

Transforming Maritime Patrol and Reconnaissance

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Although we cannot predict future security conditions, we can be certain that the environment will be marked by the unexpected. However, the kinds and scope of the conflicts we will face, the requirements for naval forces, and other unknowns will surely entail the deterrence and defeat of asymmetric threats. The Navy's Maritime Patrol and Reconnaissance (MPR) forces must be postured to sustain and advance a broad, competitive advantage over emerging 21st century threats, and the MPR community must enhance core mission capabilities with intelligence, reconnaissance, and surveillance capabilities that in turn support the Navy's transformation roadmap, Sea Power 21. MPR force transformation will be realized through co-evolving concepts of operation, changes in organizational structure, and innovative applications of legacy capabilities and newly developed technologies associated with Multi-mission Maritime Aircraft (MMA), unmanned aerial vehicle (UAVs), and high-fidelity trainers. MMA, teamed with robust and mature UAV capabilities, could be the basis for a radical change in the conduct of maritime warfare.

INTRODUCTION

The Maritime Patrol and Reconnaissance (MPR) community has a long and rich history of transformation in operational concepts and weapons systems (see the article by Keane and Easterling, this issue). The MPR force has its roots in maritime warfare, primarily anti-submarine warfare (ASW) and surface warfare (SUW), and has always been responsive and adapted to changes in targets of interest and operating environments through both evolutionary and revolutionary initiatives.

In the early years, the MPR force performed coastal reconnaissance missions that were subsequently extended to open-ocean patrols during World War II. This transition involved adaptation of legacy capabilities and

procedures along with the development of new weapons, sensors, and procedures to counter emerging maritime threats, particularly German and Japanese submarines. During the Cold War, the MPR force performed armed surveillance and reconnaissance of Soviet submarines and surface action groups over open oceans. Today, the MPR fleet of P-3C aircraft is performing a variety of operations beyond traditional ASW and SUW missions—maritime interdiction, counterdrug activities, maritime shipping protection, and overland strike mission support. These activities are being conducted in littoral environments by adapting and improving sensors and systems designed for Cold War threats and missions. The time is right, however, to transition the current

MPR force to one equipped, managed, and trained to combat ever-evolving 21st century threats.

The Navy has recently reaffirmed the importance of ASW and SUW mission areas to protect the Fleet. By virtue of speed, area of coverage, versatility, and payload, manned and unmanned MPR aircraft will continue to be indispensable against emerging maritime threats. No other U.S. military aircraft of the future will be as well suited for locating and destroying enemy submarines and surface vessels as Multi-mission Maritime Aircraft (MMA).

The systems needed for MMA to conduct ASW and SUW missions under difficult environmental conditions must be robust. Gaining and maintaining maritime superiority in the face of modern threats requires an integrated suite of sensors covering the broad spectrum of information provided by electro-optical, infrared, radar (including synthetic aperture radar and inverse synthetic aperture radar), acoustic, magnetic, and electronic support measures, among others. But it makes no sense to develop and field an expensive, limited-mission platform, such as MMA, just to sit and wait for ASW or SUW threats to become active.

To be cost-effective, MPR aircraft must add value to other warfare areas, such as intelligence, surveillance, and reconnaissance (ISR), even while conducting core missions, and they must also participate in all levels of conflict, not just war. MPR aircraft and mission systems must have fall-out capability to justify development and operating costs. Making ISR information derived from sensors and mission systems developed specifically for ASW and SUW available to the warfighter enables the MPR force to transform special-purpose MPR capabilities into a widely used warfighting service.

Since the first Navy patrol squadron (VP) was commissioned in 1922, through today's enhanced P-3C aircraft, the MPR community has provided timely ISR information to the warfighter as fall-out of its primary ASW and SUW mission capabilities. As such, the Navy is now engaged in a program to evolve and revolutionize the capabilities of the current MPR force. With the MMA and several unmanned aerial vehicle (UAV) initiatives, the MPR community will be positioned to continue traditional armed ASW and SUW missions and is poised to provide enhanced ISR capabilities well into the 21st century by again adapting legacy and newly developed sensors and systems to the unforeseen, unexpected, and unplanned situations that may arise.

