MQ-4C Triton

A Fifth-Generation Air Force Disruption for Maritime Surveillance

Michael Spencer
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Foreword

Australian-based remotely piloted operations can potentially extend Australian air power to cover distant and remote operating areas such as the South-West Pacific or Antarctica, where no significant air power exists. The Royal Australian Air Force's new MQ-4C Triton certainly fits into this concept.

Triton's combined payload provides fifth-generation Air Force agility to be flexible, able to quickly and easily adjust mission parameters to achieve and maintain an operational advantage to counter the rapid and unexpected changes in the environment. This mission agility will be further enhanced when teamed with the P-8 Poseidon in the same, adjacent or dislocated maritime patrol missions.

Wing Commanders Spencer and Small have produced this monograph as a primer for operators and planners who may have had limited exposure to remotely piloted Unmanned Aircraft Systems. Particularly to one capable of being remotely controlled by specialist mission crews, launched and recovery from forward operating bases and being able to support 24-hour missions covering large areas of over one million square nautical miles.

This monograph is a good starting point for doctrine writers and non-specialists to gain an understanding of the air capabilities, the complexities of the ground segment modes and the limitations of the whole system-of-systems associated with the MQ-4C Triton platform. I found the family-of-systems concept of operations to be of particular interest and I hope that this monograph will encourage other authors to expand on these thought-provoking ideas.

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Director
Air Power Development Centre
June 2019

About the Authors

Wing Commander Michael Spencer is an Officer Aviation (Maritime Patrol & Response), currently serving in the Air Power Development Centre, analysing potential risks and opportunities posed by technology change drivers and disruptions to the future employment of air and space power. A graduate of No 64 Navigator course, his operational background is with No 10 Squadron as P-3C Orion aircrew. He is the first Australian graduate of the Royal Thai Air Force Air Command and Staff College, an Australian Institute of Project Management Certified Practising Project Manager and an Associate Fellow of the American Institute of Aeronautics & Astronautics. He has gained completed postgraduate qualifications in aerospace systems, information technology, project management, space mission systems, and astrophysics. He is the author of AFDN 1-19 Air-Space Integration and co-author for the APDC BPAF series handbook, “Hypersonic Air Power.”

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A fifth-generation Air Force is a fully-networked force that exploits the combat-multiplier effects of a readily available, integrated and shared battlespace picture to deliver lethal and non-lethal air power. A fifth-generation Air Force will provide the joint and networked effects necessary to prevail against the increasingly complex and lethal threats of warfare in the Information Age.

Air Marshal G Davies,
AO, CSC, Chief of Air Force (2017)[1]

Introduction

Air Force is acquiring the MQ-4C Triton Remotely Piloted Aircraft System (RPAS[2]) to be operated alongside the P-8A Poseidon to replace the AP-3C Orion. The Triton mission payload relays maritime intelligence, surveillance and reconnaissance (ISR) information directly to the mission crew operator at the RPAS Mission Control Station (MCS) via the Defence Secret Network (DSN). The DSN functions as both a network, to enable the necessary link between Triton mission systems and mission crew, and as a data cloud for authorised DSN users such as deployed maritime commanders, P-8 missions, networked analysts, operations planners, and common operating picture. The Triton RPAS will use the networked ADF organisation to enable distributed operations with options to expand the footprint and "thinking" capacity of the dedicated mission team as an example of a fifth-generation air force approach to achieve information superiority in the Information Age.

Figure 1. RAAF MQ-4C Triton Remotely Piloted Aircraft.

A New Capability for Strengthening Australia's Maritime Patrol Capability

The Defence requirements that resulted in the Australian decision to acquire the Triton RPAS have their origins in a US Navy initiative to seek new capabilities for Broad Area Maritime Surveillance (BAMS). The US Navy BAMS program was designed to seek new capabilities as solutions for off-loading a significant portion of the ISR mission burden from its ageing fleet of P-3 Orion[3] long-range maritime patrol aircraft. The BAMS project developed solutions using Unmanned Aerial Vehicles to augment and complement the ISR mission performed as the US Navy prepared to transition the role to the new P-8 Poseidon multi-mission maritime patrol aircraft.

In June 2018, the Federal Government announced its approval for the Australian $1.4 billion project to acquire the first MQ-4C Triton RPAS through a cooperative project with the US Navy, in order to meet a military capability need to strengthen the security of Australia's maritime borders.[4] Built by Northrop Grumman for the US Navy, the Triton concept design was the result of joint US-led trials with the RQ-4 Global Hawk unmanned aircraft system, and included contributions from the results of flight trials conducted in Australia in 2001.[5] Defence is acquiring the Triton RPAS through a US Navy contract to Northrop Grumman Corporation.

