabilities in the time frame of the SME concept. The Army Space and Missile Defense Command would be the controlling headquarters for Red forces.

In a series of trials, Blue would be required to create an air corridor from Nellis to Bliss and establish air superiority over a simulated lodgment area on the ground at Fort Bliss. Red's mission would be to prevent Blue from reaching the airspace over Fort Bliss and to prevent Blue from establishing air superiority over any lodgment areas.

Multiple, Competing Deployment Forces Conduct Lodgment Exercises

Once DBA is established and the freedom to maneuver into the lodgment area has been secured, the SME concept calls for Blue to begin to move into ground positions to prepare to conduct the main attack. This will require expansion of the umbrella of air superiority out and up to include full dimensional force protection over the lodgment area site. The first ground units to move in would be an Eagle Force which would deploy from CONUS to establish local DBA and to secure an expanded site to accommodate the main body. As the main assault force deploys into the lodgment, the Eagle Force would assist in establishing contact with the elements of the main enemy force that will form the objectives of the Blue main body.

The campaign will require up to 8 lodgment sites, each initially about 200 – 300 km in diameter, in order to facilitate the deployment and maneuver of the incoming ground forces to their enemy force objectives. As the main body arrives the lodgment sites will expand to perhaps as much as 1000km in diameter. Initial opposition from Red will be mobilizing local militia forces of up to brigade size as well as air and missile strikes which would come from weapons within range that could be rapidly re-targeted by Red once the Blue deployment is discovered.

The National Guard Bureau, including Reserve Component Special Operating Forces, would be an ideal command to organize and conduct the local reaction portion of the Red Force for these exercises. Headquarters JFCOM would form a Joint Task Force to play Blue. The Eagle force could be played by the reconnaissance squadron of the Transformation Brigade at Fort Lewis, Washington. The main ground forces for the experiments would be provided by the 101st Airborne Division (Air Assault). Tiger forces would be formed by converting infantry battalions to assault forces equipped with commercial high-speed cross-country vehicles to replicate the speed potential of future fighting vehicles. Cobra forces would be formed by providing Attack Helicopter Battalions with modified Blackhawk and OH-58 helicopters to produce the kinds of range and speed anticipated with future aviation assets. The Transformation Brigade and the 101st Division would need to create at least four of each type of RMA maneuver force for experimentation purposes.

For experimenting with the Air Lodgment, US Transportation Command would be tasked to create organizations to provide two competing theater lift concepts. Force A would be formed around the advanced CH-47 helicopter or the V-22 tilt-rotor, modified to carry extra fuel and to conduct in-flight refueling. This aircraft would be a surrogate for future vertical lift systems, which would require no airfield in the lodgment area. Force B would be organized around the C-130 or the C-17 as surrogates for future Short Take-off and Landing aircraft with great payload and range in the mission profile. These aircraft would require a hardened ground strip as a minimum in the lodgment area.

Logistics concepts would also be experimented with in this series. For example, the two competing transport organizations would be tasked to move a brigade rotations' ammunition requirements to the National Training Center from the supplying depots to Fort Irwin on 96 hours' notice. Measures of effectiveness for this set of experiments would be the survivability of the force in the Lodgment and the length of time the supported ground units sustain their logistics requirements.

The Eagle, Tiger and Cobra forces would use the lodgment exercises to train up in their individual tactics, techniques and procedures. The focus of the experimentation in Phase III would be a fly-off between Force A and Force B. Each would be employed to lift Eagle, Tiger and Cobra forces from Fort Polk, Fort Lewis and Fort Campbell to Fort Hood to represent the distances involved in moving to the lodgment area (while Fort Polk's proximity to Fort Hood is nowhere near the 8,000 miles CONUS-to-Combat distance anticipated in the SME concept, the time-distance equation can be replicated by a variety of means). The key measures of performance for this phase of experimentation are the speed of deployment and logistics requirements of the aerial transport forces.

Phase IV: Defeat Red Forces Through Progressive Tactical Swarm Exercises

In the final phase of the Strategic Meeting Engagement, Blue forces conduct tactical swarm operations to defeat the key elements of the Red Force main body. The Eagle Force continues to develop its information advantage and passes local real time information through the tactical internet to supplement operational and strategic level situational awareness. The Tiger and Cobra Forces conduct up to 4 engagements per day, each no more than 15 minutes in duration. They move up to 80 kilometers between engagements in an hour. They must be able to conduct up to 2 logistics sorties per day between engagements. These operations will be experimented with by progressive tactical exercises. For this purpose, the Ft. Lewis Washington-based Transformation Brigade would form the 21st Century analog to the 20th Century U.S. Navy's Langley carrier aviation experimentation platform.

At the engagement level, platoon sized units conduct simulations of single engagements on computerized board games developed specifically for this experimentation purpose. Players manipulate icons possessing capabilities of future fighting vehicles through synthetic battlespace replicating the battlespace of the exercise. The computers resolve individual tactical encounters between Red and Blue forces. Based on the results of these games, those platoons then deploy 80 miles by road to Yakima Firing Center, in Washington State, to conduct half-day long tactical field exercises to develop proficiency in the SME swarm engagement. When a platoon reaches a sufficient level of proficiency in executing the engagement, it increases the pace of operations progressively until it can move from Ft Lewis to Yakima, execute an attack, return to Ft Lewis execute another attack in a local training area, then repeat the sequence within a 24 hour period.

Once a sufficient number of platoons demonstrate the proficiency to conduct such swarm tactics, platoons and companies are netted together at the battalion level to conduct simulations of a full day's worth of engagements, movement and log sorties in the computer board game environment. Once the procedures for larger unit swarm tactics are developed, the battalions deploy to the field for day-and-a-half combined exercises involving multiple simultaneous attacks by Eagles, Tigers and Cobras operating in parallel. At this time the rule-based techniques for autonomous command-and-control can be developed in the experimental environment as well. When battalions master these techniques the Joint Task Force as a whole should conduct large scale operations about 5 days in length to replicate the anticipated duration of a Strategic Meeting Engagement from start to finish. Opposing forces for these experiments would come from other US Army units, including the reserve components, tasked to deploy from their home station to Fort Lewis for this purpose.

Phase V: Transition to Subsequent Operations

As the Strategic Meeting Engagement concludes, success is exploited as determined by the Blue force commander and the National Command Authority, and the forces involved transition to subsequent operations. Experimentation in this phase of the campaign need not be addressed.

Implications for Experimentation

The preceding section presented some initial ideas and concepts for conducting experiments on the Strategic Meeting Engagement as an example of the kind of operations we might conduct in the future. These ideas are not definitive and should be refined as we continue the process of developing additional future war fighting concepts such as the Extended Range Aerospace Operations. Our purpose is to lay out an example of how to conduct the kinds of experiments that will be necessary to see if the concept can be made to work. We also wish to contrast this kind of exploratory experimentation with the more traditional forms of experimentation that should, for a time, await the completion of this more basic discovery phase.