Insight into how and where MPR transition fits into the larger DoD transformation of the U.S. services will be gained by broadly defining transformation and examining the specific need for ISR transformation across the military, with emphasis on naval ISR transformation activities.

DEFINING TRANSFORMATION

The primary purpose of military transformation is to develop the capability to perform military operations, including operations other than war, more effectively and with fewer casualties. Many definitions of military transformation exist, both within and outside the DoD. Some definitions focus narrowly on technology, others on organizational change, and still others on doctrine and strategy. However, the definitions appear to broadly align into two major groups: revolutionary and evolutionary.

The revolutionary group describes transformation as a discontinuous or "leap-ahead" change that promotes movement of resources (money, manpower, and doctrine) away from current weapon system technologies and attendant tactics, techniques, and procedures (TTPs) to entirely new technologies and new TTPs. On the other hand, the evolutionary group takes a counterrevolutionary approach, advocating incremental, systematic change to military capability by using current capabilities in new ways or with modernizing technologies to achieve radical improvements over time. Since the future is unknown, the evolutionary group deems it imprudent to cut current, proven capabilities solely in favor of new, unproven, and likely high-risk investments. They also contend that revolutionary capabilities may not match future threats any better than adaptation of current technology and that proven approaches can be modified by applying updated technology or used with revised TTPs, with lower cost and risk, to meet the emergent threat.

Upon consideration of both sides of this debate, the reality is that the DoD will need to affordably garner the best capabilities from both, for adoption of solely one approach would incur risk in the DoD's ability to counter the broad spectrum of future threats. A properly transformed military can develop significant advantages over a potential enemy. However, the process may also introduce risks that, if not properly managed, could dangerously undermine military capability.¹⁻⁵

Notwithstanding the ongoing debate over how best to define and manage transformation, several key tenets of transformation help to characterize it and, more importantly, what it provides the warfighter. Although technology is viewed as the underlying enabler, military transformation requires the co-evolution of technology, operational concepts, and organizational structures to conduct war in dramatically new ways. Transformation is not about marginal improvement to capabilities but rather about fundamental changes that result in new behaviors. Furthermore, transformation embraces new and innovative ways of using existing resources.^{2,4-6}

THE NEED FOR DOD ISR TRANSFORMATION

The DoD is undertaking a huge modernization effort to change from a force designed, equipped, staffed, and

managed to fight the former Soviet Union into a force that is better matched to projected 21st century adversaries, including nonstate and terrorist threats (Fig. 1). A key component of this transformation is DoD's ISR capability. Here, ISR refers to the larger collection of systems and personnel that derive information about the battle space from sensor data and then provide this information to a decision maker. As evidenced by recent military operations (e.g., Operation Enduring Freedom in Afghanistan), sensors are playing an increasingly important role in modern warfare. One could view the Special Operations ground forces in Afghanistan as highly capable "smart sensors."

Emerging as the most important needs in today's conflicts are the ability to sense the environment and the enemy within it and the ability to deliver critical ISR information to all who require it in a timely and useful manner. Thus, modern warfare appears to be moving away from a concentrated focus on weapons effects to a balanced match of sensor and weapons effects. The concern now is not so much one of weapon accuracy and reach, but rather a matter of sensor accuracy, resolution, and reach.

Our military has demonstrated that if it can find a target, it can render that target operationally ineffective in accordance with the emerging joint operational concept of *effects-based operations*. But adversaries are taking measures, sometimes extreme, to prevent U.S. ISR systems from detecting targets. Although the DoD determines the accuracy and resolution of sensors, the enemy can influence sensor reach through concealment, camouflage, and deception tactics.^{1,2,7}

With so many facets to the ISR domain, the most important issue is to determine what characteristics of ISR capability are needed to support warfighting needs in the 21st century. No consensus within the DoD has been reached on the exact nature of future ISR capability; however, five characteristics have emerged as leading candidates:

1. Worldwide perspective
2. Fusion
3. Detail
4. Persistence
5. Responsiveness

A brief discussion of each characteristic follows.¹

Observation of 21st century threats will require more of a *worldwide perspective* from ISR systems than that needed for the 20th century. The nature of the threat during the Cold War required ISR capabilities to focus narrowly on a small number of well-known, high-priority geographic areas to meet warfighting needs. In contrast, the emerging threat of the 21st century is widely dispersed geographically, and coverage of these regions requires a worldwide perspective from ISR systems. Now that a new threat can materialize from within a state that appears nonthreatening, future ISR systems must also be capable of observing more places more often.¹

The 21st century warfighter will rely heavily on the *fusion* of information about an entity of interest derived by correctly combining observations from multiple, dissimilar ISR sensors. The fusion process is technically challenging because the information

content of one ISR sensor may be vastly different from the information gathered from another ISR sensor. A further complication is the potential lack of opportunity to continuously observe measurable events, or signatures, of targets of interest. Efforts are under way in research and development programs to develop multi- or hyper-spectral fusion techniques that also consider the temporal effects of observable signature emissions.

The 21st century warfighter will also need more *detail* about entities of interest, for instance, to successfully use precision weapons. Precision weapons can incapacitate targets in ways not readily observable with traditional imaging techniques, thus requiring alternative, more detailed ISR information to formulate a battle damage assessment of an engagement. Incapacitation of a

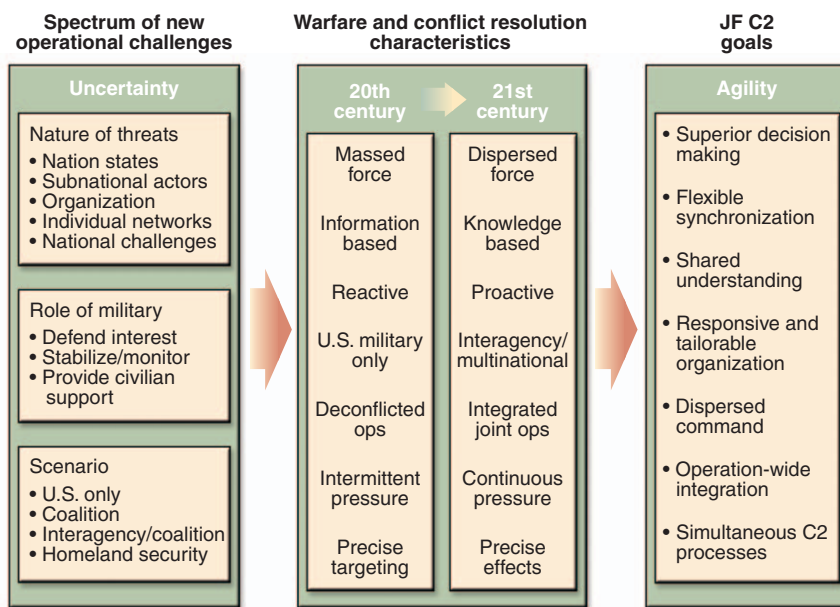


Figure 1. Changing characteristics of warfare from the 20th to the 21st century to achieve joint force (JF) command and control (C2) goals.

target does not imply physical damage, but instead means rendering the target “operationally useless” through effects-based operations. Determining whether a target has been rendered operationally useless demands a high degree of detail from ISR capabilities and could require fusion of multiple ISR observations.¹

The fourth characteristic, *persistence*, is an enabling factor for the first three. The behavior of emerging threats and their attendant signatures could be temporally and/or spectrally sporadic or random. This behavior leads to a requirement for ISR systems with long dwell times (i.e., persistence) in order to have “eyes on target” for immediate observation of a change in state of the target. Detailed, long-term observation of entities within an area of interest is key to proper combat identification and the ability to maintain full awareness of all activities of friendly, hostile, and neutral entities.¹

Finally, *responsiveness* as a characteristic of ISR capabilities is probably as important as the other four characteristics combined. Having all of the “right” information, even when provided to the “right” user, is tactically useless unless it is made available at the “right” time. The perceived lack of timely access to tactically useful information is the longest-standing complaint against today’s ISR systems. Nevertheless, the way intelligence is being produced is changing such that tactically actionable information (the right information to the right user at the right time) derived from ISR sources can be delivered directly to forces in the field. Future warfighting forces will require improved responsiveness of ISR systems to be successful on the 21st century battlefield.¹

