THE MQ-9 YOU DON'T KNOW

Thought you had it figured out? Better take another look. The world's workhorse UAS is adding a host of upgrades designed to change the fight now and bring the future faster.

The Future of Unmanned ISR/Strike, Available Today

Today's complex age in global security is shaped by rapid advances in technology with increased precision and lethality. The power of battlespace information and actionable knowledge has changed the character of war, marking a revolution in how militaries fight. At the forefront of this revolution is the ability to achieve what the Office of the Director of National Intelligence calls "decision advantage."

Battlefield success has always relied on good intelligence, but today's technology shift is ramping up that need to levels unlike any seen before. Future conflicts will be decided in favor of the side that can harness vast amounts of data, make quick sense of it, and respond faster than the adversary. A critical piece to achieving decision advantage is possessing sensing capability that has capacity, flexibility, and range. It is the ability to rapidly process data, share information, locate targets and — upon decision — act swiftly. Do it, and do it now.

To see what the future looks like, one must only examine the MQ-9A Reaper, the longtime workhorse unmanned aerial system (UAS) used daily by the U.S. military and its allies worldwide. While many view the MQ-9A strictly through the lens of an ISR/strike platform suitable for the counter-VEO (violent extremist organization) fight in a permissive or uncontested airspace environment, the reality is that this prized platform also represents the vision of future UAS, offering significant but still not-yet-fully exploited opportunity in today's fight and tomorrow's threat.

Gen. Kenneth McKenzie, Jr., commander, U.S. Central Command, addressed this in his testimony early in 2020 before the Senate Armed Services Committee: "For me it comes down to a platform, and that platform is the MQ-9. That is the platform of choice in the Central Command Area of Responsibility. It is a platform that can gather intelligence, it can strike, and it can do all kinds of things. It is a jack of all trades, and I would prefer to not divest that resource."

That platform of choice is only getting better, with a host of upgrades and configurations poised to push the MQ-9A Reaper that so many know and trust into areas and missions not yet seen, with the potential to save billions of dollars in mission costs and manpower. When it comes to UAS, the future is here and available now.

– Barry Rosenberg, Contributing Editor
Technology & Special Projects

Demand for Unmanned

Modern warfare was revolutionized in the mid-1990s with the introduction of UAS such as the MQ-1 Predator, which let militaries hunt targets from afar with persistence and precision never before seen. Built by General Atomics Aeronautical Systems, Inc. (GA-ASI), the Predator's armed follow-on, the MQ-9A Reaper, led the next revolution in warfare as the world's most important hunter-killer UAS designed for long-endurance, high-altitude surveillance, and lethal real-time response.

Shown is the heritage of General Atomics' platforms from the MQ-1 Predator to the MQ-9A Reaper to the MQ-9B SkyGuardian.

The U.S. Air Force (USAF) operates approximately 200 MQ-9A Reapers. The battlefield effects it provides through persistent intelligence, surveillance, reconnaissance (ISR) and close-air support abilities across continent-size areas makes it a highly sought after asset. It flies 11 percent of total Air Force flying hours, at only 2.6 percent of the USAF's total flying hour cost. No other AF asset comes close to flying so many hours at so little a cost. It has a demonstrated 90 percent mission-capable rate, which is the percentage of time that a specific platform can complete its mission. No other USAF asset can report this extraordinary mission capable rate which is significant given that it flies sorties 3 to 4 times longer than any manned asset, unrefueled, and the fleet in total amasses ~300,000 hours annually – something no other USAF aircraft can, or has done. In contrast, the Air Force's 2019 mission-capable rates for fifth-generation fighters (F-22 and F-35) and bombers (B-1, B-2, B-52) were just above 70 percent, Breaking Defense reported in May 2020.

The demand for GA-ASI's Predator-series of Remotely Piloted Aircraft (RPA)—which includes the Predator, Reaper (also known as the Predator B), MQ-1C Gray Eagle, Avenger (Predator C), and MQ-9B SkyGuardian/SeaGuardian

(Predator B) lines—is demonstrated daily through the accumulation of flight hours. As of October 2019, they had cumulatively surpassed six million flight hours and completed 430,495 total missions. Approximately 90 percent of those missions were flown in combat.

