Australian Government
Department of Defence
Defence Science and Technology Organisation

North West Shelf Unmanned Aerial System Trial

Duncan Craig

Intelligence, Surveillance and Reconnaissance Division
Defence Science and Technology Organisation

DSTO-TR-1958

ABSTRACT

In response to a government policy announcement issued during the lead-up to the 2004 federal election, Defence undertook two demonstrations of the application of Unmanned Aerial Systems (UAS) technology to the protection of the North West Shelf region. A real world trial took place in August-September 2006, involving the General Atomics Aeronautical Systems Incorporated Mariner Demonstrator UAS. A modelling and simulation based trial involving Northrop Grumman's Cyber Warfare Integration Network (CWIN) facility took place in October 2006, with a Global Hawk-based UAS being represented within the simulation environment. This report provides a public releasable summary of these two activities.

Published by

Intelligence, Surveillance and Reconnaissance Division
DSTO Defence Science and Technology Organisation
PO Box 1500
Edinburgh South Australia 5111 Australia

Telephone: (08) 8259 5555
Fax: (08) 8259 6567

AR- 013-853
February 2007

North West Shelf Unmanned Aerial System Trial

Executive Summary

In response to a government policy announcement issued during the lead-up to the 2004 federal election, Defence invited General Atomics Aeronautical Systems Incorporated (GA-ASI) and Northrop Grumman (NG) to participate in an Unmanned Aerial System (UAS) trial over the North West Shelf (NWS) region of Australia, to demonstrate the maritime surveillance potential of their UAS technology. The trial was also to demonstrate how such UASs could operate with patrol boats as a contribution to the protection of the NWS region and other maritime environments.

Discussions with the two parties led Defence to work towards a real-world trial with GA-ASI, and a modelling and simulation based "virtual" trial activity with NG. This report provides a public releasable summary of these real world and virtual trial activities.

The original policy announcement specified the objectives of the NWS Trial as being: to assess the maritime surveillance potential of Unmanned Aerial Systems operating with Armidale Class Patrol Boats (ACPB) in protecting the NWS and other maritime environments; and to provide data to support the acquisition of a multi-mission UAS under Defence Project AIR 7000 Phase 1.

The real world trial involved a GA-ASI Mariner Demonstrator UAS. A series of flights were flown from RAAF Edinburgh in South Australia and RAAF Learmonth in Western Australia during August and September 2006. The UAS ground station that provided mission control was located at RAAF Edinburgh. The ACPB HMAS PIRIE supported the trial sorties, enabling an investigation of how these assets should interact during the conduct of maritime surveillance operations.

The virtual trial involved simulation of similar NWS scenarios as were addressed by the real world trial. However, the virtual trial enabled further investigation of circumstances (such as particular weather or sea state conditions) that were constrained by the actual conditions encountered during the real-world trial. Simulations were run over a ten day period in October 2006.

Both the real world and virtual trial activities were able to address the above objectives, demonstrating the extent to which UAS technology could contribute to protection of the NWS region through the provision of maritime surveillance capability. A range of specific system performance and command and control issues were highlighted during these trial activities. The information gained on these issues will help inform future Commonwealth consideration of UAS technology for Defence and National Security applications.

Authors

Duncan W Craig
Intelligence, Surveillance and Reconnaissance Division

Duncan Craig graduated in Physics from Heriot-Watt University, Edinburgh, in 1982. He then worked for the UK MoD at (what was then known as) the Royal Signals and Radar Establishment from 1982-1990. He was involved in the areas of nonlinear optics and thermal imager performance modelling. During this time he gained a PhD from Heriot-Watt University on the topic of Nonlinear Optical Effects.

In 1990 he commenced work at the Defence Science and Technology Organisation Edinburgh, undertaking work on infrared sensor systems performance modelling, surveillance capability trials and studies, and later establishing the Synthetic Environment Research Facility within Land Operations Division.

In 2000 he took up the position of Head Surveillance Systems Analysis, leading a range of studies and trials related to surveillance capability effectiveness, culminating in the North West Shelf Unmanned Aerial System Trial conducted in 2006.

He is now Research Leader Information Integration within Intelligence, Surveillance and Reconnaissance (ISR) Division and is involved in a range of R&D activites related to ISR system effectiveness and ISR information management.

Contents

1. Introduction

1.1 Background

During the 2004 election campaign, the Commonwealth Government announced an intention to invite General Atomics Aeronautical Systems Incorporated (GA-ASI) and Northrop Grumman (NG) to participate in an Unmanned Aerial System (UAS) trial over the North West Shelf (NWS) region of Australia, to demonstrate the potential of their Unmanned Aerial Vehicle (UAV)[1] technology towards maritime surveillance. Following initial negotiations with GA-ASI and NG it was determined that there should be (a) a real-world trial involving GA-ASI's proposed Mariner Demonstrator UAS, and (b) a modelling and simulation ('virtual') trial involving NG's Cyber Warfare Integration Network (CWIN) capability that would demonstrate the utility of a Global Hawk based UAS.

This report will provide a public releasable summary of both the real-world and virtual NWS trial activities.

1.2 Aim

The primary aim of the NWS UAS Trial was to demonstrate a joint integrated surveillance capability for the protection of the North West Shelf region.