Defence identified the Triton RPAS to complement the new Australian P-8A Poseidon aircraft to perform the maritime surveillance role, in sustained and long range operations, as well as performing a range of intelligence, surveillance and reconnaissance tasks. Air Force will employ the Triton RPAS and P-8A within a Family-of-Systems (FoS) – a grouping of different systems having some common systems characteristics: Triton will provide long range, high-endurance surveillance and the P-8A will provide maritime response and close-in surveillance. Together, the combined utility of the Poseidon and Triton will significantly enhance the mission effectiveness of Australian anti-submarine warfare and maritime surveillance missions, including search and rescue.

Stratospheric Mission Operating Environment

The stratosphere is the region of the upper atmosphere that starts at a lower boundary of approximately 8 km at the poles to 15 km at the equator and extends up to an upper boundary of approximately 50 km. Commercial airliners climb to cruise at heights in the lower stratosphere because, normally, there are no weather storms or turbulence occurring in the stratosphere compared to lower operating altitudes below the stratosphere. This provides for a stable operating environment for deploying ISR sensors in persistent air missions.

Conventional aircraft and weather balloons reach their maximum operating altitudes within the stratosphere where the air density decreases with altitude down to about 0.1% at the top of the stratosphere compared to the air density measured at sea level. The Triton wing design provides a steady and stable platform for the mission payload, especially with long-range ISR sensors operating from high-altitudes. Additionally, the reduced drag configuration increases the efficiency of its fuel consumption, improving its mission endurance and range.

Whilst it is beneficial to operate the Triton Remotely Piloted Aircraft (RPA) at a high operating altitude, weather can exist between its on-board sensors and its target objective, potentially interfering with the mission. Even though the design of the Triton RPAS is optimised for loitering at high altitudes, it has been structurally strengthened to be able to operate in the presence of foul weather at lower altitudes. However, its design characteristics enable options for it to avoid or evade foul weather by: using its long endurance capability to continue to loiter over the target area until the weather clears below it; using its long range and endurance to divert to an alternative mission objective and return when the weather clears; and descending to a lower operating altitude below the weather, returning to high altitude after the mission objective if the remaining fuel and mission duration are adequate for the climb.

Triton also incorporates a reinforced airframe and wing for hail, bird strike, and gust load protection, with de-icing and lightning protection systems. These features allow the aircraft to descend and ascend through harsh maritime weather environments encountered at lower altitudes in order to gain a low-angle perspective at close ranges in order to view aspects of the target that may not be accessible from overhead at high-altitudes.[6]

Disruptive Technology Enables Remotely Operated Maritime Surveillance

HALE aircraft operations in the stratosphere required new systems and aircraft designs. Disruptive technology has made it possible to exploit the stratospheric altitudes for remotely piloted aircraft operations to make long-range detections on discrete targets. However, this also drove the need for a new workforce, enabling systems, and procedures to safely transit an RPA from the ground through popularly used flight altitudes and safely into the stratosphere, and remotely operate a mission payload at higher altitudes and longer slant-ranges for ISR sensors and communications links.

New and emerging technologies are necessarily disrupting the traditional approaches for the efficient employment of air power to conduct maritime surveillance, including the following examples:

a. **Remotely located mission crews**. The mission crews operate the Triton by remotely accessing and controlling the RPA on-board software-driven systems. Whilst complicated, this approach enables an aircraft design that can operate between the ground level and into the stratospheric altitudes, unburdened by the need for on-board life support systems and human-machine interfaces. The RPAS design trade-offs provide opportunities to reduce weight and make more space available for designing a tailored payload to increase mission diversity and effectiveness.

b. **Aircraft designed for operating at low to high altitudes and long endurance**. Triton's wing design follows a similar design used for gliders with a very long and thin main wing producing low drag for the amount of lift it generates, especially in the low-density air present at higher altitudes. The low drag enables HALE performance to enhance the mission range and duration. Additionally, the Triton RPA material structure uses a combination of metal and composite materials in order to improve its airframe structural strength for operations in foul weather. The forward fuselage is strengthened to house the ISR sensors and survive hail and bird-strikes at low altitudes. The bulbous airframe nose radome has also been modified with lightning protection.

c. **Miniaturised systems and technology**. Technology miniaturisation is enabling smaller and more capable air and space mission payloads, as seen in their applications in operational RPA and microsatellites that are making detailed Earth observations and communications from orbital altitudes. The drive to develop smaller and lighter systems that perform with less power is enabling the designs of smaller aircraft payloads that can perform from long standoff and slant ranges. The improved standoff ranges also benefit the survivability and counter-detection when operating in a hostile environment.

d. **Autonomous fuel management and optimisation**. An on-board mission management system benefits the operators by reducing their workload and burden, and by autonomously adjusting the fuel flow in order to optimise the fuel burn rate—given the changes in the aircraft weight and weather (i.e. winds)—as the mission progresses, in order to optimise the mission range and endurance.

