Persistence over water: Operators look to UAS for extended coverage

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Long endurance unmanned aircraft systems are set to play an increasing role in maritime and littoral surveillance missions. Richard Scott reports

While unmanned aircraft systems (UASs) have proliferated in intelligence, surveillance, and reconnaissance (ISR) roles over the battlefield, the employment of such systems in the maritime arena has to date been somewhat less common. However, the signs are that this is gradually changing as navies, coast guards, and other maritime security agencies alike explore how highly autonomous, high-altitude, long-endurance (HALE) and medium-altitude, long-endurance (MALE) UASs can be used to augment manned platforms in maritime patrol and response operations.

This comes at a time when many governments are looking at more efficient and effective ways to conduct the surveillance of expansive littoral and sea areas. Nation states with maritime borders have an enduring need to positively and unambiguously identify traffic in their maritime area of jurisdiction, and to prevent illegal activities or malign actors in territorial water or adjacent sea areas.

What is evident is that the fixed-wing maritime surveillance UAS, operating from a base ashore under the control of a ground station, requires different performance characteristics and attributes from a system watching over the terrestrial domain. In particular, the need for a wide area search capability drives the integration of a powerful multimode imaging radar for detection and classification at range, and a long-range high-resolution electro-optical/infrared (EO/IR) system for positive identification and image capture.

The integration of an Automatic Identification System (AIS) receiver provides a means to access VHF broadcast identification/position/course/speed data on radar contacts to filter targets of interest, and investigate contracts not transmitting on AIS. Electronic surveillance payloads provide additional situational awareness and/or tactical intelligence.

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Triton approaches

The US Navy (USN) is in the process of introducing the Northrop Grumman MQ-4C Triton UAS into service to meet its Broad Area Maritime Surveillance (BAMS) requirement. Selected for the BAMS programme in April 2008 following competition with the rival Lockheed Martin/General Atomics Mariner UAS, the MQ-4C is a marinised adaptation of the HALE RQ-4B Global Hawk UAS designed to provide persistent maritime ISR data collection and dissemination capability to the USN Maritime Patrol and Reconnaissance Force (MPRF). A total of 68 air vehicles are planned.

The MQ-4C is characterised as a maritime ISR ‘system of systems’ comprising the MQ-4C unmanned aerial vehicle (UAV) itself, a multisensor mission payload (maritime radar, EO/IR, electronic support measures [ESM], AIS, and basic communications relay) and supporting ground
The MQ-4C Triton is intended to provide intelligence preparation of the environment by providing a 'long dwell' source of information to maintain the common operational and tactical picture of the maritime battlespace. (Northrop Grumman)

The intention is that the ability of the MQ-4C to perform persistent ISR within a range of 2,000 n miles (3,704 km) will allow responsive P-8A aircraft to focus on their core missions, namely anti-submarine warfare, anti-surface warfare, and weapons employment. Accordingly, the MQ-4C Triton is intended to provide intelligence preparation of the environment by providing a 'long dwell' source of information to maintain the common operational and tactical picture of the maritime battlespace. Additionally, MQ-4C Triton-collected data posted to the Global Information Grid will support a variety of intelligence activities and nodes. In a secondary role, the MQ-4C Triton is to...
be used alone, or in conjunction with other assets, to respond to theatre-level operational or national strategic tasking.

Two Northrop Grumman MQ-4C Triton aircraft are seen on the tarmac at a Northrop Grumman test facility in Palmdale, California. Triton is based on the RQ-4B Global Hawk airframe, but introduces a number of adaptations and enhancements for the maritime mission. (US Navy) 1682853

While the basic design of the MQ-4C closely resembles that of the RQ-4B Global Hawk, a number of significant modifications are embodied to optimise the platform for its over-water role, allowing the aircraft to descend and ascend through harsh maritime weather environments to gain a closer view of ships and other targets at sea as required. These include strengthened wing structures for gust loads, hail and bird strike resistance, lightning protection, improved radome structural strength and aerodynamics, active fuel system centre of gravity control, bleed air inlet anti-icing, a 30 kVA generator, and a de-icing system. Triton also incorporates a reinforced airframe, for increased internal payload.