Additionally, the NWS UAS Trial provided the opportunity to gain an understanding of the technology required to support the acquisition of a multi-mission UAS capability under Defence Project Air 7000 Phase 1. (This Project Phase seeks to acquire High Altitude Long Endurance Unmanned Aerial Systems for maritime patrol and other surveillance).

2. Trials Planning

2.1 Trials organisations

The NWS UAS Trial was controlled and coordinated by the Defence Science and Technology Organisation (DSTO). Funding of the trial came from the Capability Development Executive (CDE) Project AIR7000.

The planning and conduct of the NWS trial involved a number of DSTO Divisions and included support in the areas of air vehicle technology, sensor performance, satellite communications, surveillance information exploitation and management systems.

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[1] It has become common to use the term "UAV" to refer to the air vehicle, and the term "UAS" to refer to the broader system that includes the air vehicle, the ground control element and the communications links that connect them.

The NWS UAS Trial also involved numerous parts of Defence including elements of the Royal Australian Air Force (RAAF), Royal Australian Navy (RAN) and Australian Army. Other agencies involved included Border Protection Command (BPC). Details of their particular involvement in the trial are provided in relevant sections below.

2.2 Trial Objectives

Government policy direction (Reference A) provided the following objectives for the NWS Trial:

- 'assess the maritime surveillance potential of these UAVs and their ability to operate with the [Armidale Class] Patrol Boats as a contribution to protecting the NWS and other maritime environments'; and
- 'provide data to support the acquisition of a multi-mission unmanned aerial vehicle under Project AIR 7000 Phase 1.'

2.3 Key Issues

As part of the development of trial plans, the above broad objectives were transformed in to three Critical Operational Issues (COI) that were to be addressed by the trial:

- **COI #1: Surveillance Capability.** What is the capability of the UAS to perform maritime surveillance in support of protection of the NWS?
- **COI #2: Response Capability.** What is the capability of the UAS to operate supported by, or in support of, the Armidale Class Patrol Boat (ACPB) to mount an effective and timely response to a detected or suspected threat of transgression?
- **COI #3: Australian Environment.** Is the UAS able to operate remotely in the Australian climatic, regulatory, information, geographic and logistics environment?

3. The General Atomics Mariner Demonstrator Trial Activity

3.1 The GA-ASI Mariner UAS

The Mariner Demonstrator air vehicle is pictured in Figure 1. It shows the air vehicle modified with the inclusion of a fairing under the fuselage to accommodate the antenna of the maritime radar system[2]. The air vehicle is designed to provide a long endurance, high altitude (maximum ceiling approximately 50,000 ft) capability that could demonstrate the capacity to conduct maritime surveillance and reconnaissance as well as support land/littoral surveillance and reconnaissance missions. The aircraft wing span was 20 m, and the fuselage was 11 m long. The air vehicle employed retractable tricycle landing gear, and was powered

[2] The maritime radar was a model EL/M 2022A (V) 3 produced by Elta Systems Ltd

by a rear mounted turboprop engine. The air vehicle carries sensor systems including a radar and an electro-optic / infrared (EO/IR) camera system.

The radar system provided a series of different modes of operation (tailored to various maritime surveillance tasks) that could be selected by the crew at any time during a mission. These radar modes were used to enable the UAS crew to detect, track, and classify maritime contacts of interest[3].

The air vehicle also carried a Wescam M20 electro-optic camera system that could provide colour, black and white, and infrared video imagery of contacts of interest.