In addition, these RPAs average more than 60,000 flight hours per month supporting the USAF, U.S. Army, U.S. Marine Corps, U.S. Department of Homeland Security, NASA, the Italian Air Force, the UK Royal Air Force, the French Air Force, the Spanish Air Force, the UAE Armed Forces, and other customers.

Immediate-Future Technology: Rapid Development with Low Risk

While UAVs have largely been used for intelligence gathering and airstrikes over the past two decades in the counterterrorism fight, new technologies are opening up more possibilities for diverse missions built on those flown by the MQ-9A Reaper. New ideas for use of unmanned aircraft — such as using advanced UAS as low-cost attritable wingmen supporting manned or unmanned platforms, building swarm-capable UAVs, incorporating stealthier and smaller UAS designs, and employing artificial intelligence and automation — are part of future-force discussions to meet the Great Power challenges we're seeing today from Russia and China.

To get there, the Air Force has appropriately embraced a continuous capability development and delivery concept aimed at rapid prototyping to get new capabilities out to operating forces sooner. Through an "immediate-future" orientation that uses the proven Reaper platform as a base for further innovation and modernization, the Air Force can address these future-force designs and continue to utilize the MQ-9A into the 2040s without skipping a beat.

Leveraging the MQ-9 in the role of "first mover" to on-ramp future unmanned prototype capabilities provides a readily available path to help accelerate the development and integration of new technology that will not only improve today's capabilities, but also buy down risk and development of future capabilities at the same time. This would give the USAF and others critical decision and budgetary space to develop and affordably procure next-generation unmanned platforms, while giving today's warfighter much needed

new capabilities and operational flexibility to deal with near-peer competition sooner rather than later.

A variety of new MQ-9A capabilities already in development will provide significant increase in operational flexibility. These include:

- Expanded automatic takeoff and landing capability for divert landings

- Increased maximum landing weight

- Expanded cross-wind limits of the aircraft

- External fuel pods to extend mission range

- Beyond line-of-sight and satellite communications data link control for greater data downloads and onboard data processing for faster response with human involvement.

- Laptop-based launch and recovery from expeditionary airfields eliminating forward based aircrew, maintenance and support personnel

- Multi-mission control which permits one pilot to control up to six (6) aircraft

The MQ-9A already possesses all the attributes that future UAS will need for the next fight. Future warfighting will require UAS to have endurance and range to get to targets, to have advanced sensing capabilities to find targets, the ability to either strike or pass targeting information to others, and to also be able to operate with and around manned platforms.

GA-ASI is rapidly delivering such operationally ready solutions now for the MQ-9A that keeps pace with the ever-changing threats. By doing so, the company is helping to reduce development risk for next-generation capabilities, so that fielded forces can prove operational concepts, develop tactics/techniques/procedures, and train for future operations today.

The MQ-9A's size, endurance, and payload capacity enables it to integrate new leap-ahead technologies at the lowest cost and quickest path. Its capacity and ability to be digitally interoperable and rapidly reconfigurable provides multiple operational and demonstration roles on a single platform.

The MQ-9 is a proven platform, as well as a technology testbed especially suited to the Great Power competition. This is being demonstrated by a long string of cockpit, platform, weapon, and sensor improvements that are being integrated today for combat operations.

The MQ-9A has the size, endurance, and payload capacity to deliver operationally ready solutions that keep pace with evolving threats.

Expanding Roles and Mission Aperture

Beyond simply a tactical ISR/strike platform, the MQ-9A's characteristics of automation, range, persistence, payload capacity, and affordability position it as an essential tool for the rapidly developing Great Power challenges.

"It's incorrect to look at the MQ-9A as a legacy program that's not going to be useful in the future, when the reality is, in my mind, the future is happening now," said Chris Pehrson, Vice President of Strategic Development, General Atomics Aeronautical Systems, Inc.

"Day One of the Great Powers competition is already occurring. We can't wait 10 years until a conflict is upon us to develop something new. All the capabilities that we may need in 2030 can be developed and honed well ahead of time with the MQ-9A ideally suited to that role," said Pehrson, noting that the Air Force's Reaper replacement program called the Next Generation UAS ISR/Strike Platform isn't expected to reach initial operating capability until 2031.