e. **Multi-function mission payload**. The mission payload has been configured with multiple discrete ISR sensor systems that have been tailored to the maritime surveillance role. The payload uses an on-board systems processor and integrated communications system to transmit and distribute the ISR data to users connected to a network, including the mission crew.

f. **More powerful on-board data processors**. Modern airborne sensors are providing more ISR data in various signature forms, including full-motion video and high-definition images. Network access and bandwidth limitations, however, can prevent the timely or successful sharing of real-time mission-critical data. Triton and other similar systems can use on-board data processors to process the raw ISR data and output a reduced size data file for network transmission, thereby improving network efficiency. Assured continuous access to the full SATCOM bandwidth is necessary for the crew to receive the detailed sensor imagery and determine if the mission needs to relay it to other recipients.

g. **Shared battlespace awareness**. The availability of a common shared distributed data network for sharing battlespace data enables the near real-time sharing of battlespace situational awareness between all network participants. The utility of a battlespace network that is a common design across the joint force, is that it serves to better integrate all the elements of that joint force to enable quicker situational understanding, coordination, and synchronisation of team efforts to execute joint effects and to assess their effectiveness.

h. **Beyond-Line-of-Sight communications relay**. The relaying communications signals, necessary for both flight controls and the ISR payload mission and systems data, is achieved using ground-based networked communications, SATCOM, or another HALE aircraft (e.g. during mission handover) to significantly extend the operating range of the Triton RPA from its mission control station established at RAAF Base Edinburgh. Triton can also be employed as an automatic communications relay platform for Line-of-Sight (LOS) communications, including Link-16.

i. **Secure anti-jamming communications**. Triton RPA is configured with an anti-jam GPS antenna and anti-jam module that uses encryption techniques to assure communications for the flight control signals and the mission data.

j. **Global Navigation Satellite System (GNSS) augmentation and geospatial data**. The availability of global geospatial reference data and the digitisation of air navigation position and velocity vectors provided by GNSS have helped realise the use of automatic and autonomous systems in the Triton RPA. The Triton RPA design uses autonomous system operations, in part or fully, to perform the take-off, enroute navigation to the mission area, fly the mission, and land, under the controlling supervision of the remotely located mission crew. The autonomous system follows the operational parameters derived from the crew's mission planning efforts.

Triton RPAS System Segment Descriptions

The Triton RPAS can be regarded as an integrated system-of-systems. Each subsystem can be grouped, based on its functionality, into separate mission segments. These mission segments assist to better understand their purpose in the total integrated system and their contributions to the overall Triton RPAS mission, and are described below.

a. **Air Segment**. The air segment is comprised of the remotely piloted aircraft and remotely managed mission payload. Triton is equipped with a mission payload of multiple discrete sensor systems for performing ISR missions and communicating the mission data to users, or relaying data as a network communications node, via a datalink or network.

(1) **Airframe**. The Triton RPA has a length of 14.5 m, height of 4.7 m and a wingspan of 39.9 m. It can hold a maximum internal payload of 1,452 kg and external payload of 1,089 kg[7]. Seven airframes are planned to be acquired and home-based at RAAF Base Edinburgh[8]. One Triton RPA may be flown for up to 24 hours on a mission, limited by crew availability and maintenance support, with a persistent operating radius up to 2,000 nautical miles (3,700 kilometres) and operating altitude ceiling of above 50,000 feet.[9] The mission crew monitors the Triton RPA as it automatically flies to the 3D fly-to-waypoints defined in the approved digital mission plan. Inflight changes are made manually by using a “pointing and clicking” technique and cockpit interface to a digital map; there are no “stick and rudder” controls. The aircraft speed, altitude and mission objectives are planned by the mission crew using the digital mission planning system.

(2) Mission Payload. The mission payload is comprised of ISR sensors and communications systems. The current sensor suite tracks ships in the patrol area over time by gathering information on their speed, location and type classification.

- **ISR payload**. The ISR sensors, configured to provide a 360° field of regard, include: a Multi-Function Active

Sensor Active Electronically Steered Array (MFAS AESA) radar with maritime and air-to-surface modes, and long-range detection and classification of targets; electro optical/infrared (EO/IR) Multi-spectral Targeting System model B (MTS-B) with full motion video and high resolution imagery captured from multiple fields-of-view using auto-target tracking; AN/ZLQ-1 Electronic Support Measures (ESM) to identify and geolocate radar threat signals; and Automatic Identification System (AIS) to monitor VHF AIS broadcasts from cooperating ships equipped with AIS.[10]

- **Communications payload**. The communications system includes multiple satellite beyond-line-of-sight communications capabilities for relaying flight controls and mission data; Link-16 line-of-sight communications for relaying mission data; Common Data Link for relaying high-definition imagery and full motion video; and GPS navigation receiver.[11]

b. **Ground Segment**. The ground segment is the Mission Control Station (MCS) based at RAAF Base Edinburgh and has a number of embedded systems. The MCS layout of crew stations is configured and inter-connected as if the crew were on-board an aircraft.