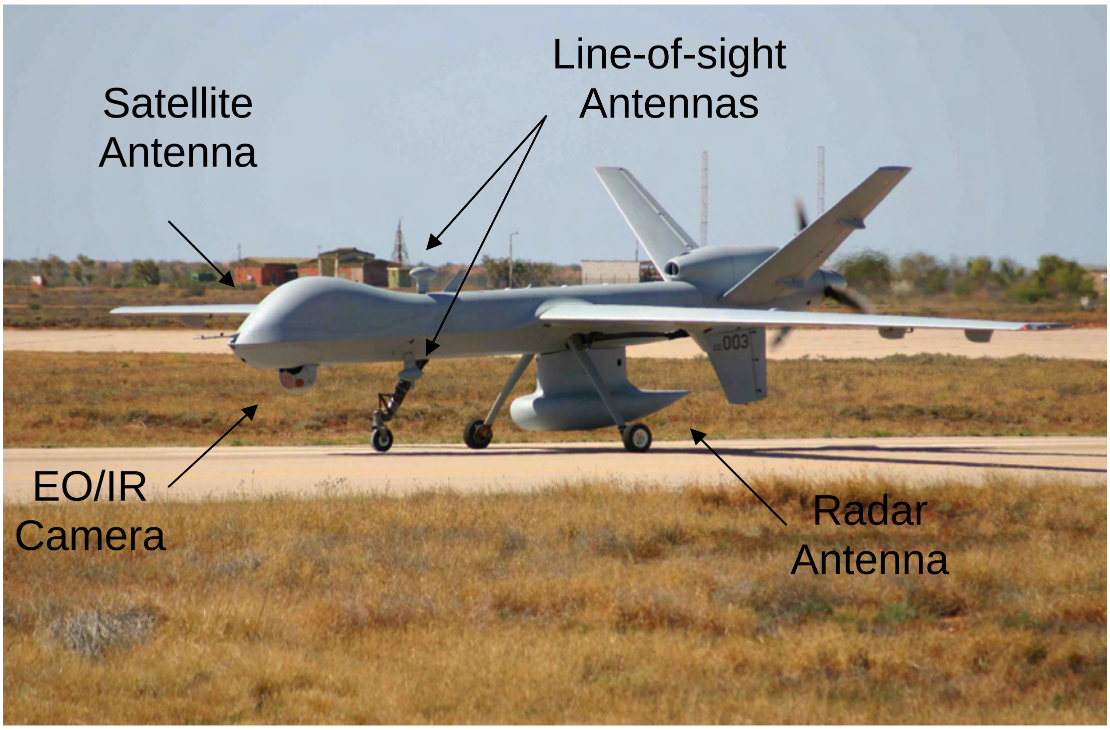

Figure 1: GA-ASI Mariner Demonstrator

Data from these sensors could be transmitted in real time to operators located in a ground control station using either a Satellite Communications (SATCOM) link (the satellite dish is located in the nose of the air vehicle under the bulge in the fuselage), or line of sight (LOS) antennas (used when the air vehicle is in line of sight and sufficiently close to a ground station).

The GA-ASI Ground Control Station (GCS) (Figure 2) had two main functions: (a) a facility for a pilot to command and control, and receive feedback for local LOS and the remote operation of the air vehicle, and (b) a facility for a Sensor Operator to control the operation of the sensor payloads and receive sensor data for display and interpretation. During the NWS Trial the GCS was located at RAAF Edinburgh.

[3] Contacts of interest could range from small fishing boasts to large commercial shipping

Figure 2: GA-ASI GCS consoles

For sorties flown from RAAF Learmonth, a GA-ASI Modular GCS was employed to control the air vehicle during launch and recovery, with the LOS antennas being used to support communication between the air vehicle and the ground. For other phases of the sortie, control was transferred to the GCS located at RAAF Edinburgh, with a satellite communications link (Figure 3) being used to link the air vehicle to the GCS at RAAF Edinburgh.

Figure 3: Ku-Band SATCOM antenna at RAAF Edinburgh (portable backup antenna also shown)

3.2 General Trial Construct – Mariner Demonstration

Figure 4 illustrates the general trial construct. The NWS trial area of operations is outlined in red. The location of RAAF Learmonth is indicated within the NWS trials area. The satellite communications link between the air vehicle (in the NWS region) and RAAF Edinburgh is indicated by the dashed line.

The GA-ASI UAS demonstration also involved other systems beyond those that made up the Mariner UAS. A series of Command Control and Communications and Intelligence (C3I) "nodes" were linked into the trial construct as illustrated in Figure 4. At RAAF Edinburgh the GA-ASI GCS was interfaced to Defence information systems within a transportable building (denoted the NWS Australian Ground Environment – NWS AGE).

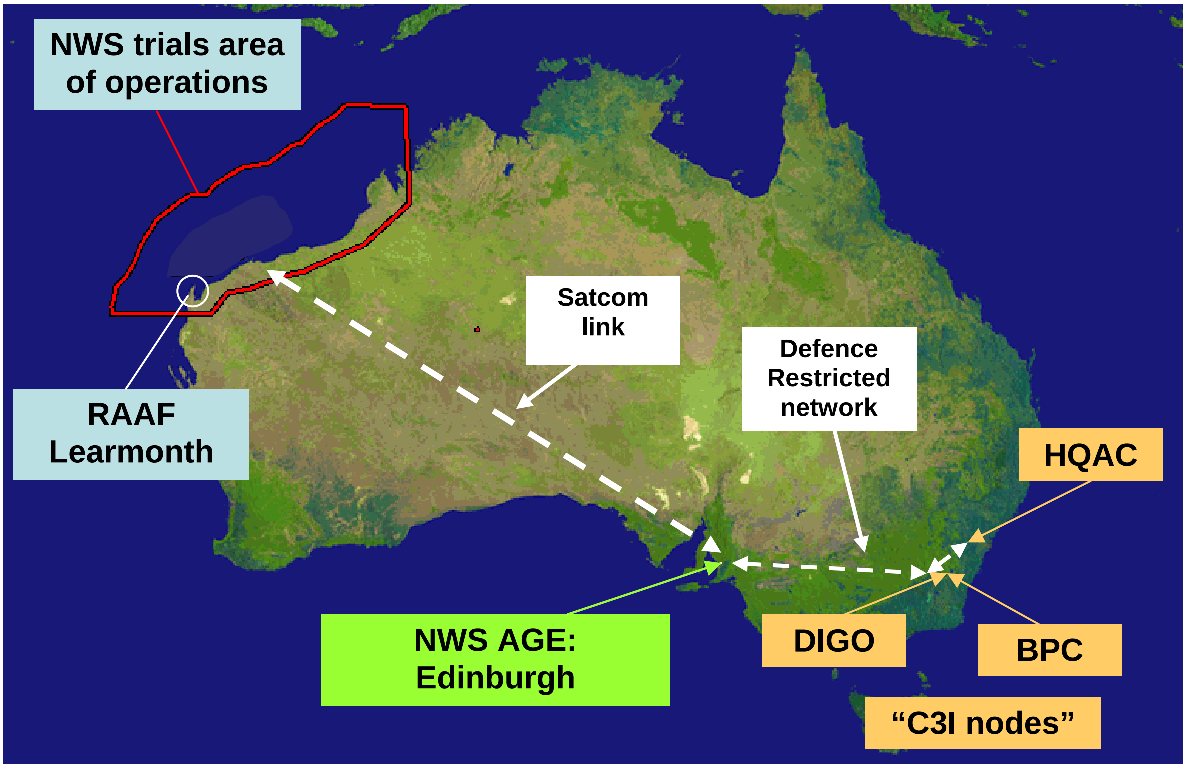

Figure 4: General trial construct.

