

**Department of the Air Force Scientific Advisory Board
FY 2023 Study**

Air and Surface Moving Target Indication

Terms of Reference

Background

The Air Force has relied on wide body aircraft (E-3 Sentry (AWACS), E-8C Joint STARS), with Moving Target Indication (MTI) radars, to support dynamic targeting and engagement of air and surface targets. These aircraft are aging and are increasingly considered unable to survive in the Highly Contested Environments (HCEs) that could be created by high-end adversaries. Hence there is a growing interest in both new air (e.g., E-7) and space-based systems as an alternative means of supporting operations in these environments. Space-based radar and electro-optical sensors can generate imagery of stationary targets. However, tracking moving targets from Low Earth Orbit (LEO) requires near-continuous target coverage and hence highly proliferated constellations (hundreds of satellites). In addition, a Space-Based Radar (SBR) able to detect slowly moving targets must have a long antenna which tends to make satellite cost high. For these reasons, past efforts to develop MTI SBRs have not resulted in the deployment of an operational system. However, current commercial efforts are driving down the cost of proliferated LEO satellite constellations with constellations comprised of thousands of satellites proposed and hundreds already launched. In addition, alternative sensing approaches and innovative concepts, at the individual satellite level and at the overall systems level, may help to drive down the cost of satellites. Given these developments and the pressing need, the Department of the Air Force would benefit from an independent assessment of the feasibility of developing and deploying a system incorporating aircraft and satellites to provide surveillance and targeting of moving targets in HCEs.

Charter

The study will:

- Survey and assess requirements for surveillance and targeting data for air and surface targets in HCEs during peacetime, crisis, and wartime conditions. Consider concepts of employment similar to those used with AWACS and Joint STARS but also new approaches.
- Survey and assess needed sensor and platform capabilities and quantities to provide the required data.
- Assess technology availability, risks and cost to develop the needed capabilities, including consideration of innovative approaches.
- Review supporting systems and technologies, including tasking and sensor resource management, communications systems to distribute and disseminate data, and tracking and fusion systems to combine data from individual satellites.
- Assess countermeasures, electromagnetic and physical to sensing systems.
- Propose science and technology investments needed in the near-, mid- and far-term to develop and deploy MTI systems.

Study Products

Briefing to SAF/OS in July 2023. Publish report in December 2023.

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Assessing Advanced Aerospace Mobility Concepts

Terms of Reference

Background

General Minihan, Commander of Air Mobility Command, has highlighted the command as the “meaningful maneuver force for the joint force in the Pacific” as well as the challenges it must overcome, including long-range air-to-air and basing attack threats.^{1,2} Due to the wide geographic expanses and limited basing availability in the Pacific, increasing Combat Air Force reliance on distant bases will place increased demands for aerial refueling offload. Similarly, base resilience concepts including Agile Combat Employment (ACE) and reduced runway dependence will rely heavily on inter-theater and intra-theater airlift for deployment and sustainment.

Large aircraft survivability technologies that address the newest threats have received some attention, but a CONOPs informed assessment of alternative survivability approaches appears warranted. Similarly, a wide range of advanced air mobility concepts have been identified over the years. Blended-wing body (BWB) aircraft concepts have been touted to have superior fuel and cargo off-load capabilities. Electric and hybrid powered aircraft are a significant area of development that are being considered for dual-use. With the development of re-useable space launch capabilities, Rocket Cargo was identified in 2021 as the fourth Vanguard program to determine their viability and utility for rapid global mobility. Finally, increased use of autonomy technologies have been identified to improve the efficiency and utility of air refueling concepts for delivery and as receivers. Given these developments, the Department of the Air Force would benefit from assessment of advanced aerospace mobility concepts to enable future warfighting and inform investments.

Charter

The study will:

- Review and assess mobility warfighting capabilities in a China scenario, including:
 - Current, future, stand-in, stand-off and ACE CONOPs that mobility assets would support
 - Survivability against long-range air-to-air, surface-to-air and counter-basing threats
 - Fuel and cargo off-load shortfalls
 - Ability to support and use autonomous aircraft
- Assess the effectiveness of new DAF mobility approaches to meet future CONOPs to include:
 - Alternative survivability enhancing technologies and approaches
 - Advanced aerospace mobility developments, to include BWB, tactical tankers, hybrid powered transports, unmanned technologies and re-useable heavy space lift
- Determine needed S&T investments

Study Products

Briefing to SAF/OS in July 2023. Publish report in December 2023.