(1) **Mission Control System**. Air Force qualified pilots will fly the Triton RPA, and communicate with air traffic controllers and other airspace users, using the pilot stations configured into the MCS; the mission commander and team of sensor operators will operate the mission payload and manage the network connectivity using the mission specialist stations in the MCS. The crew will also use the MCS to perform mission planning for defining how the mission payload sensors, communications systems, and navigation systems will be employed.

(1) **Launch and Recovery System**. The launch and recovery system controls the operation of the ground support equipment as well as the Triton landing and take-off. A small skeleton crew will perform launch and recovery tasks at RAAF Bases Edinburgh

and Tindal while the main team will fly the Triton and manage its mission payload remotely from RAAF Base Edinburgh.

(2) **Mission Planning System**. Air Force adopted the US developed Joint Mission Planning System (JMPS) as part of an ADF-wide common mission planning system and support environment. Triton uses JMPS, with Triton RPA-specific performance data, to provide the information, automated tools and decision aids needed for planning its missions around the aircraft, sensors, and communications links.

(3) **Training Simulator**. An embedded flight and mission simulation training capability is built into the MCS to exercise the pilots, Mission Commanders and payload operators.

(4) **Mission Replay**. The original US system version includes a 3D mission replay functionality to provide operators with the option to play back a previously recorded mission for review and post-mission analysis.

(5) **Live, Virtual & Constructive (LVC)**. The Triton program has a future development path to integrate the MCS into an LVC simulation and training environment for its mission outputs, synthetic or real, to be electronically exchanged with other networked exercise participants.

c. **Space Segment**. Defence access to the US Wideband Geostationary SATCOM (WGS) satellite system provides beyond-line-of-sight communications of the control signals for both the RPA and mission payload operations, and the mission data signals output by the payload. The network connectivity between the WGS and DSN is mission-critical for the real-time exchange of message signals and control data. This signals and data include the flight control messages sent from the pilot and feedback sent from Triton; telemetry data on systems status, fatigue monitoring, and subsystems usage and for the engineers and logisticians; and payload control messages sent from the mission sensor operator and raw sensor data messages, including the video and still imagery from the payload sensors.

d. **Mission Support Segment**. The support segment includes aerospace ground equipment, technical orders, spares, support equipment, training and maintenance contractors to support operation of the Triton RPAS.

What the Australian MQ-4C Triton is not

The US Defense Standardised Mission Design Series[12] identifies the Triton RPA as "MQ-4C" which translates as a multi-mission unmanned drone, where: M = "multi-mission" as its listed type of mission; Q = "Unmanned Aerial Vehicle" as its listed type of vehicle; and 4C = the fourth drone design, manufactured as modification block "C".

MQ-4C is a defined system with a declared design and a strictly controlled configuration. MQ-4C should not be alluded to as having other capabilities or the potential to be modified to have similar capabilities to other dissimilar drones, including other well-known RPAS.

a. **Triton is not a Global Hawk**. The Triton RPA is a high altitude long endurance and unarmed aircraft design that is based on the US RQ-4B Global Hawk[13] but has a slightly different airframe design and sensors. RQ-4 Global Hawk is operated by the US Air Force to provide a broad spectrum ISR capability to support joint forces in worldwide peacetime, contingency, and wartime operations. Until Triton enters service, the US Navy will continue to operate the RQ-4N, a marinised version of Global Hawk, for reconnaissance missions.

b. **Australian Triton is not an Australian-unique design**. The Triton RPAS has the same configuration as the US Navy RPAS. Australia is a member of the Cooperative Development, Production and Sustainment Program[14] and as a partner has influence over configuration changes to change the Triton capability baseline.

c. **Triton is not a weaponised drone**. Although MQ designation is linked to Unmanned Aircraft Systems (UAS) that are designed to carry a weapons payload, such as the General Atomics Aeronautical Systems MQ-1 Predator and MQ-9 Reaper, the MQ-4C Triton RPA is not a weaponised UAS. The Triton RPA design is configured to carry a sensor and communications payload; it is not configured to carry a weapons payload.

d. **Triton is not an autonomous RPAS**. The Triton RPA will be flown by a qualified Air Force pilot[15], from a pilot station in the MCS located at RAAF Base Edinburgh. The Triton RPA will rely on the mission crew for digital mission planning, remote operations and communications via satellite-enabled networking, and a flight control system that can update and override the RPA operation.

e. **Triton is flown with due regard to other airspace users**. The Triton RPA will be configured with a collision avoidance radar to comply with an International Civil Aviation Organization requirement for military aircraft to fly with its pilot being informed with "due regard" for the safety of airspace and other aircraft when operating over international waters. Triton has a Traffic alert Collision Avoidance System (TCAS) and Automatic Dependent Surveillance-Broadcast (ADS-B) transmitter/receiver. However, the installation of these systems may not be considered adequate for a RPA to autonomously "sense and avoid" other airspace users - a pilot will continue to be needed for supervising and controlling the safety of flight in airspace shared with other aircraft.