The scope of the kind of experimentation contemplated in the Strategic Meeting Engagement concept is larger in scale and time than any currently under consideration. The sheer complexity of the operations as well as the resource demands will require that a high-level, perhaps permanent, command be formed to execute such a program. It should be staffed with a large number of specially selected officers and technicians who have demonstrated a capacity for innovation. The command and its staff would have to be resourced for the long term and would need to be programmed in such a way as to maintain continuity in its overall objectives.

We must be prepared to conduct such an experimentation process for at least the next ten years. It would take a year just to stand the force up, but the force should begin immediately to conduct experiments on the Strategic Meeting Engagement. The Phase III and IV experiments could begin within the first year of the experimentation program. Dominant Battlespace Awareness (DBA) and Long Range Precision Strike (LRPS) – Phases I and II – are key capabilities required for Extended Range Aerospace Operations as well as the Strategic Meeting Engagement. Thus, as technology, organizational and operational concepts mature, the command will need to integrate additional forces and experiments to explore the Extended Range Aerospace Operations concept in another related experimentation program.

The need for continuity might mean that the command should have tasking authority over forces that could be assigned to experimentation. Those forces might need to be exempted from all other current or contingency force planning requirements. The command would probably need its own RDT&E and O&M budgets in order to have the necessary bureaucratic power to plan experiments over the longer-term and will require special regulatory authority for contracting and acquisition decision-making. It should also have its own professional development forums to provoke discussion of ideas and to disseminate contending views on the results of experiments.

The experimentation headquarters might routinely command certain forces such as an Air Expeditionary Force, a Carrier Battle Group, or an Army Division containing experimental ground forces. Other forces could rotate through various experiments for designated periods of time. A Joint Support Command might have to be created to provide the unique logistics capabilities demanded by the force as well as to conduct support experiments themselves.

Finally, there must be clear linkages from the experimentation program back to the concept development process on the one hand, and to the acquisition system on the other. The intellectual vitality of the future war fighting concept development process must be maintained by the established institutions that have done this so well in the recent past -- the military services, the joint community, the Defense Agencies and the Defense Staff -- while the experimentation command must constantly interact with that process. Experiments will provide practical feedback to concept development as to the realistic limits of future war-fighting ideas while the generation of new ideas must not come to a halt just because an experimentation process has begun. Ultimately, the results of this experimentation process must be integrated into the Title X decision-making processes which shape Doctrine, Organization, Training and Education, Materiel, Leader Development and People systems so that key investment and policy leap-ahead decisions can be made based on the results of the experiments.

Conclusion

These efforts at understanding experimentation for the future of warfighting, has suggested a number of preliminary answers to the research questions we set out to address.

What does it take to be better than our opponents? The United States will need military capabilities that can overcome an enemy determined to keep us out of its own area of operations. We must be able to do so without the advantages of forward bases we enjoyed during the Cold War era and we must be able to do so rapidly.

How do we do that? We will need to exploit the opportunities brought about by the information revolution to understand the opponent quickly, then move and shoot faster, and more precisely, than the opponent's forces. We will be required to do so from a position of initial disadvantage in terms of geographic distance from the battle space.

What are the measures of effectiveness? We have identified a number of potential measures of effectiveness that should apply to this problem. These include such quantities as:

- ability to know the locations of enemy platforms in real time
- ability to know the locations of friendly systems in real time
- number of enemy systems that can be targeted
- identification of enemy sensor-to-shooter information links
- time required to establish an air corridor
- degree of force protection that can be provided over a lodgment area
- number of lodgment areas that can be sustained
- speed-weight-volume relationship of ground vehicles
- fuel consumption of ground and air vehicles

This is an area where initial experimentation can focus and provide a number of refinements and preliminary answers. We must make a clear distinction between measures of effectiveness in this type of environment and measures of effectiveness in a Testing and Evaluation environment. The purpose of the experiments connected with the Strategic Meeting Engagement is exploration and discovery. Therefore, we may not necessarily know which measures of effectiveness to use before experimentation begins. In fact, the purpose of initial experiments may even be to determine the appropriate measures of effectiveness to use in subsequent experiments. Such a process of exploration has proven highly effective in the past.

How do we change operational concepts to achieve enhanced capabilities? We can explore concepts such as the Strategic Meeting Engagement. In this first year of effort we have developed the Strategic Meeting Engagement in sufficient detail to begin to evaluate options for experimentation. Subsequent efforts under the Net Assessment project consider Extended Range Aerospace Operations and Maritime Operations.

How do we organize military units to conduct such operations? For maneuver forces, where the emphasis is on speed, both to get to the theater rapidly and to deliver lethal blows quickly across multiple objectives, the need is for smaller units and fewer echelons of command. For the large number of precision targets that will need to be struck the requirement will be for more automation among sensor-to-shooter links, deconfliction of targeting, weaponeering, and avoidance of fratricide or friendly fire casualties. Such organizations will demand new approaches to integrating necessary human decision points into the overall command and control architecture as well as sophisticated engineering of the automated strike architectures themselves.

What kinds of systems do we need? Clearly there is a need for new technology to allow the design of system platforms that are faster and more fuel-efficient than today's systems. We also need to continue to exploit the information revolution and integrate it into the military capabilities of the far future.

While these are preliminary answers, subsequentworkshops on experimentation will provide more refined answers by examining other operational concepts and developing experimentation program ideas for them as well.

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APPENDIX B: CASE STUDIES IN EXPERIMENTATION

The following summaries are based on case studies conducted for this project. Dr. James Perry conducted the case studies on the U.S. Navy and U.S. Army Air Corps. Tammy Furrow conducted the case study on British, French, U.S. and German Mechanized Warfare. Blake Furrer conducted the case study on US Air Mobility.

Although this is a time of revolutionary changes in war fighting, we have some experience to draw from to guide us to the future. In the period between World War I and World War II, a somewhat analogous period of dramatic change in warfare, the examples of how military institutions coped with such change are instructive. We conducted a number of case studies in this area and found, at a fundamental level, that when the military provides a long-term (decades) environment for innovation to occur, and when it then integrates the acquisition of new capabilities to that innovation process, it can achieve decisive advantage over its opponents. Two such case studies are highlighted, the U.S. Navy and the German Army in the inter-war period.

Those who do not produce innovation and subsequent modernization commit institutional errors that result in military forces being outclassed on the battlefield. Those errors can be of several types, which we define as follows. The Type I error is the failure to innovate combined with the failure to acquire new capability. Type II error is the stimulation of innovation, but failure to acquire new capability based on that innovation. A Type III error can happen if the acquisition of capabilities derived from a successful innovation process is diverted by a sudden shift in military strategy. The Type IV error occurs when the acquisition of innovative capabilities is cut short by a reversion to non-revolutionary methods. We found instances of each error type in this project.