The force-multiplying potential of the MQ-9A gives military planners operational flexibility to ensure that forward-deployed forces are prepared to respond decisively in a variety of ways. This includes the MQ-9's capability to be digitally interoperable and rapidly reconfigured, which offers planners multiple operational roles on a single platform. In addition, the MQ-9's 1,500-pound, single-pylon payload capacity and 45 kW of power give it the capacity to host the latest generation of active and passive sensor technology to provide standoff wide-area surveillance on par with that of other ISR platforms, such as the manned E-8 Joint Surveillance Target Attack Radar System.

Supporting the Future Security Environment

Like many other assets, the MQ-9A is not a low-observable weapon system designed for highly contested areas. However, those first hours of "hot" conflict are just the first escalation in the spectrum of confrontation, which ranges from vital stages of detection and deterrence to active engagement in contested combat.

The MQ-9A can be a particularly valuable asset to deter what's known as "gray zone" aggression. This is where Chinese, Russian, Iranian, and other countries "coerce or compel others using ambiguous forces (through) use of unattributed military forces, island building, and the use of proxy forces," according to the Center for Strategic & International Studies.

The MQ-9A is ideally suited to help deter peer aggression through what's called "deterrence by detection" in the initial contact phase, because of its

unmatched mission endurance and capacity to carry a variety of high-TRL (Technology Readiness Level) standoff wide-area surveillance sensors that are well suited for gray zone operations.

Properly equipped and properly employed with the right concept of operations, the MQ-9A can provide affordable 24/7 coverage of targeted territory, notably without risk to U.S. personnel. While doing so it can verify urgent intelligence in a disputed area in a non-intimidating, observable manner — just as it does today. As such, the MQ-9 provides operational commanders great latitude in achieving their intelligence objectives within acceptable risk boundaries.

The increased warning time delivered by MQ-9As can help mitigate the U.S.' time-distance disadvantage in remote parts of the world, thereby giving U.S. forces, allies, and partners time to effectively marshal combat power to prevent aggression.
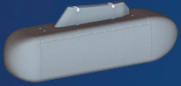

ELECTRONIC WARFARE

Scalable Open Architecture Reconnaissance (SOAR)
• Electronic Order of Battle (EOB)
• Op Eval Q3 2020

Sledgehammer
• Electronic Attack
• TRL7

COMMUNICATIONS

Rosetta Echo Advanced Payload (REAP)
• Connecting Sensors to Shooters
• OMS Capable Gateway (ABMS Building Block)
• Flight Test Q2 2021

Laser Comms
• 2 Gbps Datalink
• Low Probability of Intercept / Detect
• Flight Test Q2 2022

MARITIME

Maritime Patrol Radar
• State-of-the-art, 360°maritime radar with MWAS, ISAR, SAR, GMTI & Weather
• Earlier version fielded with DHS since 2010

AIRCRAFT SURVIVABILITY

Self Protect
• IR & RF Threat Awareness & Countermeasures
• Op Eval Q3 2020

PNEUMATIC DISPENSER POD

SUAS / Weapons / Sonobuoy Launcher
• 10 tubes per pod to support CLT munitions, Sonobuoy or SUAS
• Sonobuoy Flight Test Q2 2020

Airborne Situational Awareness 24/7, Worldwide

Modular Payloads MULTI-ROLE MULTI-MISSION

The MQ-9's modular open architecture lets the platform rapidly accommodate numerous different payloads.

Improving Survivability and Automation

When it comes to survivability, many are surprised to learn the MQ-9 is successful despite an obvious vulnerability: *unlike virtually every asset headed into harm's way,* the MQ-9 has amassed millions of hours in combat without any protective measures against enemy missiles or other counter-UAS systems.

GA-ASI is working to reduce this exposure as the aircraft finds itself in increasingly tough situations, investing in survivability research and development over the past decade to assess operations across the entire kill chain. The result is the first self-protection pod purpose-built for its UAVs, as part of a Cooperative Research and Development Agreement (CRADA) with U.S. Special Operations Command. These countermeasures will enable operations in higher-threat environments, including regions where MQ-9As have been previously shot down or engaged with anti-aircraft weapons systems.