NAVAL TRANSFORMATION

Naval transformation will support joint transformation by expanding the options available to joint force commanders to project power, assure access, and protect and advance U.S. interests worldwide in the face of emergent threat technologies and strategies. The Naval Transformation Roadmap⁶ explains the naval contribution to joint warfighting and describes concepts, capabilities, and processes necessary to achieve future warfighting capabilities expressed in Naval Power 21,⁸ the top-level Navy/Marine Corps vision of a transformed naval force.

Sea Power 21, the Navy’s component of Naval Power 21, will be realized through a triad of interdependent operational concepts (Fig. 2): *Sea Strike* (projection of offensive military capabilities), *Sea Shield* (projection of defensive capabilities), and *Sea Basing* (forward presence of military capabilities and resources independent of national boundaries). In addition to this triad, *FORCEnet* enables the operational concepts in Sea Power 21 by integrating sensors, networks, decision aids, weapons, and supporting systems into a single, comprehensive architecture.^{6,8}

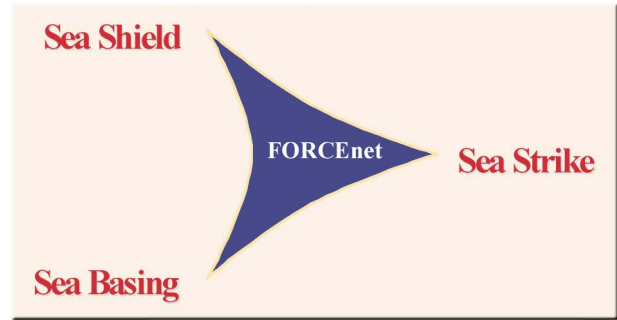


Figure 2. Sea Power 21 operational concepts triad, supported by *FORCEnet* integrated capabilities.

The Navy and Marine Corps are committed to establishing the environment, culture, and processes required to generate and sustain transformational thinking and action. Co-evolving emerging technologies and innovative operational concepts—along with the aligning of organizational relationships to exploit them—will allow the development of new naval warfighting capabilities. While the capabilities of *Sea Strike*, *Sea Shield*, and *Sea Basing* enabled by *FORCEnet* form the core of naval transformation activities, developing the concomitant culture of innovation requires the establishment of processes that nurture continuous innovation.

A second triad represents the instantiating processes: *Sea Warrior* (development of a force with the knowledge, skills, and abilities to function effectively across the range of military operations), *Sea Trial* (concept development, experimentation, and validation), and *Sea Enterprise* (business processes that empower and equip the warfighter with needed capabilities). Of the three, *Sea Trial* is of most interest here. *Sea Trial* is the Navy process of integrating emergent concepts and technologies that leads to continuous improvements in warfighting effectiveness while maintaining a strong commitment to innovation. It is based on the mutually reinforcing mechanisms of technology push, concept pull, and spiral development. *Sea Trial* will better align efforts throughout the Navy, implement a lasting process of transformation, and, most importantly, improve the delivery of enhanced warfighting effectiveness to the Fleet.⁶

Additional transformational capabilities will surely arise as new concepts and technologies are generated by service organizations that value innovation, promote change, and take advantage of opportunity. Often, these new ideas will depend in part on using existing capabilities in novel ways.

NAVAL ISR TRANSFORMATION

ISR Pursuits

ISR enhancements planned by the Navy and Marine Corps include improved networking, integration of legacy and new systems, and modernization of organic

sensors for persistent ISR. The primary effort is the concept of network-centric warfare that links weapon systems in local- and wide-area networks. Examples are the Cooperative Engagement Capability for air and missile defense and the emerging Navy and Marine Corps Intranet to exchange information and control actions. For networking and analysis, the Distributed Common Ground Station-Navy (DCGS-N) forms the foundation to bring all sources of intelligence together, while the Naval Fires Network (NFN) is a major effort supporting the Navy's end-to-end process of identifying and striking targets.