US Navy

In 1919 Admiral Sims initiated a war game series at the U.S. Naval War College aimed at developing concepts to exploit the then-emerging Revolution in Military Affairs involving carrier warfare. These games took two forms. “Chart Maneuvers” examined strategic issues with regard to potential war with Japan, while “Board Maneuvers” were tabletop exercises to explore tactics, operations and force mixes. In 1920 the United States began work on its first aircraft carrier, the USS Langley, which was completed in 1922 and was capable of embarking up to 34 aircraft of the day. By 1922 then, the United States Navy was fully engaged in the intellectual and the practical development of carrier warfare.

The British Royal Navy, in contrast, had already placed one carrier, HMS Argus, in service in 1918, had another under conversion and two more under construction by 1919. By war’s end the Royal Navy counted 3500 aircraft in its service, although, because of the limitations of its carrier decks, it could only put 60 to sea. Both the British and the American navies continued to experiment with carrier concepts in the inter-war period. Both services communicated their results freely with each, often comparing notes for similar experiments, sometimes evincing skepticism of each others' alleged accomplishments.

In the 1920s the U.S. Navy introduced an element of interaction between its war games at Newport and its experiments at sea that had no analog in the British efforts. The more promising results of the Naval War College "Chart" and "Board" Maneuvers were examined in annual Fleet Problems employing the carrier assets available. In these experiments, the theoreticians were provided ample resources and were encouraged to try new ideas freely. For example, an early conclusion of the war games was that the Lanchester model of battleship effectiveness did not apply to carriers. The former delivered ordnance in steady streams while carriers delivered "pulses" of power. The key Measure of Effectiveness was hypothesized to be numbers of strike aircraft that could be launched into the skies, not the caliber or number of guns. So an early focus of the Fleet Exercises was to see how many aircraft could launched and how fast they could be hurled into the skies. The experiments consequently involved such tasks as jockeying with the geometry of the deck surface, parking schemes and launching mechanisms. Through a process of exploratory trials the U.S. Navy developed technical solutions such as folding wings and arresting cables with tail hooks. In addition, the development of more powerful piston engines for naval aircraft was a major factor in improving launch efficiency.

Once in the air, American Naval Aviators then experimented with techniques for delivering ordnance. In the early days most of the displaced volume of a carrier was devoted to the needs of the aircraft – parking, take-off and landing, servicing, crews, fuel and ordnance. Not much space was left for stowage of vast quantities of bombs and in any case the carrier aircraft could not lift much of a load anyway. It would be the late 1930s before carriers would be able to deliver the kind of firepower that battleships could deliver after extensive experimentation to develop new aircraft engines and airframes. But it would take the development of revolutionary new bombing tactics in order to give aircraft carriers the ability to deliver battleship-like firepower equivalence without the massive warhead tonnage associated with the big guns.

In late 1920 the U.S. Navy began to conduct secret bombing tests to discover how they might drop bombs to destroy enemy ships at sea. This was a much more challenging problem than the already daunting issues facing the Army Air Corps in finding a static target, navigating to it, dropping a bomb on it and returning safely to a land base. For the Naval Aviator, the target would be moving, in elevation with the sea state as well as in latitude and longitude. Navigation was more difficult since the launch point, the carrier, itself was a moving object and its own location was not known as precisely as that of a land base, the terminal munitions effects to sink a ship at sea were more complex than those required to blow up a building or suppress troop formations, and the return flight was likely to be more uncertain since the carrier could have moved a considerable distance during the flight time.

The most difficult problem to solve was achieving the terminal effects needed to be assured of target destruction. The limited range and staying power of early naval aircraft meant that an attack would be likely to get only one pass at its target. Level bombing techniques employed by the Air Corps, necessarily conducted from higher altitudes for aircraft survivability, could not drop bombs accurately enough to hit a target as small as a ship that also happened to be moving irregularly. Highly lethal air-dropped torpedoes were developed, but in order to ensure a hit the aircraft had to fly in on a very low level approach at a fairly broad side angle of attack, making it very vulnerable to close in defense weapons that most warships of any size could mount.

This problem was handed to the fleet naval aviators to experiment with during the annual fleet exercises. Each year a handful of young pilots would make several runs at target ships employing a variety of bombing techniques to explore the trade-offs among accuracy, lethality and survivability. They discovered that Marine Corps aviators, who were themselves experimenting with bombing techniques during their extended operations in occupied Haiti and Nicaragua in the 1920s, had developed dive bombing techniques that seemed to produce a kind of optimized balance among the three contending requirements. By the 1930s the naval aviators had perfected the technique at sea and collected convincing data over several years to discover that dive-bombing would prove to be the most effective procedure for carrier warfare.

Year	USS Utah's Tactics	% Hits by Dive Bmbg	% Hits by Lvl Bmbg	Alt. of Bombers Level(ft)
1932	simple	18.2	5.6	8,000
1933	radical	20.0	0.0	8,000
1934	radical	13.0	0.0	8,000
1935	restricted	17.3	9.4	8,000
1936	radical	23.7	8.3	10,000
1937	steady	12.7	11.1	10,000
1937	sharp turns	11.3	5.6	10,000
1938	steady	13.9	4.1	12,000
1938	sharp turns	14.5	2.4	12,000
1939	zig zag	21.8	4.4	17,000
1939	unrestricted	18.1	1.1	17,000
1940	zig zag	19.1	1.9	17,000
1940	unrestricted	23.1	1.9	17,000

The commitment to exploratory experimentation paid off for the U.S. Navy. The results of the sea trials were employed by the War College to develop adjudication rules for the seminar war games, making them, in turn, more realistic and useful both as a future warfare exploration tool and a concept development and refinement mechanism. As the inevitable disputes arose over design concepts for carriers, experiments of the late 1920s addressed those issues. Although resource and arms control constraints precluded vast test and evaluation efforts, the experiments were able to determine what the key measures of effectiveness would be – e.g., numbers of strike aircraft in the air – what the unique vulnerabilities were – the necessity to be close to the enemy and the dictates of wind direction for carrier speed and course – and the essential operational concepts – once in the range of the enemy carriers must strike immediately and the first targets must be the enemy's carriers in order to achieve air superiority over the opposing fleet.