Figure 2. Triton RPAs can be deployed into the same concurrent mission or multiple independent missions.

Concepts of Employment for Triton RPAS

The primary functionality for shaping the mission(s) and employment of Triton is persistence. The term 'persistence' is used in reference to Triton to mean the maintenance of a constant – or near constant – overwatch of a surveillance area, or areas, using a single or multiple RPA, multiple crews, and in rare cases, multiple MCS.

The MCS comprises one primary pilot station, attached to redundant pilot stations for controlling the flights of two additional Triton RPA concurrently. Triton will be flown by qualified Air Force pilots using the MCS.[16] The launch and recovery is performed by the pilot located at the ground site where the Triton RPA is being maintained by the ground crew. This location may be remotely displaced from the MCS.

The MCS controls the Triton RPA and its payload for the airborne ISR mission. Command and control data links enable the pilots to remotely control the aircraft. The pilot workstations in the MCS and launch/recovery location provide the control and display interfaces (i.e. cockpit) to inform the pilot of the aircraft health and status, sensors status and a means to alter the navigational parameters of the aircraft. The pilot also communicates with outside entities to coordinate the mission (e.g. air traffic control, airborne controllers, ground controllers, other ISR assets).

This RPAS systems and design configuration makes it possible for a Triton mission team to potentially be deployed in the following notional concepts of employment (CONEMP):

a. **CONEMP1 - Single Triton sortie for a single mission**. Using a resource-driven approach, the mission is planned around employing a single or multiple teams of pilots and mission specialists operating a single Triton RPA for the duration of a single mission or a maintenance sortie. The mission duration is constrained by the availability of crews and all RPAS elements. The long endurance of the RPA enables multiple sortie events to be flown in sequence, either as a deliberately planned mission or with agility in response to unexpected changes arising during the mission.

b. **CONEMP2 - Multiple Triton sorties conducting a single mission for extended persistence**. Using a mission-focused approach, the extended mission is planned with multiple separate teams of pilots being tasked to independently operate three different RPA sorties. The sorties are tasked to support a single mission, with only one RPA on station at a time, with the second and third Triton RPAs replacing the preceding RPA at the end of their respective sorties. The sequence of three RPA sorties serves to extend the persistence of one Triton RPA on a mission: the remote pilot redeploys the first RPA after the end of its mission period; another remote pilot is operating the second RPA that is on station; a third remote pilot is deploying the third RPA that is relieving the second RPA on station. At shorter distances, you will be able to provide persistent coverage with two aircraft that continually relieve each other. The crews change MCS configuration for the mission specialists to operate the mission payload only for the RPA that is on station in the mission area and not in transit. This concept is characteristic of a persistent mission using all pilot stations, without repetition, and ceases after the three RPA rotations, with options to extend further depending on aircraft and crew availability.

c. **CONEMP3 – Multiple Triton sorties, in a repeating cycle, conduct a very long mission with enduring persistence.** Using a mission-focused approach, the mission is planned for teams of pilots, and their replacements, to be rotated through each of the three MCS pilots' stations. Each pilot independently operates each of three different RPA sorties, concurrently and in a repetitive cycle, in order to assure that one RPA is on station to perform the mission with a very long persistence until crew or resources become unavailable.

d. **CONEMP4 – Multiple Triton sorties conducting separate missions, concurrently.** Using a resource-driven approach to operations planning, teams of pilots are employed to independently operate separate Triton RPAs, deployed on different discrete missions, within the same or different geographical areas; the mission specialists can only operate the payload on the one RPA at any one time, and can alternate access to each different deployed RPA. However, the viability of this CONEMP is challenged by the crew capacity to manage situation awareness and make time available to allow for the preparation and execution of the rotations between the different live missions. Only one airborne RPA can access and utilise the

> SATCOM bandwidth to communicate mission data, at any one time. The others can still safely fly, automatically, while the pilots continue to communicate with air traffic controllers. This concept provides an operational–level response to the needs of the battlespace that is characterised by operational agility with multiple missions, responsiveness, and increased coverage and reach.