As for sensors, the focus is on unmanned platforms with new sensors for better signals intelligence and measurement of signature intelligence. Naval organic intelligence data will be fused with data from the broader national and joint intelligence activities within the DCGS-N program, the Marine Air-Ground Intelligence System, and the NFN. This fusion will improve the accuracy and speed of producing actionable tactical intelligence (Fig. 3). The new DCGS-N family of systems features common components, open architecture design, adherence to interoperability standards, and excellent "reach-back" connectivity.^{1,6}

Combined with joint and national ISR systems in the Expeditionary Sensor Grid, naval ISR capabilities will be significantly increased by the next generation of MMA and naval unmanned vehicles with advanced, mission-reconfigurable sensors and payloads. The Expeditionary Sensor Grid, which will extend from subsurface to space, will provide pervasive, persistent battle space sensing to create shared awareness throughout the theater and support agile, adaptive battle force operations.⁶

Persistent naval ISR, in conjunction with networked joint and national capabilities, provides prompt and precise battle space awareness at any time and in any weather, allowing commanders a significant advantage in the application of both force and decisive maneuver. Most critically, persistent ISR enables naval expedition-

ary forces to outmaneuver adversaries spatially and temporally. Persistent ISR capabilities for naval forces are being modernized and will significantly improve the contributions of naval surveillance and reconnaissance assets to joint battle space awareness. In addition, data links will be enhanced to enable forward-deployed forces to use timely intelligence information collected and, in many cases, assessed by national and joint collection systems (e.g., space-based radars) and intelligence analysis centers. Persistent ISR will be supported by state-of-the-art radio-frequency, cyber-exploitation (information operations), and other sensitive sources of information that contribute to advantages in battle space awareness and targeting. A family of Navy and Marine Corps UAVs, equipped with various sensors, will play a key role in extending the reach, coverage, and persistence of the naval ISR systems that provide information to the joint force.⁶

Transformation Assessment

Are the above naval ISR pursuits truly transformational? This question is answered by assessing naval ISR transformational activities against measures of effectiveness (MOEs) such as those proposed by Vice Admiral Arthur Cebrowski (USN, ret.), Chief of the DoD Office of Force Transformation.

Cebrowski has identified several criteria for assessing the transformational qualities of military programs,^{1,2,7} the most important being the interoperability of the weapon system or operating procedure. "Interoperability" means that the system can function and communicate information easily with a variety of other systems, including joint, allied (e.g., NATO), and ultimately coalition systems. Interoperability, as realized through the Navy's Network Centric Warfare effort, appears to be the centerpiece of naval ISR programs. Consequently, naval ISR enhancement efforts seem to meet the all-important interoperability MOE (Fig. 4).

Two additional criteria identified by Cebrowski are (1) whether the system helps the user change warfighting methods, as opposed to merely improving existing methods, and (2) whether the system can address a wide range of threats.¹ Changes in warfighting methods resulting from system enhancements are perhaps best illustrated by example. Operationally, some degree of transformation appears to have already occurred as demonstrated by the successful integration of naval ISR assets, particularly the P-3 and space assets, with Air Force assets to produce persistent surveillance and a common operating pic-

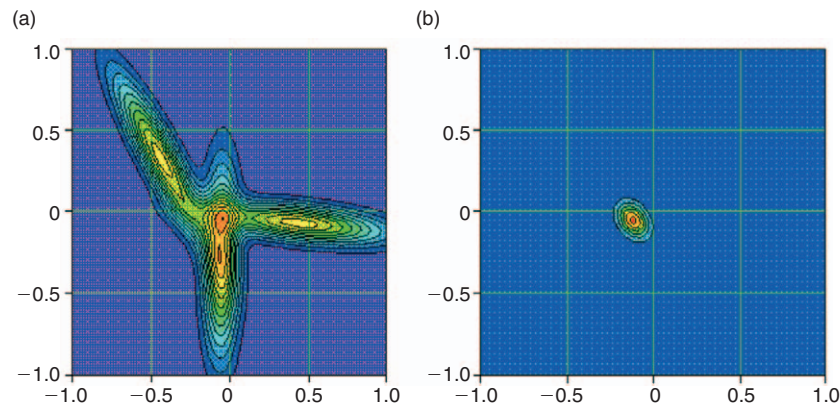


Figure 3. Example of improved position estimation from the fusion of three independent position observations: (a) three sensor position estimates ("hits") and (b) fused sensor position estimate.