As early as 1927 Admiral Reeves was developing the more complex concepts of multiple carrier operations and battle group composition for achieving a fast striking force capable of rapid concentration at the time of decision. By the mid 1930s the essential design elements were recognized and the U.S. Navy aimed to build large high-speed vessels of around 27,000 tons and 33 knots with large numbers of aircraft employing dive bombing tactics. In the 1930s the US Lexington class carriers carried a complement of some 80 aircraft. At the beginning of World War II the U.S. had two such advanced carriers along with five older, developmental designs in service. In 1937 construction of the first Essex class 27,000 ton carrier was authorized in the Vinson Navy Bill, and by the end of the war the U.S. had 17 Essex class carriers in the fleet.

In contrast with the US Navy experience, the Royal Navy was less innovative and moved more quickly to an acquisition program. It had six aircraft carriers under way by 1930, twice as many as in the U.S. Navy at the same time, and could embark 190 aircraft. But the British had not conducted the kind of open-ended fleet experiments executed by the United States and thus had no reason to believe that they were mistaken in their steadfast notion that the battle line would be decisive in the next war as it was in the most recent. They therefore continued to develop and integrate aerial scouts and torpedo planes. They assumed the problems they faced were universal and largely did not believe American claims of progress in such areas as larger deck procedures, dive bombing techniques and pulse attack operations. By 1941 the Royal Navy had already retired three of its first generation carriers but three were still fully operational. In the first half of the 1930s they completed only one new hull, the Ark Royal and did not order additional ones until 1937, when it ordered four, and in 1938 ordered two more. By the end of 1941 Britain had already lost three of its older carriers in battle; it had three obsolete decks in its fleet, four evolutionary designs in service, and two more of the same class under construction.

In the transformation involving carrier warfare, then, the US got it right and got it first, while the British got it wrong but realized it too late to change course to affect the role of British carriers in World War II. Much of the reason for the difference had to do with how the U.S. Navy conducted its experimentation process in the inter-war period.

American Naval Aviators were not deterred from their quest for revolutionary innovations by lack of available resources or by skepticism among the technologists of the day. When confronted with a technological barrier, in the form of lack of engine power in available commercial aircraft engines to carry larger bomb loads, the Navy created its own new type of engines, the radial, and built its own manufacturing facilities for future production needs. The Navy was able to maintain an effective, though under funded, acquisition program as a result of strong support from the top of the Navy's command structure. Key senior Navy leaders, including Admiral Moffett in Washington and Admiral Reeves in the Fleet, were important players in this regard and weighed in on behalf of carrier warfare in the interminable bureaucratic battles inside the Navy and the War Department among competing advocates for battleships and an independent air arm. These committed leaders left a legacy of strong institutional support for the innovation and experimentation processes at the Naval War College, in the Bureaus of Aeronautics and Ships.

But for all the horsepower of the Admirals and organizations in the U.S. Navy, there would have been little or no revolutionary innovation applied during World War II carrier warfare were it not for the enterprising efforts of the band of revolutionaries at the bottom of the Navy's innovation ladder. Admiral Moffett, as Chief of the Bureau of Personnel, recruited a strong cadre of youthful, enthusiastic aviators who developed a certain elan for their craft that carries forward to today. While the battleship community largely controlled the careers of most other officers in the Navy, an Act of Congress required that naval aviators be given equal treatment in career advancement. This ensured that by the time of Pearl Harbor a number of them had reached Flag rank. Throughout their careers these professional naval aviators exchanged ideas among high and low ranking officers through regular correspondence with each other and by means of debates and discussions in published journals. The Naval War College faculty was not permitted the luxury of tenured ossification and routinely communicated game results and experimental outcomes with the fleet and aviators at sea.

Such experiences make the U.S. Navy's inter-war period transformation process the most complete model for exploiting today's emerging RMA. Innovation was encouraged and supported from the top of the military institution over a long period of time. When it was time to procure large quantities of the most advanced systems to complete the transformation during war, the acquisition system was fully responsive to timely investment decisions.

France

The least appropriate model for approaching transformational experimentation is that of France during the inter-war period. The postwar French Army, guided by an entrenched senior leadership, remained captivated by the technologies that dominated World War I – fortifications, the machine gun, and massed artillery. They convinced themselves that the real Revolution in Military Affairs had already been demonstrated in its totality by the attrition achieved during the Great War.

Hence, the French tanks designed during World War I were optimized for slow speed and large numbers. France produced 3500 of these two-man, lightly armored, 3mph vehicles, which were improved only in modest increments by service life extensions and remained the mainstay of the French armored force until the mid-1930s. The French High Command took a conservative approach to the need for innovation, preferring study to experimentation and did not establish an armored division until mid-December 1939, fully two and a half months after the German invasion of Poland. Even when they conducted field exercises they were highly stylized and scripted under the watchful eyes of political and military superiors whose constant gaze ensured that no serving officer took any real risks.

There were some notable advocates of more ambitious approaches to future land warfare, but their ideas never found their way into officially promulgated doctrine nor even were subjected to public scrutiny in the kinds of open debates that characterized the US Navy at the same time. French inter war concept development was almost entirely theoretical, not even created in the virtual theater of the seminar war game. No experiments were tried and even large maneuvers were proscribed with rare exceptions. And for the French, the exception proved the rules when the result of the 1925 Camp de Mailly exercises, in which the tanks outpaced the infantry was the promulgation of design parameters requiring that the next generation tank was to have its speed limited so as not to allow any of them to get ahead of the infantry. Thus France fielded its most advanced tank in 1936, the Renault, with a top speed of 10 kilometers per hour. Lieutenant Colonel Charles de Gaulle was a notable voice of opposition, but his ideas were denounced as dangerously politically incorrect and anti-republican since he argued that future combined arms armored warfare would have to be manned by military professionals rather than citizen-soldiers.

The French conducted a third and final inter war experiment with armored warfare in 1937 in Sissone, fully ten years after the British had completed a similar exercise at Salisbury Plain and the Germans were conducting large scale exercises involving multiple panzer divisions in coordination with large Luftwaffe formations. But these exercises lacked any prior development of operational or organizational concepts and were confined to tactical level trials to develop techniques, again, for the newer tanks to support the infantry.

So the example of the French Army in the inter-war period demonstrates the worst case involving experimentation – a Type I error. There was a lack of innovation from bottom to top in the French army and the acquisition system procured vast quantities of precisely the wrong kinds of tanks.

Britain's Experimental Armored Force

While the Royal Navy lost out on the Carrier Warfare aspect of the inter-war transformation, the British Army almost got it right on land warfare. Embarrassed by the inability to exploit the surprising technological success of the tank in battle at Cambrai and elsewhere during the course of the war, Basil Liddell Hart and J.F.C. Fuller developed a sophisticated doctrine that promised to create a whole new and decisive warfare area. Fuller, in particular, in 1918 saw the development of the Medium D 20-mph tank as the instrument of a new style of mobile warfare, similar to that practiced by Allenby in Palestine with armored cars and horse cavalry. His papers, speeches and manuals sparked an era of innovative thinking within the British Army and created for him international notoriety.