The MQ-4C’s key long-range maritime search sensor is the 360° AN/ZPY-3 Multi-Function Active Sensor (MFAS) X-band active electronically scanned array radar, which combines electronic scanning with mechanical rotation in azimuth (using a three-panel array mounted in a belly fairing). According to Northrop Grumman, this allows the radar to spotlight a geographic area of interest for longer periods to increase dwell time on smaller targets, particularly in sea clutter. Once targets are detected by the MFAS radar, the data is sent to ground station units in the form of tracks, single frame snapshots, as well as high-resolution snapshots while still maintaining full 360° coverage. Northrop Grumman claims that the endurance of Triton and the coverage afforded by the ZPY-3 sensor enables the MQ-4C to cover more than 2.7 million sq miles in a single ISR mission.
ZPY-3 also provides mode agility to switch between various surveillance patterns. These include maritime-surface-search (MSS) mode for tracking maritime targets and Inverse Synthetic Aperture Radar (ISAR) mode for classifying ships. Image-while-scan capability is used to interleave very short duration ISAR functions (ISAR snapshot and high-range resolution) during MSS scans. SAR modes are also available for ground mapping: spot SAR for images of the ground and stationary targets and strip SAR for images along a fixed line.

An MQ-4C seen at altitude above the US Navy guided missile destroyer USS Zumwalt. (NAVAIR) 1682854

A Raytheon AN/DAS-3 MTS-B EO/IR sensor turret provides auto-target tracking, high-resolution EO/IR at multiple fields of view, multimode colour video, and still imagery of surface targets. Sierra Nevada Corporation is responsible for the supply of the AN/ZLQ-1 ESM suite.

L3 Technologies CS-West is responsible for the Triton's Wideband Command/Control Communication Subsystem (WCCS). The WCCS provides SATCOM and line-of-Site (LOS) communication with main and forward operating bases.

Developmental flight testing of the MQ-4C with integrated mission systems and the Integrated Functional Capability (IFC) 2 software release began in April 2015. An operational assessment (OA), which consisted of six planned flight events (totalling approximately 60 flight hours in addition to ground and simulator events) was performed between November 2015 and January 2016 using the IFC 2 software build. According to Northrop Grumman, the joint navy/industry OA
team analysed and validated sensor imagery and performance at different altitudes and ranges, and examined the ability of the MQ-4C to classify targets and disseminate critical data.

Successful evaluation of the MQ-4C's time on station confirmed that it will meet flight duration requirements. However, the OA also revealed a number of deficiencies, including poor EO/IR sensor control, poor ESM interface, and difficulty managing the temperature of the radar.

Another identified deficiency is the lack of a Due Regard capability (traffic de-confliction and collision avoidance) in order to independently maintain prescribed minimum separation distances. The original Ku-band airborne sense-and-avoid (ABSAA) radar under development for the MQ-4C was shelved in 2013.

Director, Operational Test and Evaluation's (DOT&E's) 2016 annual report noted that Due Regard capability "provides critical mission capability for operation of the MQ-4C in civil and international airspace in support of global naval operations", adding: "Any limitation to this capability at IOT&E [Initial Operational Test and Evaluation] will reduce the effectiveness of the MQ-4C."

The USN is currently investigating alternative means of Due Regard compliance, including procedures and other co-operative avoidance systems already integrated in the MQ-4C, in order to support operations at initial operational capability (IOC). A sense-and-avoid solution is to be selected after IOC.

A further test milestone was achieved in June 2016 when Triton transferred full-motion video to a P-8A Poseidon in flight via the Common Data Link. This proved Triton's ability to track a target with its MTS-B EO/IR system to build situational awareness for a distant P-8 aircrew; in an operational environment, this would enable the P-8 aircrew to become familiar with a contact of interest and surrounding vessels well in advance of the aircraft's arrival on station.

IFC 3 software will serve as the build for operational evaluation and for Early Operational Capability (EOC). This build is installed at the MQ-4C Triton Systems centre at the Northrop Grumman facility in Rancho Bernardo, California, and should begin flight testing in 2017.