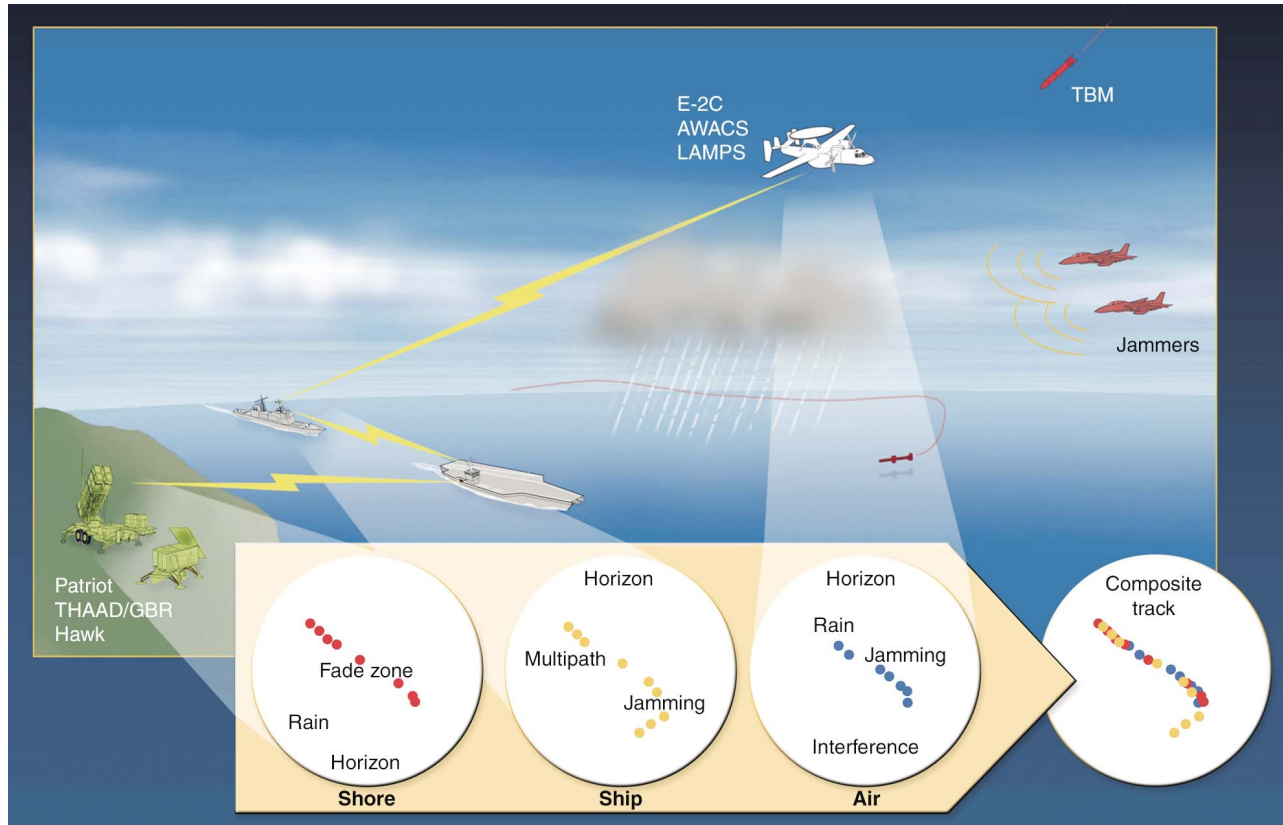


Figure 4. Combining multiple independent track information enhances and extends coverage while minimizing interference effects. The composite “picture” is then shared among all users. The benefits of sensor networking include near-real-time exchange of sensor measurement data, cueing of remote sensors, jam resistance, and low probability of intercept.

ture of the battlefield for all combat assets operating in Afghanistan. This was not the case during Desert Storm, where the services operated cooperatively, but essentially independently. Finally, naval ISR programs appear to be designed to address such threats in both littoral and urban warfare environments and promise to provide the detail and persistence warfighters believe they need to defeat the threats under uncertain and challenging conditions.