Inspired by the debates, General Sir George Milne, the Chief of the Imperial General Staff, authorized the creation of an experimental armored brigade in 1926. It was formed at Tidworth on 1 May 1927 comprised of a medium tank battalion, an armored car battalion, a motorized machine gun battalion, an artillery brigade and an engineer company. This force conducted its first experiment in September of that same year. The Experimental Armored Force, supported by a Royal Air Force Squadron, was pitted against an infantry division reinforced by a cavalry brigade on the fields of Salisbury Plain. In the unscripted free-play exercise, the EAF thoroughly routed its thrice-larger opponent. The following year, based on this early success, the experiments were repeated but in set-piece fashion as a demonstration for the Staff College and Members of Parliament. While this served to generate political support for the ideas, there was little budgetary support for continued technological development and the application of innovative tactical ideas was squelched. In addition, to prevent the embarrassment of a general officer with the seniority of a Division Commander at the hands of a much smaller force led by a mere field grade (as had happened the previous year) the Armored Force's opponents were further weighted with tanks and armored cars. This time the exercise ended in a stalemate.

Later iterations of the Salisbury Plain experiments returned to the more innovative approaches of the earlier exercise. One theorist in particular, Colonel Charles Broad, was permitted to implement his bold new ideas of using tanks in independent formations to exploit their firepower and shock action in the attack during the 1931 Salisbury Plain maneuver. This proved to have equally unexpected power and subsequent experiments were used to develop new command and control procedures. But in 1933 the High Command's enthusiasm for open-ended experimentation waned in the face of continuing resource constraints and the increasing strategic burden of garrisoning the far-flung empire. The 1934 experiment was the last for the British as Milne's successors stripped the Armored Force of its resource priorities. Burdened by an improvised staff, a poor operational plan, and a chief evaluator determined to level the playing field, the experimental force performed badly against a conventional infantry division reinforced by two armored car companies and a cavalry brigade. Based on this singular disappointment the British Army turned exclusively to motorization of the entire force.

This British experience with armored forces experimentation in the inter-war period is a Type II transformation error, in which innovation occurs but has its support from the top removed. When that happens, acquisition of new capabilities cannot accompany or follow. This only slightly better than the Type III transformation error committed by the Royal Navy in encouraging innovation but employing the wrong concepts while proceeding to acquire the wrong capabilities. In the Type II error the British army at least did not face the huge divestiture challenge which confronted the

Royal Navy. While the Royal Navy had to unload its fleet of inappropriate carriers well beyond the end of World War II, at least the British Army did not have a large inventory of obsolete tanks to get rid of after Dunkirk, it simply had to turn elsewhere – the United States through the lend-lease program – to acquire the armored warfare capability it had passed on a decade earlier.

US Air Mobility

An interesting variant is the Type III transformation error occurs when innovation is encouraged but the strategic rationale from the top shifts. In such a case, the military may develop the RMA concept and even acquire some of its capabilities, but the military is required to employ it in ways that do not exploit its potential. This, in turn, curtails the complete acquisition of the new capability. With this kind of error, the acquired capability may prove to be effective for non-RMA war fighting, but is sub-optimized for the kinds of future battles envisioned in the transformed condition. The Type III error does not require divestiture, but it delays the acquisition of the optimal capability until the military strategy changes. Such was the case with the US development of the Air Mobile concept.

The military problem confronting armies of the early 1950s was how to survive, fight and win a nuclear war. The U. S. Army official solution to the problem was to mechanize, disperse and reorganize ground forces. The result of the Army's official doctrine development process was the Pentomic Division. But an influential and vociferous band of innovators argued that an equally viable and potentially more capable solution was to break contact with the ground. General James Gavin was the most prominent adherent of this idea. He published a seminal article in 1954 in which he argued that the helicopter was to mechanized forces in the nuclear age what horse cavalry had been to the foot infantry in the age of Alexander – a synergistic force multiplier.

Gavin was never given the opportunity to develop his ideas in an experimentation environment. But as fortune would have it, shortly after the publication of Gavin's "Cavalry, And I Don't Mean Horses" article, the Army consolidated all of helicopter aviation efforts at Fort Rucker Alabama in 1956. Up to this point, procurement and development authority for helicopters had been widely distributed to any command which felt it had a need and was willing to spend its money on rotary wing aviation. Helicopter capabilities were available at Fort Benning for transport of the infantry, at Fort Sill for aerial rockets and forward observers, at Fort Knox for aerial scouting, and at Fort Eustis for supply transport. The consolidation of all Army helicopters at Fort Rucker and the appointment of General Howze as the first Director of Army Aviation, was an attempt to achieve cost savings through consolidation.

While much of the Army was not happy with such bureaucratization of the requirements and acquisition process, Howze seized on the opportunity to initiate a long series of technical experiments in which experienced helicopter mechanics and small unit leaders, who had up to this time been spread widely throughout the army in small pockets of expertise with little or no outside help, could share knowledge and lore about their emerging craft and create new opportunities to try out field expedients through trial and error. It was a classically American style of innovation that served to advance the state of the art in helicopter technology in the absence of any sizable programmed resources from Washington. By the end of the decade of the 1950s unit trials conducted under Howze's stewardship demonstrated that armed helicopters and "sky-cav" units were feasible.

In 1962 the Army created a special board under General Howze's leadership with a mandate to conduct bold and innovative experiments to apply the helicopter to the new national military strategy of combating communist insurgencies around the globe. In a series of over 50 field experiments, such as company and battalion strength assaults into the simulated "jungles" formed by the densely wooded mountains of West Virginia, the Howze Board experiments explored concepts for conducting larger scale helicopter unit operations. In its final report the Howze Board recommended the creation of an entire division organized around the helicopter.

In 1963 the 11th Air Assault Division was indeed created to test the helicopter-based operational and organizational concepts, but the McNamara Defense Department co-opted the Army's exploration and turned it into an exercise in validating the concept of employing helicopter units in the counterinsurgency role. Under these terms, failure to achieve pre-determined test objectives was unacceptable so those objectives were set more conservatively and the event became a demonstration, not an experiment. The tests were judged to be a success, the 11th Air Assault Division (Test) was converted to the 1st Air Cavalry Division and deployed to Vietnam in 1965.

The success of the helicopter in Vietnam pre-empted further experimentation with revolutionary helicopter operational and organizational concepts until long after the end of the war. The shift in the strategic imperative, away from the employment of conventional forces in nuclear war to their employment in unconventional war, preempted the methodology put in place by General Howze to explore and discover the concepts first articulated by General Gavin for creating a decisive mobility differential among ground forces by breaking contact with the ground. As a result the Army would first have to divest itself of a generation of thousands of "Huey" helicopters before it could again experiment with air assault and air attack concepts employing advanced technologies such as the Cobra and Apache attack helicopters developed in the 1970s and 1980s.