The technical limitation on mission planning is access to, and capacity of, the wideband satellite link, which permits it to support communications of control signals for both the flight controls and payload, and the data from the payload sensors. Mission planning is also limited by crew availability, including endurance limits. Sequential sorties may need to be with some sortie gaps depending on the availability of pilots, mission crews, and ground crews, in the two base locations.

Manned Un-Manned – Teaming (MUM-T)

Whilst an operational driver for pursuing RPAS designs is to extend the reach, endurance, and performance of aircraft capability by displacing the mission crews to operate remotely from a benign location, these same RPAS can be integrated with other manned missions to augment and extend their capabilities. Manned Un-Manned-Teaming (MUM-T) describes the integration of separate discrete manned and unmanned mission systems in order to extend and enhance the capabilities of the manned systems. MUM-T[17] describes a standardised systems architecture and communications protocol that enables live video and still images gained from the sensor payloads of RPAS to be shared throughout a force in order to improve, and achieve, a common level of battlefield situational awareness, thereby enhancing decision superiority.

The capabilities of the crewed P-8A Poseidon aircraft (refer Annex B) have some overlaps with those of the remotely piloted MQ-4C Triton (refer Annex C). Both aircraft are capable of performing missions for maritime surveillance, maintaining the surface picture (e.g. SURPIC) and the classification, identification, detection, and tracking of surface units; both aircraft have different but complementing performances, in respect of ISR capabilities, responsiveness, range and endurance. The Triton will complement P-8A Poseidon's maritime surveillance and response capabilities, "flying missions in excess of 24 hours with a range of over 8000 nautical miles, while providing 360 degree surveillance and imagery of an area of up to 2000 square miles."[18] Employing them both together, as a FoS, enables Air Force to respond to maritime patrol needs with a team to generate a synergy that can better support the joint force in a range of ISR tasks.[19]

Figure 3. MQ-4C Triton and P-8A Poseidon are designed with common integrated systems.

The P-8A Poseidon is also configured to fulfil mission requirements that the Triton cannot, including antisubmarine warfare and search and survivor assistance. If the P-8 Poseidon has a primary mission in anti-submarine warfare, then the mission burden of managing maritime surveillance over the same mission area can be assigned to the Triton RPA. When flying complementary roles in the same battlespace, the respective operators of both platforms are able to chat and collaborate via networked communications. It is noteworthy that both Triton and Poseidon have been designed from the outset to operate together using interoperable and integrated systems to exchange large volumes of mission data, including data formatted for targets and target locations, imagery, and video.[20]

Networked Distribution of Triton ISR Mission Data

Australian experiences gained during Operation OKRA proved the successful Air Force implementation of networking systems to distribute operational data and inform tactical air combat elements deployed into the same air missions. The core of this Air Force networking capability is the Distributed Ground Station Australia (DGS-AUS). DGS-AUS is a "centralised intelligence, surveillance and reconnaissance (ISR) system capable of processing, exploitation and dissemination (PED) from numerous ADF and allied imagery and signals intelligence."[21] Information is sourced from ADF ISR missions, potentially operating in diverse operational theatres, and networked with other Australian Defence systems and stakeholders in order to improve commanders' situational awareness.

The Triton RPAS network connectivity to the DGS-AUS provides mission-planning options to use an extant deployed communications system to access and inform all relevant mission elements tasked to collaborate on the same mission, and /or monitoring the progress and effectiveness of the longer-running operation or air campaign.

The network connectivity enables the live collaboration and teaming with other remotely located and dispersed tactical elements, irrespective of physical geography, remote location, or distance. Information gathered by Triton's airborne ISR payload can be analysed and communicated to other networked users, including operational staff such as aircrew, intelligence, operations and administration officers, engineers, and logisticians, who are assigned as needed for the training or mission requirements.

A significant benefit of RPA is using them as an ISR node that is agile and operated in hostile areas with degrees of risk that are more acceptable than for manned missions. Current airborne and space-based ISR platforms are capable of providing an almost overwhelming stream of data for contemporary battlefield communications systems. However, this problem of coping with a seeming deluge of raw digital data can be alleviated, in part, by using networked stakeholders to collaborate in the data analysis and intelligence processing. The addition of networked resources can assist to complement the mission resources and transform the data into a more usable product that can be more efficiently communicated over the battlespace communications network to inform deployed mission elements. The benefit of network connectivity is being able to collaborate with a variety of knowledgeable resources, accessible throughout the networked organisation, in a timely manner. No longer is mission effectiveness constrained by reliance only on the resources that can be assigned and deployed with an air mission.