Survivability is more than just having defensive systems, however. It is also about being able to conduct expeditionary operations from non-fixed locations to disrupt targeting by adversaries. Access to smaller runways and unimproved surfaces opens up the number of available locations for temporary, permanent, and divert MQ-9A operations. From a 3,500-foot runway, a small team can launch and recover a properly equipped MQ-9A using laptops and portable communications gear.

Onboard automation and flexible-basing technologies allow the MQ-9A to disaggregate and reposition faster than an adversary can counter, which is a strategy in alignment with the Pentagon's 2018 National Defense Strategy objectives.

To reduce the manpower footprint required to operate MQ-9As from small and austere locations, the company has developed automation capabilities such as Automatic Takeoff and Landing Control (ATLC), autonomous taxi and taxi via satellite communications, as well as automated aircraft start and shutdown. This automation also plays a vital role when moving aircraft from base to base, and in rapidly shifting operations to maintain unpredictability and increase survivability of launch-and-recovery systems.

"(The MQ-9) is a jack of all trades, and I would prefer to not divest that resource," said Gen. Kenneth McKenzie, Jr., commander, U.S. Central Command.

New USAF Enhancements for Reaper

As part of the ongoing U.S. Air Force contract for MQ-9A Reaper modernization, GA-ASI demonstrated in June three expanded ATLC enhancements that provide the MQ-9A with a dramatic increase in operational flexibility. One enhancement enables the Reaper to land under SATCOM control at an alternate or divert airfield in which no ground control station is present. Such capability ensures mission effectiveness in case of inclement weather, changing mission requirements, or damaged runways.

The second enhancement expands the cross-wind limits of the MQ-9A. The third increases the maximum landing weight for normal and emergency landings. "All three enhancements provide MQ-9A aircrews with increased runway options, as well as expanded weather tolerances that greatly improve mission flexibility, operational availability and time on station. It will also lead to a substantial reduction in aircrew," said GA-ASI President David Alexander.

For operations from airfields close to the battlespace, UAS platforms will need jam-resistant GPS receivers and non-GPS navigation solutions such as vision-based systems. This will offer the ability to survey potential runways from the air, including divert and emergency unimproved landing locations, to create an automatic landing profile for the UAS, all of which has been already incorporated into the MQ-9A, but has yet to have corresponding military Tactics, Training, and Procedures (TTP's) to fully implement.

Injecting system automation into the portable control unit will allow the Air Force to remove rated pilots and sensor operators at forward operating locations, creating

a more agile and low-risk scenario. GA-ASI has proven such ATLC capabilities over nearly two decades and has accumulated 119,000 such takeoffs and landings. ATLC improvements currently in development flight test include SATCOM-only Launch and Recovery Element (LRE) operations that are scheduled to field in 2022.

In SATCOM-denied environments, GA-ASI is adding automated taxi capability to complement ATLC. Automated ground operations with future taxiing designs based on self-driving automotive technology will enable operations when lacking access to satellite datalinks.

Full expeditionary launch and recovery operations including laptop pre-flight, beyond line of sight taxiing, and automatic takeoff and landing were demonstrated during flight tests in late 2018 as part of the UK Protector program (the UK version of the MQ-9B SkyGuardian). These capabilities are bought and paid for by the USAF and will be fielded with AFSOC MQ-9's in early 2021. The entire non-AFSOC MQ-9 fleet should be equally equipped to ensure the USAF maintains dominance in UAS operational employment.

These capabilities make the MQ-9A suited for the adaptive basing and "agile combat employment" initiatives being considered for future combat. Such agile combat employment capabilities, as they're being called by the DoD, were also recently demonstrated during the recent USAF deployment of two MQ-9A Reapers to Estonia.

"Clearly there's still a demand signal out there from the Combatant Commands to have those types of capabilities," said Air Force Gen. Jeffrey Harrigian, commander of both U.S. Air Forces in Europe and NATO Allied Air Command, speaking to the Washington, D.C.-based Defense Writers Group in June.

"The Estonian MQ-9 deployment really is one of our initial steps in demonstrating the agility of our MQ-9 capability from an agile combat employment perspective. As we looked at what was frankly a runway closure in Poland where we typically operated, I wanted to use this as an opportunity to quickly move the capability to another location that would afford us opportunities to not only better assist in a rapid fashion, but at the same time allow us to gain exposure and operating [experience] up in the Baltics."