US Army Air Corps

The least objectionable transformation error is that experienced by the U.S. Army Air Corps during the inter-war period, an error in which innovation occurs but the acquisition of the new capability is incomplete – a type IV error.

The Army Air Corps faced several military problems in the late 1920s and early 1930s. First and foremost was the challenge of finding and striking economic, military and maritime targets effectively. The Air Corps also had to develop concepts for cooperating most effectively with Army ground forces. This was a time of intense competition between advocates of close air support versus longer-range interdiction. Moreover, because the Air Corps of the inter-war period was so small in numbers, it also had to learn how to concentrate its entire force anywhere in the country on short notice in a very short time period – they aimed for assembling the entire Corps within 24 hours within one week's warning.

The fundamental device for Army Air Corps experimentation was an annual Air Corps maneuver, held in conjunction with the Army and the Navy in which the entire Air Corps was employed in a top-down approach to solving a problem drawn up by the Chief of the Air Corps and approved by the War Department. Out of these maneuvers the Air Corps developed the organizational and operational concepts it would apply later during World War II strategic bombing campaigns. The General Headquarters (GHQ) Air Force was the prototype organization for numbered Air Forces formed in the war and it developed concepts and doctrines to permit the rapid movement of mobile air units, including ground services, across great distances – hundreds of miles – and rapid concentration. Technologies developed to support high altitude, daylight precision bombing included advanced precision bombsights, autopilots, long endurance power plants, and high-octane fuels.

But there was also a measure of bottom-up innovation in the Air Corps. Younger officers developed tactics, techniques and procedures on their own to explore additional capabilities of air power. In the late 1920s, for example, a widely held view across the Air Corps was that low altitude bombing was inherently more accurate than dropping bombs from higher up. One Air Corps Training School instructor, Lieutenant Kenneth Walker, concluded from his own experience that this was not the case. Between 1928 and 1931 he wrote to pilots, commanders and ordnance men in the field, asking them to relate their experiences to him. They replied that their experience was that low-altitude bombing proved to be inaccurate because of navigation problems and ricochets associated with low-level flying.

In 1931 LT Walker took his data to the Chief of the Army Air Corps, General Fechet. Fechet was convinced and ordered controlled tests to be conducted at Aberdeen Proving Ground. Those tests discovered that bombers flying at 150 feet could achieve high accuracy only when the bombs penetrated their targets – old concrete and block buildings – and came to a stop. But when bombs were dropped from an altitude of 6,000 feet they were 4.5 times more powerful than an equivalent static charge because of the tamping effects of the impact of the bomb. These tests moved Fechet to direct the Air Corps concept development priority to high altitude bombing.

In another instance of junior officers challenging the conventional wisdom in the Army Air Corps, Air Corps Training School instructor Captain Claire Chennault won permission to conduct an experiment during the 1933 Air Maneuvers. Air Corps doctrine in the early 1930s held that long range, high altitude bombers could evade and outdistance any pursuit fighters that an opponent might be able to send against strategic bombing formations. The 1931 Air Corps GHQ exercise convinced the Air Corps leadership of this doctrinal tenet. But Captain Chennault believed that with adequate early warning and robust command and control, pursuit operations could indeed disrupt bombing missions.

For the 1933 maneuvers he created an ad hoc network of warning and communications relays in a scenario which pitted the Army Air Corps bomber force operating out of Dayton, Ohio, flying against mock targets at Fort Knox, Kentucky. Chennault placed 69 observations posts in an arc radiating out from Ft Knox where observers were given standard forms and dedicated telephone lines back to his Fighter Control Headquarters. The observers would call in reports on the whereabouts of the bombers and Chennault's staff would plot and track the formations on a large map. Chennault calculated that if he could receive and record 1,000 messages within 4 minutes he would be able to predict the flight path of bomber formations in sufficient time to scramble his fighters and intercept them with sufficient dwell time to engage them in aerial combat.

During the experiment, Chennault's system of systems was able to manage those 1,000 messages in an average of 2.7 minutes. Once the intercept points were plotted he would scramble the awaiting fighter pilots, who were assembled on the flight line with their aircraft armed, fueled and ready, via a public address system, assign them their intercept points, heading and altitude and turn them loose. En route the fighters were vectored in to their final intercept points by radio from an airborne command post – a converted bomber outfitted with multiple radio systems to receive updates from Ft Knox on the ground and send final instructions to individual aircraft. In the exercise 27 of the 30 bomber formations launched from Dayton in daylight were identified and intercepted, 19 of 30 at night. Some squadrons were intercepted twice, once going to Fort Knox then again while returning to Dayton.

Despite the success of Chennault's 1933 experiment, the Air Corps high command was not dissuaded from its belief in the dominance of strategic bombing. Pursuit fighter concepts were not developed until well after the beginning of World War II. While the US Army Air Corps was the pioneer for technologies associated with strategic bombing it missed an early, pre-war opportunity to achieve revolutionary capability in fighter aircraft.

Germany

Another example of the realization of new, revolutionary capability through exploratory experimentation is that of the German armed forces' development of the "blitzkrieg".

Completely dismantled after losing World War I, the German military was not constrained by large inventories of obsolete equipment as other nations' armed forces were in the 1920s. As the political situation stabilized in the Weimar Republic, Chief of

Staff General Hans von Seeckt set out to build a new German military based on ruthless study of lessons learned from World War I, traditional military theory, and the emerging technologies of the airplane, radio, and automotive vehicles both wheeled and tracked.

As was the case with the US Army Air Corps, the Germans used their entire army as a test-bed for new operational concepts. These concepts were outlined in the official manual – Leadership and Battle – which called for decentralized command and control to achieve rapid maneuver at decisive points, high operational tempo to keep the enemy off balance, and the integration of all arms including tanks, infantry, artillery, anti-aircraft guns and tactical aircraft. Rather than limiting the speed of operation to that of the slowest element, the infantry in the case of French inter-war doctrine, von Seeckt insisted on the development of mobility technologies that would enable all arms to move as fast as the fastest ground force – the tanks.

Despite the lack of even prototypes for such capabilities, the German Army conducted its own field trials following the example set by Britain in the Salisbury Plain experiments. In fact the Germans took much of their concept development from the theories of Fuller and Liddell-Hart. The Russians secretly provided the German military with field facilities for experiments beginning in 1926 when the Germans used surrogate equipment such as bicycles mounting plywood tank silhouettes and officers on motorcycles for aerial reconnaissance. Throughout the late 1920s and early 1930s the Germans conducted brigade sized field experiments and headquarters command post exercises to work out organizational and operational concepts as well as to define the performance parameters for the future equipment they would need to develop and field future military systems.