¹ <https://www.af.mil/News/Article-Display/Article/3075912/amc-aligns-strategic-priorities-with-counterparts-in-pacific-theater/>

² <https://www.thedrive.com/the-war-zone/a-guide-to-chinas-increasingly-impressive-air-to-air-missile-inventory>

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Developmental and Operational Testing

Terms of Reference

Background

Air Force Chief of Staff Gen Brown stated in his directive, “Accelerate, Change or Lose”, that the service “must accelerate the transition from the force we have to the force required for a future high-end fight.” Developmental Testing (DT) and Operational Testing (OT) are key steps in the development of weapon systems. They are the primary means of ensuring that a system will reliably perform its intended functions in its intended environment. As military systems have become more complex, testing has become more time consuming and costly. In an era of competition with China, which is developing and introducing new operational capabilities at a high rate, there is concern that the Department of the Air Force (DAF) DT/OT enterprise is not helping to provide operational capabilities rapidly enough to adapt to the changing technological and competition environment. An area of particular concern is effective testing of software and Artificial Intelligence (AI) intensive systems, which are growing in complexity and functionality. A number of efficiencies have been proposed and implemented, such as increasing use of modeling and simulation, combining DT and OT, and use of commercial software development and test practices. Given these developments and the pressing need, the DAF would benefit from a review of DT and OT processes and culture in view of technical advances.

Charter

The study will:

- Survey technical and process advances and issues in weapons system development stressing traditional testing culture, including
 - Software intensive systems and use of DevOps/Agile development process
 - Digital engineering
 - Reduced availability of threat data
 - Prototyping and other rapid development processes
- Survey and assess new approaches to testing, including
 - More integrated S&T-Acquisition-DT-OT-Operations
 - Modeling and Simulation
 - Automated testing, including the use of AI
 - Distributed testing
- Recommend solutions, assessing implementation cost and complexity, ability to cover essential test points, and effects on weapon system development timelines, in determining the most cost-effective approaches
- Determine needed S&T investments to support future testing processes

Study Products

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Scalable Approaches to Resilient Air Operations

Terms of Reference

Background

The Department of the Air Force is facing threats to its fixed forward bases from theater ballistic missiles, cruise missiles, and other adversary capabilities. While significant work is being done in the DoD to develop and deploy active and passive defenses to improve base resilience, these approaches typically do not have a favorable cost exchange ratio and hence do not scale well against increasing threat numbers. Agile Combat Employment (ACE) strives to quickly establish a base to at least a minimal operational capability, under the threat of sustained attacks, with a potential need to relocate on short notice. ACE presents substantial operational and logistical challenges and there are also limitations on the number of suitable airfields that might be used. Thus, there is a need to consider alternative approaches that address the shortcomings of current approaches. Such approaches might include Directed Energy Weapons (DEWs), both lasers and High-Power Microwave (HPM) systems; runway independent aircraft technologies to increase the number of places to launch and recover aircraft; non-kinetic defense approaches, for either fixed based or ACE locations; and low cost kinetic interceptors fired from guns.

Charter

The study will:

- Survey current and foreseeable future kinetic and non-kinetic threats to PACAF, USAFE and AFCENT airbases and characterize their effects on essential air operations.
- Review current passive and active base defense and ACE concepts being explored in these Commands and identify gaps in their ability to ensue resilient air operations with favorable cost-exchange ratios that scale to increasing threat numbers and quality.
- Investigate alternative approaches to provide resiliency in air operations with favorable cost-exchange ratios, including but not limited to
 - Directed Energy Weapons (DEWs), including lasers and High-Powered Microwave (HPM) systems
 - Runway independent aircraft technologies
 - Non-kinetic defense
 - Gun-fired interceptors
- Assess effectiveness, cost and infrastructure cost of these approaches used in concert with active defenses and base hardening techniques. Identify operational challenges to employing, deploying, pre-positioning and sustaining such systems as part of an overall ACE CONOPS, including maintenance of a common operating picture.
- Propose DAF science and technology investments in the near, mid and far term to enable these agile basing technologies and address their vulnerabilities and operational challenges.

Study Products

Briefing to SAF/OS in July 2023. Publish report in December 2023.