Bring the Future Faster through Automation

The capability that Harrigian demonstrated in the Baltics is facilitated by GA-ASI's Software Defined Control System (SDCS) along with associated applications. They're designed to move UAS platforms from man-in-the-loop to man-on-the-loop configuration, where operators let the platform make basic decisions on its own and only provide oversight. While there is a person to give the aircraft tasking orders and to receive information, the aircraft is capable of making many mission-related decisions on its own without procedural human intervention.

One of the most valuable applications being developed as part of SDCS is called Multi-Mission Control (MMC). It enables one pilot to manage up to six MQ-9As conducting benign, routine missions.

"When you place the MMC in the context of the Air Force's continuing need for pilots, we've developed a new MQ-9A-related technology that can address that need by reducing the number of operators required," said Pehrson.

GA-ASI partnered with Air Force Special Operations Command to develop MMC under a CRADA. Over the next 24 months this team will continue to refine systems requirements, execute flight tests, and complete an Operational Assessment. GA-ASI estimates that manpower savings from MMC would pay for the program in one year, saving approximately $700 million over the lifetime of the program.

In late 2020, GA-ASI plans to demonstrate autonomous flight through use of software auto-routers integrated onto the aircraft. Under minimal supervision from a trained pilot, the air vehicle will fly routes through tasks assigned by an external entity. This will be accomplished through a tactical datalink to demonstrate interoperability with existing DoD networks and systems. The autonomous flight demonstrations will leverage the DARPA Collaborative Operations in Denied Environments (CODE) framework for collaborative UAS operations.

Additionally, to address the greater speed and intensity of Multi-Domain Operations that is poised to overwhelm today's ISR Command and Control and Processing, Exploitation, and Dissemination construct, GA-ASI has

teamed with the Joint Artificial Intelligence Center's Project Maven team to use the MQ-9 to harness the power of AI at the edge to create a pathway to collaborative, multi-domain, and AI-powered mission tasking, sharing and operations. These efforts are aimed at fixing the complex, manpower intensive domain of ISR collection management, analysis and intelligence product dissemination. They will not only shift the burden from airman to machine/AI, but will eventually lead to fully autonomous ISR operations.

The Takeaway

After two decades of experience and over six million flight hours, the vast majority in combat, GA-ASI is leaning forward to achieve the next leap in UAS capability for warfighters by modernizing its MQ-9 platform with new critical capabilities for both the anti-terrorist fight and the Great Power competition. The proven MQ-9A Reaper is unparalleled as a platform for innovation and checks all the boxes for what the USAF is looking for in a Next-Generation UAS ISR/Strike Platform: flexibility, modularity, open systems,

endurance, persistence, autonomy, and affordability from the standpoint of operations and manpower. The exact configuration of what a potential "MQ-Next" might look like is still in the study phase, but it's clear that many of those future attributes exist today or are on a development trajectory that will see them introduced soon on the MQ-9A.

The Reaper bridges the past as it helps to build the USAF vision for an ISR/strike platform of the future. The MQ-9A is showing us today what the future of an unmanned ISR/strike platform can accomplish.

The open architecture of General Atomics' operations center enables collaborative, reliable, and secure mission planning and execution to rapidly accommodate future growth requirements while reducing manpower.

Three Ways the MQ-9 is Expanding Roles and Mission Aperture

In an era of declining budget resources, the need for affordable operational concepts and capabilities is more important than ever. The most vital asset the Air Force possesses is airmen, not hardware. The Air Force needs each airman to perform essential duties as it defends America and prepares for peer competition. GA-ASI has developed automated capabilities that enable the Air Force to free up critical pilots, maintenance personnel and others needed to fill critical positions for tomorrow's fight.

The force-multiplying potential of the MQ-9A provides operational flexibility to ensure the Air Force is prepared to respond decisively in a variety of ways. The following are examples:

1 Operational Flexibility

- *REAP* - GA-ASI is delivering resilient communications via two gateway relay pods called Rosetta Echo Advanced Payload (REAP) and Freedom. These pods provide essential communications in contested airspace for fighter aircraft and other platforms so they can seamlessly communicate through Intra-Flight Datalink, Multifunction Advanced Data Link, Link 16, and Tactical Targeting Network Technology.