The NWS AGE (Figure 5) provided a means for the sensor and air vehicle data to be extracted from the GA-ASI GCS, and hence permit a RAAF UAS crew to undertake Mission Command and to also support the mission by exploiting sensor data and generating surveillance reports. A suite of software and hardware was assembled for the trial to support the above functions. These included software applications from General Dynamics and Mediaware that provided a means for the distributed crew (at RAAF Edinburgh and the C3I nodes) to share surveillance reports and examine and manipulate video imagery from the air vehicle in near real time.

Figure 5: NWS AGE: illustrating Commonwealth workstations (the row of terminals closer to camera) and the GA-ASI GCS consoles at rear

The surveillance data and reports available to the RAAF UAS crew at RAAF Edinburgh was also made available to HQAC, DIGO and BPC C3I nodes located at Headquarters Air Command (HQAC) located at RAAF Glenbrook, the Defence Imagery and Geospatial Organisation (DIGO), and Border Protection Command (BPC), both located in Canberra. These nodes provided the ability for staff at these locations to see sensor data from the air vehicle in near real time, along with the surveillance reports generated by the RAAF crew at RAAF Edinburgh. In addition, staff at DIGO could also undertake sensor data exploitation and contribute to the generation of surveillance reports. The data was transferred between RAAF Edinburgh and these nodes using the Defence Restricted communications network.

The final element of the NWS trial construct was HMAS PIRIE (Figure 6) that operated in the NWS region during the trial. HMAS PIRIE was equipped with a Remote Video Terminal (RVT) that could be used to receive video imagery directly from the air vehicle when it was within line of sight and sufficiently close. This enabled, for example, the patrol boat crew to see airborne imagery of a contact of interest as they approached it, and before they commenced boarding operations.

The characteristics of the above "distributed construct" reflect the principles of Australia's Future Warfighting Concept that are, in turn, based on a Network Centric Warfare approach.

Figure 6: HMAS PIRIE

3.3 Flying program – Mariner Demonstration

3.3.1 Airworthiness and Airspace Management

The GA-ASI Mariner Demonstrator was operated in Australia as a state aircraft[4]. Extensive operational and technical analysis was conducted as part of the issuing of a Special Flight Permit (SFP) by the Australian Defence Force Airworthiness Authority. This permitted the air vehicle to operate in Australian airspace. Air traffic management for the air vehicle was addressed through an Air Traffic Management Plan. Extensive discussions were undertaken during the planning phase of the trial (including involvement of Air Services Australia and aircraft operators) to ensure that a suitable set of airspace management procedures were developed to support the flying program.

3.3.2 NWS Trial flights

The flying programme for the GA-ASI Mariner Demonstrator Trial activity began with two shakedown/test flights out of RAAF Edinburgh, before proceeding to RAAF Learmonth for five NWS based sorties. A list of sorties is provided in Table 1.

[4] This meant that the Department of Defence held the responsibility for all airworthiness aspects

Table 1: Schedule of NWS Trial flights.

Date	Location	Trial Sortie
28 August 2006	RAAF Edinburgh	Functional Check-Out Flight
30 August 2006	RAAF Edinburgh	Functional Demonstration and Acceptance Test Flight
05 September 2006	RAAF Edinburgh	Transit Edinburgh-Learmonth Flight
08 September 2006	RAAF Learmonth	Familiarisation Flight
09 September 2006	RAAF Learmonth	Barrier Surveillance Flight.
11 September 2006	RAAF Learmonth	Relocate Critical Contact Of Interest
13 September 2006	RAAF Learmonth	Low Level Surveillance Flight
15-16 September 2006	RAAF Learmonth	High-Low Surveillance Flight
25 September 2006	RAAF Learmonth	Transit Learmonth-Edinburgh Flight

The first flight comprised a series of initial flight tests following the reassembly of the air vehicle after its arrival in Australia to confirm aircraft airworthiness and operation. The second flight addressed a variety of system performance and employment tests designed to characterise the UAS before the Mariner transited to RAAF Learmonth for the flights to be flown in the NWS region.

The five RAAF Learmonth flights involved a range of surveillance related activities including the employment of the UAS to:

- Perform maritime surveillance in a 240 nautical mile by 150 nautical mile search box in the NWS region.
- Provide a persistent maritime surveillance capability (during a greater than 22 hour sortie).
- Undertake a number of altitude excursions during a sortie to permit the collection of close-up imagery of contacts of interest when required.
- Detect, classify and identify a number of maritime contacts of interest.
- handover the role of monitoring of a contact of interest between the UAS and a manned Coastwatch aircraft.
- Vector HMAS PIRIE towards a contact of interest, and provide sensor imagery directly to the HMAS PIRIE, supporting the planning and conduct of their boarding operations.
- Provide sensor imagery directly to elements of the Pilbara Regiment during episodes of land/littoral surveillance activities to assist with the conduct of their response operations.