In summary, at least from a high-level perspective, naval ISR efforts appear to have the appropriate characteristics to be transformational.¹

TRANSFORMATIONAL PARADIGM FOR MARITIME PATROL AND RECONNAISSANCE

Combatants have three primary objectives: find, assess, and kill or neutralize the enemy. Since inception, MPR forces have satisfied these objectives, which are supported today by large numbers of P-3s and concomitant force structure. The current MPR force structure relies on P-3 aircraft for training, transiting, searching, localizing, and attacking on the open oceans, in the littorals, and more recently, over land as a use of legacy maritime capability not employed since the Vietnam War.

As noted earlier, MPR transformation will be provided in the technologies associated with MMA, UAVs, and high-fidelity trainers to reduce force structure and total life-cycle costs. MMA—coupled with ubiquitous, long-dwell UAVs—fits this transformational paradigm for MPR by providing the foundation for a radical new way to conduct maritime warfare, whereas high-fidelity trainers can be used to maintain operational readiness of flight crews while reducing flight hours on airframes. In addition, since a primary measure of transformation is interoperability, MPR forces will address this MOE by providing timely on-scene information about the battle space to the carrier battle group and other forward-deployed maritime forces.

Recall also that, because of their speed, area of coverage, versatility, and payload, manned and unmanned aircraft will be indispensable against maritime threats. Armed ASW and SUW will be the core missions of MMA and cornerstones for Sea Shield.

UAVs are a pillar of transformational technologies for MPR. MPR needs a fleet of long-range, highly persistent UAVs having a variety of sensor payloads for search and localization missions. Payloads could potentially include electro-optical, infrared, radar, signals intelligence, communications intelligence, hyper-spectral, or other acoustic and nonacoustic sensors. UAVs could be flown

singly or in constellations. They could be used by joint services and allies in other missions and for homeland defense, border patrol, and counterdrug operations.

UAVs could also be used initially by MPR forces to search the seas and littorals and provide data when timely dissemination of data is not critical. MPR UAVs could also provide cueing data to remote decision makers, while the more robust capability of the manned MMA is used more judiciously and launched only when necessary. UAVs could reduce the requirement for manned surveillance in low-intensity, routine search, or hazardous missions and significantly reduce MMA life-cycle costs. A balanced blend of manned and unmanned capabilities could transform the way the MPR force conducts future missions.

The end-state for MPR transformation is a complete migration to unmanned platforms. In some circles, MMA is described as the last manned MPR platform to be fielded. If current UAV technology were more mature, perhaps MMA would not need to be developed. However, such is not the case, and a capabilities bridge is needed to get the MPR community from today to a future time when an unmanned platform can complete the full range of tasks required for ASW and SUW missions. MMA provides that bridge as an evolutionary capability while the revolutionary UAV capability is matured.

The operation of manned platforms is expensive, and employing them as training systems to maintain crew readiness levels increases life-cycle costs through extra hours of airframe use and increased maintenance. MPR will decrease these costs through the application of high-fidelity trainers to augment actual flight time, much as commercial airlines use flight simulators for pilot training. Current MPR trainers, although sufficient for personnel to learn the systems they operate, typically lack the fidelity required to adequately train pilots on the true aerodynamic characteristics and performance of MPR aircraft. Trainees learn to fly the simulator, but then need an equivalent amount of time in the cockpit to learn to fly the real aircraft. The advanced application of high-fidelity trainers and flight simulators would increase operational readiness while reducing flight time on aircraft.

The last major component of MPR transformation addresses interoperability, especially timely information flow to the carrier battle group, special operations forces on the ground, and other forward-deployed maritime fighting units that would benefit from access to

tactical-level intelligence about the battle space that MMA could provide. From the outset, MMA requires a wide spectrum of communications capabilities to communicate and interoperate not only with naval forces, but also with joint, allied, and coalition forces. This is a shift away from the independent operations of the Cold War toward operations where MMA and UAVs are highly interactive contributors to the battle space picture.