The Russians also provided secret support to the development of German fighter aircraft development. While the US Army Air Corps high command was convincing itself in the late 1920s of the futility of fighter pursuit of strategic bombers, the Germans designed and built 50 fighters and secretly trained pilots in Russia. These were employed in experiments designed to explore how to operate in close coordination with tank-based ground formations.

By 1930 the Germans were conducting design tests on advanced prototype tanks and fighters. In 1935 the Germans created three panzer divisions and conducted their first field experiment near Munster in August of that year. These free play exercises gave panzer commanders tremendous experience in the revolutionary kind of fast moving combined arms warfare they were to exploit in the opening phases of World War II. The Germans integrated the results of their inter-war experiments with their acquisition programs in the run-up to World War II. As prototypes were tested in the field, design changes were incorporated into future mass production plans. The 1938 annexation of Czechoslovakia provided Germany with a large number of additional tanks and a well-developed armaments industry whose production lines further supplemented the equipment of the panzer forces. The 1,000 tanks acquired from the Czech Army were robust types that the Germans designated the Panzer 35 and Panzer 38. The latter proved to be very useful throughout the war.

As with the case of the U.S. Navy in the inter-war years, the German army achieved revolutionary capability despite severe resource limitations between World War I and World War II. It represents a paragon of how to combine innovation with acquisition to achieve a successful military transformation.

Appendix C: Annotated Bibliography

Prepared by: Dr. James Perry and Mark Logan

Corum, James S., *Luftwaffe: Creating the Operational Air War, 1918-1940* (Lawrence, KS: University Press of Kansas, 1997). A complete study of the development of German military aviation theory, doctrine, war games, experiments, and operations from 1918-1940. Shows how the Germans thoroughly studied the lessons of World War I, analyzed the emerging air doctrines of other nations, and experimented with innovative aviation technology. Challenges previous accounts and demolishes a number of myths (such as that Germany dismissed the potential of strategic bombing). Contains a particularly useful discussion of how war games were used to refine German doctrine, training, and technology for future war.

______ *The Roots of Blitzkrieg: Hans von Seeckt and German Military Reform* (Lawrence, KS: University Press of Kansas, 1992). Examines the development and implementation of military doctrine in the Reichswehr in the 1920s. Shows how von Seeckt created an environment favorable to innovation by encouraging open discussion of doctrinal development, and by giving the ideas of the best thinkers -- regardless of rank -- a full hearing. Thoroughly discusses the many experimental programs conducted to explore various tactical doctrines, and demonstrates the crucial link between doctrine and training.

Krulak, Victor H., *First to Fight* (Annapolis: Naval Institute Press, 1984). Examines Marine Corps innovation and experimentation, focusing on the development of organizations and technologies for amphibious warfare. Includes discussion of visionary thinking, experimentation, and war games during the interwar period, and of improvised innovations during World War II. Contains excellent examples of the benefits of exercises that are allowed to fail, and of the learning generated by such failures.

McFarland, Stephen L., *America's Pursuit of Precision Bombing, 1910-1945* (Washington: Smithsonian Institution, 1995). Traces the evolution of strategic bombing theory, doctrine and technology (especially bombsights and automatic pilots) in the U.S. Army Air Corps from 1910-1945. Includes an outstanding discussion of the research, experimentation, and analysis of bombing accuracy conducted by the Air Corps Tactical School in the 1920s and 1930s. Offers a complete account of the development of the Norden bombsight as the underpinning of American bombing strategy.

Murray, Williamson, and Allan R. Millett (eds.), *Military Innovation in the Interwar Period* (Cambridge: Cambridge University Press, 1996). Studies major military innovations in the 1920s and 1930s (armored, amphibious, carrier, and submarine warfare, strategic bombing, close air support, and radar), and explores differences in exploiting innovation by the six major powers. Investigates how and why innovation occurred or did not occur, and shows how military services developed new technologies and weapons and incorporated them into their doctrine, organizations, and styles of operations.

Murray, Williamson, *Experiments and Exercises: Innovation in the 1920s and 1930s* (Washington, DC: National Air and Space Museum, Smithsonian Institution, 1998). Comparative analysis of the German, British, and French experiences with military innovation during the interwar period. Case studies include the development of combined arms, mechanized war, and strategic bombing.

Payne, Richard, *Advanced Warfighting Experiments in an Era of Peace* (Fort Monroe, VA: Training and Doctrine Command, 1996). Comparative analysis of the German, British, and French experiences with military innovation during the interwar period. The analysis suggests that military culture was a major factor in each case and that senior leadership plays a key role in fostering innovation. Furthermore, the relationships between senior military leaders and the civilian national command as well as between national military strategy and doctrinal innovation at the tactical/operational level of war also have important consequences.

Rosen, Stephen Peter, *Winning the Next War* (Ithaca, NY: Cornell University Press, 1991). Examines the conditions in which innovation can take place, the relative ease of peace-time and wartime innovation, the special problems of technological innovation, and the role of intelligence in all of these. Concludes that resource constraints do *not* necessarily hinder innovation – in fact, talented personnel, time, and information are more important than money. Intelligence regarding enemy plans and capabilities has rarely provided the basis for innovation. Furthermore, civilian political leaders and scientists have played a relatively minor role in initiating and managing military innovation, though they have protected or accelerated innovations already in progress.

Silver, Benjamin S., *Ride at a Gallop* (Waco, TX: Davis Brothers, 1990). History of the 11th Air Assault Division from the establishment of the experimental unit to the 1st Air Cavalry Division and Vietnam. Includes examination of airmobile concepts and early combat operations by a participant in the 1963-65 creation and testing of the air assault concept. The Author served as the first Executive Officer of the 11th Air Assault Aviation Group at Fort Benning; the first Battalion Commander of the first Chinook helicopter battalion; the first aviation rated G-4 in Vietnam; the Commanding Officer of the 1st Cavalry Division Support Command in Vietnam, and Assistant Division Commander of the 1st Cavalry at Fort Hood, Texas.

Stockfisch, J.A., *The 1962 Howze Board and Army Combat Developments* (Santa Monica: RAND, 1994). Detailed study of airmobile experiments in the late 1950s and early 1960s. Argues for a close connection and interaction between models/simulations and experiments in the field, since previous models were used with little attention to whether the model was empirically validated. Moreover, many data and numerical inputs in previous models represented outputs from some other invalidated model, and were therefore of dubious quality.

Van Tol, Jan M., "Military Innovation and Carrier Aviation - The Relevant History" *Joint Force Quarterly*, Summer 1997, pp. 77-87.

______ "Military Innovation and Carrier Aviation - An Analysis" *Joint Force Quarterly*, Autumn/Winter 1997-98, pp. 97-109.