The Mariner Demonstrator flew a total of 75.5 hours during the NWS UAS Trial. Sorties took place between 28th August and 25th September 2006. This total included the transit flights between RAAF Edinburgh and RAAF Learmonth.

3.4 Outcomes – Mariner Demonstration

During the conduct of the trial a DSTO analysis team undertook a series of data collection and observation activities at the various trial sites including the C3I nodes. Following the trial a comprehensive classified internal Defence report has been completed. Although the details of that report cannot be included in this document, the following section summarises the general outcomes with respect to the critical operational issues.

COI #1, Surveillance Capability:

- The ability of the Mariner Demonstrator UAS to execute various elements of maritime surveillance operations was assessed, with its general performance characteristics being determined.
- The ability of the GA-ASI UAS to support the geographically split main/forward operating base construct adopted for the trial was successfully demonstrated, where mission control was conducted from RAAF Edinburgh during the sorties.
- The commercial satellite communication coverage and data rate available for the trial demonstration was sufficient for the UAS to conduct its maritime surveillance mission in the specific regions addressed by the NWS trial.
- The C3I construct implemented for the trial was sufficiently well developed to support the trial Concept of Operations, with staff at the C3I nodes being linked in to the mission conduct during the sorties.
- The software tools, mission crew construct and Standard Operating Procedures enabled surveillance reports to be generated during the trial sorties. Data gathered during the trial will also assist the Commonwealth to understand the detailed requirements for such aspects of UAS capabilities to be acquired in the future.
- The trial demonstrated the value of having a well defined set of standard operating procedures to govern interagency interactions, as the Australian Defence Organisation and other Commonwealth agencies continue to move towards future modes of operation that have an increasingly distributed / networked flavour.
- The trial demonstrated that a dedicated MUAS crew was still required to command and control the MUAS platform and for the successful conduct of operations. However, locating the pilots and mission crew on the ground, rather than in an aircraft, significantly reduced the effects of fatigue in long endurance sorties. The potential use of the ground environment to support a wider range of training and crew familiarisation functions was also noted during the trial.

COI #2, Response Capability:

- The UAS demonstrated an ability to monitor and shadow contacts of interest, and vector HMAS PIRIE towards a target of interest.
- The ability to supply sensor imagery directly from the air vehicle to HMAS PIRIE and to the Pilbara Regiment was demonstrated, with the benefits to their response operations being identified.
- The use of the UAV on-board VHF radio to support communications between the NWS AGE and HMAS PIRIE was demonstrated, enabling better coordination of the supply of suitable imagery from the air vehicle to the patrol boat.

COI #3, Australian Environment:

- The UAS successfully completed the trial flying program.

- The air vehicle flew as a State military aircraft in military and civilian airspace as detailed in the Special Flight Permit.
- The trial provided a means for the Commonwealth to gain further significant experience regarding the undertaking of unmanned flying operations.
- The UAS worked well with the commercial satellite communications service provided for the trial.
- The trial provided an indication of the level of effort and technical challenges associated with establishing a distributed ground environment construct, and integrating specific data feeds from a UAS.
- The impact of weather was assessed throughout the various trial flights, with the UAS crew being able to investigate options for overcoming weather related impacts on the conduct of the mission (this included changing altitude or stand-off range from the contact-of-interest as required).

3.5 Conclusions – Mariner Demonstration

In summary, this element of the NWS Trial provided a demonstration of the extent to which UAS technology could contribute to protection of the NWS region through providing a maritime surveillance capability. The GA UAS successfully completed its flying program, including the demonstration of the conduct of an endurance sortie of greater than 22 hours duration. The real-life trials of operating an actual UAS directly in the Australian and NWS environment provided considerable benefits to the demonstration. The trial also enabled the Commonwealth to investigate and demonstrate how a UAS could contribute along with an ACPB, maritime surveillance aircraft and Army units to provide a surveillance and response capability in this area. The GA UAS was successfully integrated into the Defence ground environment construct that was developed for this trial, linking a series of "C3I nodes" together during the conduct of each sortie. The trial helped advance the understanding of a broad range of system performance and command and control issues that will, in turn, inform the Commonwealth's future consideration of UAS operations and technology.

4. The Northrop Grumman Cyber Warfare Integration Network Trial Activity

4.1 The Northrop Grumman Global Hawk UAS

Due to the current level of operational requirement for Global Hawk UASs, there was not an opportunity to undertake the NWS real-world trial activity with this particular type of UAS. It was therefore decided to demonstrate the ability of a Global Hawk-based UAS to contribute to the protection of the NWS region via a modelling and simulation based 'virtual' trial activity. (Note that the Commonwealth undertook an investigation of the utility of a Global Hawk UAS in a real-world demonstration activity in 2001).

Figure 7: Global Hawk air vehicle

An illustration of a Global Hawk air vehicle is shown in Figure 7. The RQ-4B Global Hawk UAS represented in the CWIN simulation was equipped with a maritime radar and electro-optic camera system along with other sensor systems that would support maritime surveillance operations. The CWIN simulation also represented a commercial satellite communications link that permitted the transmission of air vehicle and sensor data to a ground control station in real time. The ground control station element of the Global Hawk UAS that was represented within the CWIN trial activity included pilot, mission commander and sensor operator workstations that were manned by "Human-in-the-Loop" RAAF operators.