- *Lynx Radar* - GA-ASI has improved its Lynx radar's long-range targeting capability, which expands the 3D targeting range from 50 km to 140 km. It provides a modular solution that provides Synthetic Aperture Radar (SAR), GMTI/Dismount Moving Target Indicator (DMTI), Velocity SAR (for ocean surveillance), Maritime Wide Area Search (MWAS), and Inverse SAR.

  - Lynx's MWAS mode detects ship and boat traffic in various sea state conditions. It also integrates Automated Identification System (AIS) information for target correlation and identification

  - *Ground/Dismount Moving Target Indicator* – The GMTI mode provides a quick and easy method for locating moving vehicles. While the GMTI mode continues to be a crucial resource, DMTI marks a real paradigm shift. DMTI allows operators to detect very slow moving vehicles and personnel (dismounts) moving at about 1 mph.

- *SOAR Pod* - The Scalable Open Architecture Reconnaissance (SOAR) pod enables standoff surveillance. Manufactured by L3Harris and integrated on the MQ-9A by GA-ASI, it incorporates the latest Electronic Support Measures (ESM) sensor technology derived from strategic, manned ISR platforms. This provides secure, full-spectrum, long-range electronic surveillance, improved communications intelligence (COMINT) and electronic intelligence (ELINT) detection range and accuracy. The pod is currently undergoing evaluation by U.S. European Command.

2 Survivability

- *Self-Protect Pod* - GA-ASI is developing the first self-protection pod purpose-built for its UAVs as part of a Cooperative Research and Development Agreement (CRADA) with U.S. Special Operations Command. This innovative countermeasure system will be compatible with the MQ-9A and the U.S. Army's MQ-1C Gray Eagle. The system is composed of infrared and radio frequency defeat technologies found on current 4th generation aircraft such as F-15s, F-16s, and F/A-18s. It features proven and DoD-sustained Aircraft Survivability Equipment (ASE) and is capable of expending IR flares, RF chaff, and Digital RF Memory (DRFM) countermeasures. The ASE is managed through both semi-automatic and fully automatic modes with real-time situational awareness provided to the MQ-9A aircrew.

- *DAA System* - The Detect and Avoid (DAA) System consists of GA-ASI's Due Regard Radar (DRR) and processor, and a Traffic Alert and Collision Avoidance System (TCAS). GA-ASI's DAA system also enables safe access to uncontrolled airspace and will comply with Due Regard procedure when operating in international airspace.

  - The all-weather capable DRR tracks non-cooperative aircraft and enables a collision avoidance capability onboard the RPA, which allows the pilot to separate the aircraft from other air traffic in cooperation with Air Traffic Control (ATC).

3 Autonomy

- *ATLC* - To reduce the manpower footprint required to operate MQ-9As from small and austere locations, the company has developed automation capabilities such as Automatic Takeoff and Landing Capability (ATLC), autonomous taxi and taxi via satellite communications, and automated aircraft start and shutdown. This automation also plays a vital role when moving aircraft from base to base, and in rapidly shifting operations to maintain unpredictability and increase survivability of launch-and-recovery systems.

- *SDCS* - The Software Defined Control System (SDCS) and with its associated applications are designed to provide UAS platforms with stand-off, stand-in capabilities allowing the platform to make decisions on its own. SDCS includes multiple automation applications to reduce manpower while improving survivability and communication between software and operators.

  - *Multi-Mission Control (MMC)* - It enables one pilot to manage up to six MQ-9As conducting benign, routine missions. Such missions would include orbit management, transit operations, automated collection, and non-full-motion-video-centric missions that enable electronic support measures, communications nodes, and other wide area surveillance such as GMTI.

  - *Portable Aircraft Control System (PACS)* laptop allows a forward-deployed maintainer to use the laptop to employ automated preflight and post-flight checklists that reduce setup times by up to 50 percent. It also reduces the airlift requirements by eliminating the need for a forward-deployed Ground Control Station (GCS).

GENERAL ATOMICS
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Breaking Defense thanks General Atomics for their support of this Pathfinder custom report.