Being responsive to forward-deployed forces also requires the MPR force to have flexible capabilities. This would apply particularly to UAVs that would provide the bulk of the on-station time during a mission. The ISR capabilities needed to fulfill the MPR role in the various levels of intensity in future missions will best be met with a flexible sensor configuration. Trades can then be made, for example, between payload and mission endurance and range. An MPR payload that is tailored to meet a variety of ISR mission needs would be a transformational capability for the MPR community.

CONCLUSION

To seize the advantage over potential adversaries in the face of modern threats, U.S. naval forces must exploit the power of information (Fig. 5) and must be postured—through technological advances, changes in force organizational structures, and experimentation with innovative concepts of operation—to sustain and advance a broad competitive advantage.

Naval transformation is a continuous process that culminates in a set of complementary capabilities in support of joint forces. The naval services are embarked on a wide range of initiatives to radically change orga-

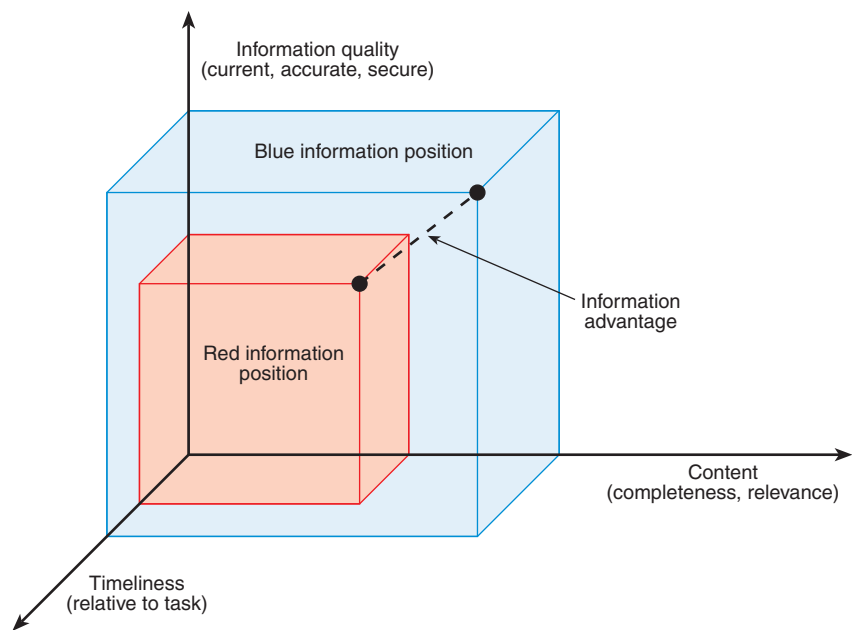


Figure 5. Achieving an information advantage over adversaries requires outperforming the competition in the multi-dimensional information space.

nizational arrangements, adopt fundamentally different concepts for military operations, and alter existing operational concepts with the incorporation of advanced technologies to achieve profound increases in military capabilities.⁶

While the Navy acknowledges that manned airborne ASW and SUW capabilities are still needed, the MPR community must take advantage of this requirement and pack MPR assets with the capability to support Sea Power 21. MPR must work to minimize the missions necessary for manned platforms and off-load flight hours to UAVs for long-duration search and localization missions. High-fidelity trainers will further off-load flight hours for training, thus reducing the necessary force structure for MMA sustainment.

MMA will have a robust capability that will support Sea Strike missions of persistent ISR and precision strike and will participate as a principal node in FORCENet. Additionally, MMA will possess a number of sensors to support high-intensity missions such as localization and attack/strike warfare.

Until data transmission rates, artificial intelligence, and the fusion of distributed sensors replace the capabilities of large manned platforms with an array of integrated sensors, MMA will be the core capability of MPR. This applies to ISR as well as ASW and SUW missions. As technology advances, the fusion of distributed sensors and a remote but immediate kill capability will obviate the need for large manned aircraft. However, that is a generation away, and an affordable and effective transformation to this futuris-

tic approach is required.

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