4.2 Northrop Grumman Cyber Warfare Integration Network

The Cyber Warfare Integration Network (CWIN) facility in San Diego, California (Figure 8) enables Human-in-the-Loop experimentation in a system of independent but fully integrated models representing the UAS air vehicle sensors and systems. This Human-in-the-Loop capability permits human operators to interact in real time with the simulation as it runs. The simulation experiment designer can select what functions and inputs are required to be addressed by human operators within the specified simulation activity.

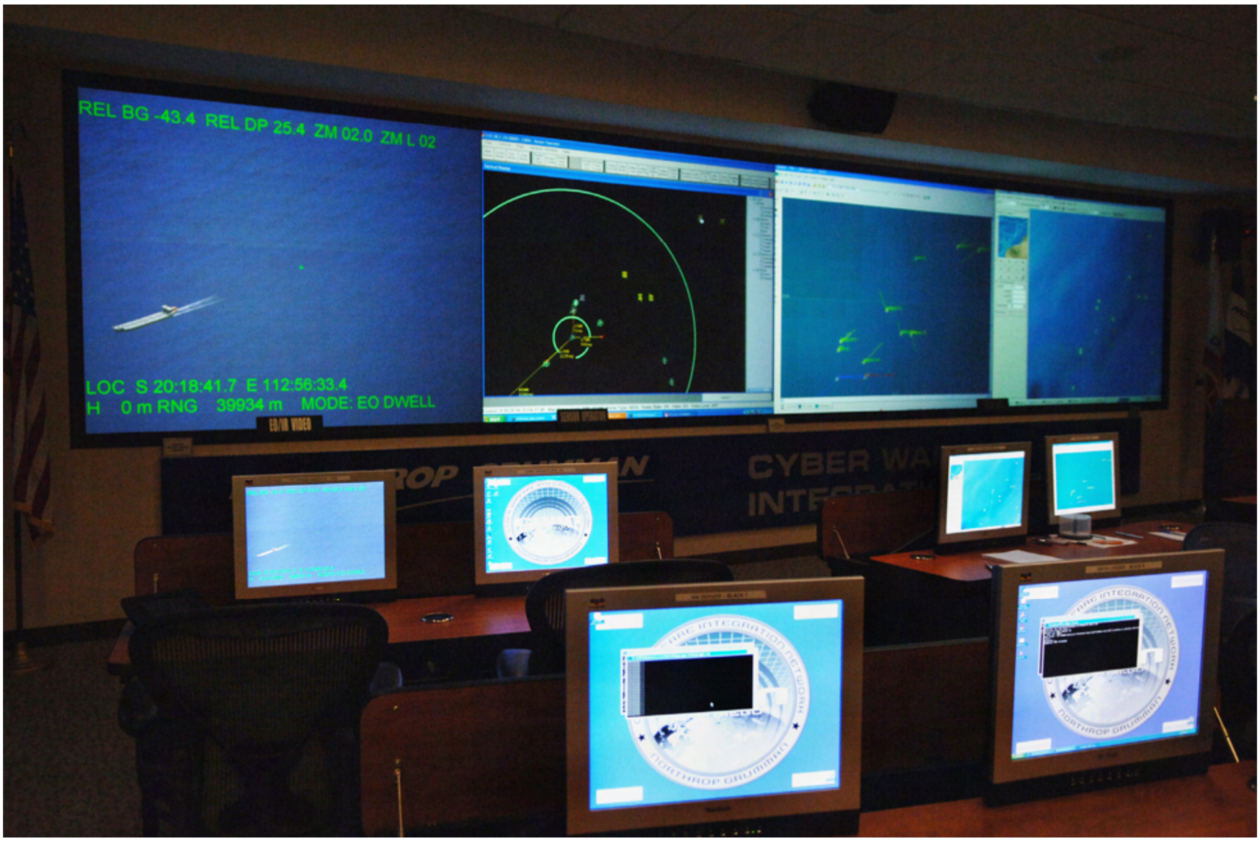

Figure 8: Inside the CWIN facility

Among the system and scenario elements modelled within CWIN are:

- Air vehicle flight performance.
- Communications models representing various communications links and communications related utilities including satellite communications and direct line of sight links.
- A radar sensor model that addresses maritime surveillance radar performance.
- An electro-optic camera sensor model that estimates target detection and classification performance.
- Maritime targets including neutral and hostile contacts of interest.
- Relevant elements of NWS region infrastructure.
- Environmental aspects including sea state and weather effects (including cloud cover)

Two specific UAS operator workstations were constructed to support the Human-in-the-Loop aspects of the CWIN activity. These comprised "Mission Commander" and "Sensor Operator" workstations, akin to those included in the real-world trial, and hence provided a "virtual" ground control station. In the CWIN activity, RAAF operators manned these workstations during simulated sorties in a similar fashion to that observed in the real-world trial.

Two main sets of human players were involved in the conduct of CWIN simulations: the "White Cell" and "Blue Cell".