In August 2016, the MQ-4C programme achieved Milestone C approval from the US Department of Defense (DoD), clearing the way for the start of low-rate initial production (LRIP). The first USN unmanned patrol squadron, VUP 19, was formally commissioned in October 2016 (the same month that the aircraft completed its 100th flight): VUP 19 will operate the aircraft out of Naval Air Station Jacksonville, Florida, with a maintenance wing at Naval Base Ventura County in Point Mugu, California. It was announced during the VUP 19 commissioning that Guam would be the first of a planned five forward operating bases.

Planned future system upgrades include an air traffic collision avoidance radar system and a multi-intelligence (Multi-INT) configuration SIGINT collection system. The Multi-INT configuration provides a SIGINT capability, and includes sensors, supporting software and hardware, and changes to permit processing of Top Secret and Sensitive Compartmented Information; the USN intends that the MQ-4C Multi-INT configuration will replace the EP-3 Aries II aircraft for most missions.

It had originally been planned to achieve IOC with the baseline maritime ISR capability, and introduce the Multi-INT capability some years in the future. However, the decision was taken in September 2016 to accelerate the Multi-INT variant's delivery to service by fielding a single version of Triton and so removing the need for separate operational evaluation and IOC periods.
General Atomics' SeaGuardian UAS is based on a type-certified version of the company's Predator B UAS. (GA-ASI)

General Atomics Aeronautical Systems Inc (GA-ASI) is developing a maritime version of its new SkyGuardian UAS. Developed as a type-certified version of the company's Predator B UAS, SkyGuardian is the result of a five-year company-funded effort to deliver a UAS system that can operate under the stringent airworthiness requirements of non-military airspace. Compliant to NATO STANAG 4671 and UK DEF-STAN-00-970, the aircraft leverages the legacy of the multimission Predator B fleet, which has amassed nearly two million flight hours. SkyGuardian can fly in excess of 35 hours with airspeeds of up to 210 kt, and reach altitudes of more than 45,931 ft (14,000 m).

To facilitate qualification testing, GA-ASI is building three company-owned aircraft, along with two airframes designed specifically for full-scale fatigue and static testing to satisfy type-certification requirements. It plans to deliver the first production aircraft in 2018.

SkyGuardian can host a variety of sensor and communications payloads and is capable of transmitting high-resolution video to manned aircraft and ground forces. The maritime patrol variant of this system, designated SeaGuardian, is equipped with a surface search radar centreline pod to support open ocean and littoral surface surveillance.

Heron over water
IAI Malat's Maritime Heron houses an Elta EL/M-2022 radar inside a prominent belly radome. (IAI)

The Malat division of Israel Aerospace Industries (IAI) has long experience of maritime unmanned operations from the design, operations, and support through the iterative development of its Maritime Heron UAS, which itself builds on the pedigree of the Heron MALE UAS (sold to more than 20 customers worldwide). A full system typically consists of a minimum of three air vehicles, equipped with a ground control station (GCS), a launch and retrieval station, a ground data terminal, a launch and retrieval data terminal, and a mission-oriented payload.

While re-using the standard Heron 1 air vehicle, the Maritime Heron adds a multisensor payload (up to six sensors with a combined mass of up to 450 kg) typically comprising a multimode radar, an EO/IR turret, AIS, and an optional electronic intelligence (ELINT) package. The system can be controlled from either land- or sea-based GCS, with the ability to enact seamless real-time transfer of control from one GCS to another. Data can be transmitted from the unmanned aerial vehicle (UAV) to the control station via a LOS link (up to 250 km range), an air data relay (extending the range to 350 km), or via SATCOM.

Operations over water are typically carried out from an altitude of between 4,000 ft and 6,000 ft. Endurance is in the order of 20 hours.

Sister company IAI Elta supplies the EL/M-2202ML multimode radar, which is mounted in a belly radome and provides broad area search. Offering a sea mode, range signature, ISAR, strip/spot SAR, air mode, real-beam mapping, and navigation/weather mode, the radar payload is linked to a ground operator station and radar data processor via the UAS datalink.

IAI's Tamam business is responsible for the MOSP 3000 Multi-mission Optronic Stabilized Payload. As well as EO and IR sensors, the MOSP 3000 turret also incorporates a laser rangefinder.
The maritime variant of the Hermes 900 UAS introduces a multisensor suite incorporating a Leonardo Gabianno T-200 multimode surveillance radar. (Elbit Systems)

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