These articles compare British and American carrier development in the interwar years, and show how the programs diverged due to the political environment, organizational and technical factors, and the influence of key individuals. At the Naval War College, Admiral Sims developed tactical and strategic simulations to test the potential of carrier aviation in war. His "board maneuvers" compared the military value of various tactical formations, offensive/defensive concepts, and force mixes. The game results were then verified by experience from fleet problems. British carrier aviation, on the other hand, was hampered by the lack of viable career paths for naval aviators, the lack of strong institutions and individuals to champion naval aviation, an early investment in small carriers, and an unwillingness to experiment.

Zuriff, Laurence, *The Revolution in Military Affairs: Looking Back to the Future* (McLean, VA: The Strategic Assessment Center, SAIC, 1993). Author reviews the British attitude towards experimentation in the 1920s with respect to mechanized forces. In doing so, the author suggests that questions and issues from this experience provide a useful context for the present state of military affairs.

Appendix D: Seminar War Games and Studies

Prior to the first workshop, project planners reviewed the results of the previous five years of research on the Revolution in Military Affairs. These results included the following reports on war games, workshops, simulations, round-tables, and other studies conducted by the Office of Net Assessment, as well as future warfare studies and analyses conducted by the Departments, Services and Defense Agencies and Joint Staff since 1993.

SECTION I: Air Force/Space

RMA Operational Concept Wargame Space Warfare 2020 Wargame (U) (7/94)
Space Warfare Operational Concepts Wargame #1 Report (U) (4/97)
RMA IW and Space Warfare Paper (U) (12/97)
The USAF Roundtable on the RMA (U) (1/97)
Final Report on the Alternative Air Forces Game Series (U) (7/97)

SECTION II: Dominant Battlespace Awareness

Dominant Battlespace Awareness II: Report on WMD Study (U) (1/98)
Dominant Battlespace Awareness II: SOF Counters to DBA Study (U) (1/98)
Dominant Battlespace Awareness II: Red Counters to DBA Study (U) (1/98)

SECTION III: Army

Dominating Maneuver Wargame #7 Read Ahead Book (U) (2/98)
Dominating Maneuver Workshop #3 Report (U) (9/95)
Dominating Maneuver Workshop #4 Report (U) (4/96)
Dominating Maneuver Workshop #5 Report (U) (1/97)
Dominating Maneuver Synthesis Report (U) (2/98)
Dominating Maneuver Annual Report (1997)
SWARM Infantry Combat Model User's Manual (U) (3/98)
Operational and Tactical Mobility Workshop Report (U) (6/97)
IIT on Operational and Tactical Mobility Summary Report (U) (10/97)

SECTION IV: Information Warfare

Information Warfare Wargame #2 Report (U) (8/97)
Information Warfare War Game IV IW/Exploit (7/97)
Information Warfare: Russian Case Study (U) (1/96)
Information Warfare Case Study: Regional Competitor-Iran (U) (3/96)

Information Warfare: Somalia Case Study (U) (4/96)
Russian IW Measures of Effectiveness Report (U) (10/96)
Impact of Commercial Technology Development on IW (U) (10/96)
Information Warfare War Game Report (U) (1/94)
Information Warfare Case Study: Cali Cartel (U) (Unknown)
Information Warfare: Russian Case Study (U) (1/96)
Russian/Soviet Information Warfare: Measures of Effectiveness (10/96)
Crystal Genesis: 94-2, Niche Competitor Game (10/94)
Information Warfare: Interim Progress Report (10/94)
Information Warfare War Game Regional Competitor (10/97)
Information Warfare Infrastructure WS IV: China's Info. Infrastructure (3/96)

SECTION V: Marines

Close Support End to End Assessment MOUT Wargame (U) (6/97)
RMA Urban Warfare Workshop (U) (1/98)
The RMA & the United States Marine Corps Roundtable (U) (3/94)
The US Marine Corps Roundtable on the RMA (U) (4/94)
Marine Corps RMA War Game III (U (9/97)

SECTION VI: Navy

Future Navy Roundtable Report (U) (12/97)
Navy Operational Concepts-2020 Game II Report (U) (3/95)
Navy Operational Concepts-2020 Game III Report (U) (9/95)
Maritime Wargame Series "2020 Vision" Final Report (U) (5/96)
Future Navy Game Series Final Report (U) (6/97)
Future Navy Game III (U) (11/96)
The U.S. Navy Roundtable on the RMA (U) (7/94)

SECTION VII: Regional

Korean Unification Study Final Report (U) (12/97)
Eurasia Futures Workshop Final Report (U) (10/96)
Eurasia II Workshop: Final Report (U) (12/97)
Turkey Futures Workshop (U) (2/97)
China Contingencies and Scenarios - 2020: Final WS Report (U) (6/96)
China Contingencies and Scenarios Workshop (U) (3/97)
Korean Unification Study Report (U) (6/97)
Korean Unification and US Regional Defense Strategy WS I: Final Report (U) (7/96)
Korean Unification and US Regional Defense Strategy WS II: Final Report (U) (1/97)
Korean Unification and US Regional Defense Strategy WS III: Final Report (U) (2/97)
Korean Unification: Implications for U.S. Regional Defense Strategy: FR (Unknown)

China Futures Workshop: Final Report (12/96)
Large Peer Competitor 2020-Asia Simulation Report (U) (10/94)

SECTION VIII: Future Warfare

Future Warfare 20XX - Volume 1 (U) (8/96)
Future Warfare 20XX - Volume 2 (U) (5/96)
Future Warfare 20XX - Volume 3 (U) (2/97)
TMD in Future Warfare: Quantitative Analysis (U) (4/98)
Impact of Complex Science on Future Warfare Workshop (U) (1/97)
Robotics Workshop 2020 Report (U) (6/97)
Future Warfare 20XX: Aerospace Issues Workshop (U) (4/96)
Future Warfare 20XX: Command and Control Workshop (U) (4/97)

SECTION IX: Future Technology

Joint Cruise Missile Defense Game Final Report (U) (1/96)
Biotechnology Workshop 2020 Summary Report (U) (5/96)
Biotechnology Workshop 2020 Analytic Report (U) (9/96)
AAN Winter Wargame Technology Workshops Report (U) (7/97)
Civilian and Military Technologies (U) (6/95)

SECTION X: RMA OTHER

"OSD: Creating a New Organization for a New Era" (U) (5/97)
RMA Conference Final Report (U (4/97)
Wargame Lessons Learned Briefing (S) (10/95)
RMA: Operational Concept Wargame; Large Peer Competitor 2020, V. II (U) (6/94)
The Summary Roundtable on the RMA (U) (10/94)
PME and the Emerging RMA Conference Report (U) (9/95)