The White Cell consisted of four staff who provided overall control of the simulation scenario and ensured that each simulation serial ran according to plan. They were also responsible for ensuring that sufficient appropriate data had been captured following each simulation run, or whether scenarios were to be altered or repeated.

The Blue Cell consisted of two RAAF operators who undertook the roles of Mission Commander and Sensor Operator at the operator workstations (Figure 9).

Figure 9: Blue Cell and analyst personnel at CWIN

Two other groups were involved in the conduct of the CWIN trial.

A Defence analysis team provided assistance with data capture and analysis for each simulation serial. They were responsible for auditing the simulation process and assessing the validity of the results. Part of the analysis team comprised human factors analysts who undertook observations of the RAAF operators during the simulation runs, and hence were able to investigate a range of workload and operator workstation suitability issues.

A Northrop Grumman CWIN simulation team were involved with the detailed preparation and operation of the simulation and modelling environment associated with each serial.

4.3 General Trial Construct – CWIN

The general construct for the virtual trial was similar to that in the real world trial activity, with both a UAS and ACPB represented within the simulation runs. The major difference was that the Commonwealth information system elements (NWS AGE, C3I nodes and Defence Restricted network links) were not explicitly modelled. However the influence from these latter elements was handled by the White Cell applying suitable scenario control.

The scenarios used were of a similar nature to the real-world trial activity, involving a range of maritime surveillance and response mission elements. The CWIN simulation environment provided flexibility for the characteristics of certain system elements (eg the radar) or scenario conditions (eg the amount of cloud cover) to be varied to support the overall objectives of the investigation.

The Critical Operation Issues employed to govern the overall scope of the simulation activity were the same as used for the real-world trial.

The overall simulation program was designed to make suitable use of the various CWIN models. The limitations associated with model validation were considered as part of this program development. The program was structured not to focus on high fidelity sensor performance, but rather on the investigation of the broader employment options related to the UAS and the other force elements such as the ACPB.

4.4 Simulation Program - CWIN

As part of the preparations for the trial, the CWIN environment underwent further development by Northrop Grumman over a period of approximately seven months to address the requirements of the NWS Trial. In that time models were tailored to include the maritime surveillance aspects of a Global Hawk UAS, and develop appropriate scenario details such as the distribution of shipping traffic in the region and typical weather conditions found in that area.

Following the above simulation development, a series of simulation runs were undertaken over a ten day period in October 2006. Table 2 lists the simulation runs and the associated general objective or activity.

Table 2: CWIN simulation serials

Simulation Serial	Serial Description / objective
1	Familiarisation and calibration
2	Classify all maritime targets in primary area of operation
3	Detect, classify and identify all maritime targets of a specified type
4	Demonstrate protection of NWS infrastructure
5	Investigate particular radar performance issues
6	Address all targets of a specified type
7	Maintenance of a surveillance picture
8	Conduct of a surveillance barrier patrol
9	Conduct of a surveillance barrier patrol
10	Conduct of a surveillance barrier patrol
11	Investigation of radar sensor options
12	Conduct maritime surveillance operations at night
13	Conduct surveillance barrier patrol in poor weather conditions
14	Conduct broad area surveillance
15	Conduct broad area surveillance at night
16	Conduct broad area surveillance with poorer weather conditions
17	Conduct focal area surveillance over a reduced area

The above simulation serials provided a means to demonstrate how a Global Hawk-based UAS might be used to undertake a range of maritime surveillance tasks within the NWS region including:

- Performing general surveillance operations within the NWS area of operations, where the objective was to find a particular vessel of interest.
- Undertaking systematic surveillance barrier patrol operations aimed at detecting and identifying all vessels that crossed a particular designated boundary line.
- Detection, classification and identification of a number of maritime contacts of interest.
- Interacting with other Commonwealth force elements such as the ACPB.
- Vectoring an ACPB towards a contact of interest, and providing a direct feed of sensor imagery directly to that vessel.
- Undertaking persistent maritime surveillance including operations at night.
- Undertaking a number of altitude excursions during a sortie to permit the collection of close-up imagery of contacts of interest as required.

4.5 Outcomes - CWIN

COI #1, Surveillance Capability:

- The ability of the Global Hawk UAS to execute various elements of maritime surveillance operations was assessed, with its general performance characteristics being determined.

- The ability of the Global Hawk UAS to detect, classify and identify maritime targets of various sizes was assessed, with the Mission Commander being able to investigate how best to utilise the various sensor payloads carried by the air vehicle for these specific tasks.
- The area coverage capability of the UAS was assessed during each simulation run, with an analysis of how this varied with scenario conditions.
- The extent to which the operator workstations developed for the purpose of the trial were able to meet the mission requirements of the Mission Commander and Sensor Operator were assessed. This activity has provided the Commonwealth with a more detailed insight into the requirements for such system elements within UAS capabilities to be acquired in the future.
- A significant amount of data on the flight performance characteristics of the air vehicle were captured during the trial. This will assist the Commonwealth to extend its consideration of such UAS capabilities beyond the scenarios addressed in the NWS Trial.

COI #2, Response Capability:

- The Global Hawk UAS was used to cue the ACPB in a number of simulation serials
- Tools and processes for supporting the coordination between the UAS and the ACPB were assessed, with the trial illustrating that they could support the interaction between these assets.
- The benefits resulting from the ability to transfer sensor information from the UAS to the ACPB were demonstrated, with imagery being provided that could support boarding operations as in the real-world trial.
- During particular phases of simulation runs the Mission Commander successfully demonstrated the ability to interact with the ACPB whilst continuing to support the ongoing surveillance task.