The on-scene support for the Triton RPAS missions could be enhanced with the appointment of appropriately qualified Liaison Officers (LO) from complementary missions or other mission expertise areas. The LOs would augment the Triton RPAS mission specialist team for faster mission analysis and decision-making. Appointing LOs into the MCS, from the other services, can assist to improve the functioning of other parts of the larger Defence organisation that might be dependent on Triton RPAS mission outcomes. Additionally, the appointment of an LO need not necessarily be the physical placement of an LO at the MCS but could be a remotely located LO using a network connection on the DGS-AUS or Defence Secret Network (DSN) to access the Triton RPAS mission data.

For example, the Triton RPAS might be tasked to perform a Humanitarian Assistance Disaster Relief (HADR) mission following an earthquake in a regional country. A Triton RPA can be sending back live video and still imagery captured from the affected area whilst naval support ships are still berthed at the Fleet Base in Sydney and preparing to deploy. The support ship's commander can request tasking for the Triton RPA to gain imagery that is specific to the needs of the ship on arrival at the mission location (e.g. sea navigation hazards, status of port facilities, helicopter landing site options, etc). Triton is capable of geolocation with its imagery, taken from any altitude and aspect requested by the ship's crew. An LO in the MCS can exploit the communications links and have direct access to the mission crew to implement ship requests for information. Additionally, the crew connectivity with the LO brings everyone into the mission and enhances the crew's capacity and knowledge base to better perform the mission.

Notional FoS Concepts of Operation

The system attributes of the Triton RPAS can be used to explore notional designs for missions and operational employment of the Triton RPAS and P-8A Poseidon FoS. Triton RPAS could be deployed in a range of missions that are traditionally described as maritime surveillance, multi-domain ISR, strike support, battle damage assessment, and communications relay. However, it is the diversity in the options for Triton to operate independently or be integrated with other mission elements that makes it key to the fifth generation Air Force designs.

It will directly support Navy ship organic aircraft in the conduct of their air missions in maritime interdiction, anti-surface warfare, battlespace management, and strike support missions.

a. **CONOPS1 – Triton-enabled Maritime Surveillance Picture (SURPIC).** The Triton RPAS could be tasked and deployed to conduct independent surveillance missions in support of national security operations, collaborating with or informing other mission elements connected on the DSN.

b. **CONOPS2 – Triton Support the Fleet**. Triton will fly at high altitudes to cover huge areas of ocean to enable maritime situation awareness and relay a common operating picture to deployed mission elements, under the control of a fleet task group. With SATCOM, Triton RPA may be able to operate at BLOS ranges in advance from the fleet task group, to enhance situation awareness and provide an option for communications relays over the horizon.

c. **CONOPS3 – MUM-T (LOS) Maritime Surveillance Support to Organic Air (ASW)**. The Triton RPA flies a maritime support mission in support of a fleet task group, as an integrated team with a ship's organic aircraft conducting ASW or ASUW. Whilst the Triton pilots and mission specialists are responsive to the ship's air controller, the Triton payload data can be received directly by the ship's organic aircraft to directly influence their mission, if the ship's aircraft mission systems are configured with interoperable data and communications systems.

d. **CONOPS4 – MUM-T (LOS & BLOS) Maritime Surveillance Support to P-8 Poseidon (ASW)**. The Triton RPA flies a maritime support mission in support of a P-8 Poseidon, as an integrated team, while the P-8 is conducting ASW and/or ASUW. Whilst the Triton pilots and mission specialists are responsive to the P-8 mission commander, the Triton payload data is received directly by the P-8 on-board mission system to directly influence its mission.

Conclusion

Information has become the vital commodity that can be rapidly processed by computers and quickly and widely distributed throughout computer distribution networks, defining the Information Age, and setting the stage for Air Force to realise designs for the fifth-generation Air Force. Networked information can be accessible from sources deployed everywhere throughout the Defence networked organisation, providing raw and processed data including history and future projections, and in different data formats ranging from descriptive text, technical data, machine code, still-imagery, and full-motion video.

The technology revolution in networked communications has entrenched the Information Age as one that could stand-alone as an epoch of a different nature.[22] Having ready access to the network for communicating this information, to inform or to control mission elements, is a hallmark of the transformation to the fifth-generation air force.[23] Triton RPAS represents the operationalisation of a new remotely operated and networked mission system that is, in part, contributing to the realisation of the fifth-generation networked Air Force.

Epilogue - Planned Triton RPAS Delivery to Air Force

The first Triton RPA is planned to be delivered to Air Force in mid-2023[24]; Initial Operating Capability is planned for 2024/25; and Final Operational Capability is planned for 2025/26.

Figure 4. MQ-4C Triton RPA.