COI #3, Australian Environment:

- The ability to conduct surveillance operations against typical contacts of interest pertaining to the NWS region was demonstrated during the trial. The ability to undertake surveillance against various contact densities was also assessed.
- The impact on surveillance operations in the NWS region resulting from poorer weather and sea state conditions was investigated (note that this investigation included impacts on both sensor performance and communications link performance). As with the real world trial, the UAS crew investigated approaches to overcome such effects.
- The ability to utilise available satellite communications bandwidth was investigated as part of the simulation runs. Techniques directed at improving the utilisation of available bandwidth were investigated, demonstrating how an improved flow of sensor information from the air vehicle could be achieved.

4.6 Conclusions - CWIN

The benefits of being able to conduct a large scale simulation to assess UAS operations under varied weather conditions, under complex threat conditions, and with the freedom to explore a wider range of situations and conditions were considerable. In particular, the virtual trial provided an opportunity for rapid exploration of new tactics and procedures in a wide range of scenarios and environmental conditions. Additionally, this type of activity was not impacted by some of the overheads associated with real-world aviation operations (for example, logistic support requirements, or transit time to trials area of operations). However, these considerations are always part of the complex mix required to deliver real-world capability.

The virtual trial provided insights into some particular system issues (for example, options for employment of the satellite communications link, or the functionality provided by the operator workstations) as well as on issues related to the more general UAS concept of operations. The Human-in-the-Loop aspect of the simulation activity provided an opportunity for current military maritime patrol and attack operators who had been involved in the real-world trial activity to bring that experience to bear within the CWIN virtual trial activity. This enabled these operators to rapidly refine the employment concepts during early phases of the simulation activity.

5. Conclusions

The two elements of the NWS Trial both successfully demonstrated the extent to which UAS technology could contribute towards protection of the NWS region. Each trial activity was tailored to address the primary trial objectives and COIs, with the involvement of military and civilian organisations and operators adding to the range of lessons and issues that were identified. Both activities will inform future Commonwealth consideration of UAS technology to maritime surveillance operations.

It should also be noted that the real world and virtual trial approaches each had their separate strengths. However, as understood when a decision was made to pursue a combined real world and virtual trial approach, the differences between the two trial approaches preclude a direct and detailed comparison between the systems.

The real world activity provided an excellent opportunity to gain direct experience on supporting and employing a UAS of this general type within Australia. The Commonwealth agencies who were involved in the planning and preparation for the trial have improved their understanding of the operation and utility of this type of capability. DSTO has gained significant insight into a range of issues associated with the technical performance, capability effectiveness and design of distributed system constructs.

The virtual trial activity permitted a range of scenario issues not encountered in the real world trial to be explored in a more comprehensive fashion, and allowed more straightforward revisit to situations that needed further investigation. These same simulation tools could permit similar considerations of UAS capabilities to be extended in the future to address other situations.

The internal Defence reports that have been prepared following the trial document in more detail how UAS such as Global Hawk and the Mariner Demonstrator can be used to contribute towards protection of the NWS region.

6. References

A. Coalition Government Election 2004 Policy: Securing Australia's North-West Shelf

DISTRIBUTION LIST*

North West Shelf Unmanned Aerial System Trial

Duncan Craig

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2. TITLE	3. SECURITY CLASSIFICATION (FOR UNCLASSIFIED REPORTS THAT ARE LIMITED RELEASE USE (L) NEXT TO DOCUMENT CLASSIFICATION)
North West Shelf Unmanned Aerial System Trial	Document (U) Title (U) Abstract (U)
4. AUTHOR(S)	5. CORPORATE AUTHOR
Duncan Craig	DSTO Defence Science and Technology Organisation PO Box 1500 Edinburgh South Australia 5111 Australia

6a. DSTO NUMBER	6b. AR NUMBER	6c. TYPE OF REPORT	7. DOCUMENT DATE
DSTO-TR-1958	AR- 013-853	Technical Report	February 2007

8. FILE NUMBER	9. TASK NUMBER	10. TASK SPONSOR	11. NO. OF PAGES	12. NO. OF REFERENCES
	JTW05/260	DGAD	18	1

13. URL on the World Wide Web	14. RELEASE AUTHORITY
http://www.dsto.defence.gov.au/corporate/reports/DSTO-TR-1958.pdf	Chief, Intelligence, Surveillance and Reconnaissance Division

15. SECONDARY RELEASE STATEMENT OF THIS DOCUMENT

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Umanned aerial vehicles, Mariner

19. ABSTRACT

In response to a government policy announcement issued during the lead-up to the 2004 federal election, Defence undertook two demonstrations of the application of Unmanned Aerial Systems (UAS) technology to the protection of the North West Shelf region. A real world trial took place in August-September 2006, involving the General Atomics Aeronautical Systems Incorporated Mariner Demonstrator UAS. A modelling and simulation based trial involving Northrop Grumman's Cyber Warfare Integration Network (CWIN) facility took place in October 2006, with a Global Hawk-based UAS being represented within the simulation environment. This report provides a public releasable summary of these two activities.

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