Annex A - Abbreviations

ADS-B	Automatic Dependent Surveillance-Broadcast
AIS	Automatic Identification System
BAMS	Broad Area Maritime Surveillance
BLOS	Beyond Line-of-Sight
CONEMP	Concept of Employment
CONOPS	Concept of Operations
DGS-AUS	Distributed Ground System - Australia
DSN	Defence Secret Network
FoS	Family of Systems
GNSS	Global Navigation Satellite System
HADR	Humanitarian Assistance Disaster Relief
HALE	High Altitude Long Endurance
JMPS	Joint Mission Planning System
LO	Liaison Officer
LOS	Line-of-Sight
LVC	Live, Virtual, & Constructive
MCS	Mission Control Station
MFAS	Multi-Function Active Sensor
MPS	Mission Planning System
MQ-4	Multi-mission Unmanned Drone
MUM-T	Manned Un-Manned – Teaming
PED	Processing, Exploitation and Dissemination
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Aircraft System
SURPIC	Surface Picture
TCAS	Traffic-alert Collision Avoidance System
UAS	Unmanned Aircraft System
USN	United States Navy

Annex B – RAAF P-8A Poseidon

OPERATIONAL CHARACTERISTICS[25]

Manufacturer: Boeing
Speed: 907 km/h
Dimensions: 39.5 m long, 12.8 m high, 37.6 m wingspan
Ceiling: 41 000 feet (12.5 km)
Range: 2200 km Combat radius with four hours on station
Ferry Range: 7500 km (extended with air-to-air refuelling)
Endurance: 10 hours (extended with air-to-air refuelling)
Crew: Air Force pilots and mission aircrew (up to ten crew) are assigned to meet the mission needs.
Weapons: Mark 54 torpedoes, AGM-84 Harpoon anti-ship missiles, and self-protection.

OPERATIONAL EMPLOYMENT

With four times the data processing capacity of the AP-3C Orions, the P-8A Poseidon provides a more advanced, manned Maritime Intelligence, Surveillance, Reconnaissance & Response (MISRR) capability, including anti-surface and anti-submarine warfare, maritime and overland ISR, electronic support, and search and survivor assistance.

The P-8A will also be capable of receiving air-to-air refuelling from the boom of a tanker aircraft, such as the KC-30A, once testing is complete, pushing its endurance out to over 20 hours – making it possible to patrol Australia's isolated Southern Ocean territories.

RAAF Base Edinburgh will be the main operating base for the P-8A Poseidons, operated by No 11 Squadron. The Government has committed to acquiring 15 P-8A Poseidon aircraft. Twelve P-8A Maritime Patrol Aircraft have been approved for acquisition, and three are subject to normal Government Defence acquisition approval processes.

Annex C – RAAF MQ-4C Triton RPAS

OPERATIONAL CHARACTERISTICS[26]

Manufacturer: Northrop Grumman
Speed: 613 km/h
Dimensions: 14.5 m long, 4.6 m high, 39.9 m wingspan
Ceiling: 50,000 feet (15.24 km)
Range/Endurance: 24+ hours
Crew (on ground): Flown by pilot and operational staff to analyse and disseminate information.
Equipment: ISR sensor suite that provides a 360-degree view of its surroundings to over 2000 nautical miles.

OPERATIONAL EMPLOYMENT

Triton is a remotely piloted type of Unmanned Aircraft System (UAS) that Air Force will operate alongside the P-8A Poseidon. Triton, together with P-8 Poseidon, will provide Australia with an advanced maritime patrol and surveillance capabilities to replace the ageing AP-3C Orion.

It is a high-altitude, long-endurance aircraft capable of all-weather surveillance and reconnaissance tasks over maritime and land environments.

Reinforcements to the airframe and wing, along with de-icing and lightning protection systems allow the Triton to descend through cloud layers to gain closer views of ships and other targets at sea. With Australia's maritime area of operational interest covering over one seventh the world's oceans, the multi-mission Triton will be a critical complement to the P-8A Poseidon in maintaining a credible level of maritime awareness.

Up to seven MQ-4C Tritons will be stationed at RAAF Base Edinburgh near Adelaide, South Australia.

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MQ-4C Triton

A Fifth-Generation Air Force Disruption for Maritime Surveillance

Air Force is acquiring the MQ-4C Triton remotely piloted aircraft system (RPAS). The MQ-4C Triton is disrupting traditional concepts used for Maritime Patrol Aviation. With its long range and endurance, it will enable teams of Air Force remote pilots, mission specialists, and ground crew to plan and conduct airborne search missions across all areas of Australia's primary operating environment, from their fixed home base. The reconfigurable multi-station ground control station provides options to concurrently manage a single sortie mission or multiple sorties within single or multiple discrete missions.

The integration of the MQ-4C Triton RPAS into the Distributed Ground Station - Australia (DGS-AUS) will deliver a networked capability that not only enables the ground control of the Triton mission but also connects the mission outputs to networked users located throughout the Defence-wide networked organisation, including aircrew flying the P-8A Poseidon. The MQ-4C Triton will be the fifth-generation disruption to maritime surveillance.

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