The Electronic Warfare Self Protection Ground Systems of Project Echidna, AIR 5416, Phase 2A.

Dr Derek Rogers

Product Development Manager,
BAE Systems Australia Pty Ltd

Adjunct Senior Lecturer,
Department of Electrical and Electronic Engineering,
University of Adelaide, South Australia.

Abstract

Project AIR 5416, commonly known as Project Echidna, provides Electronic Warfare Self Protection (EWSP) to various aircraft platforms. Phase 2A of Project Echidna applies to the Chinook and Blackhawk Helicopters. The project involves development of a Common Electronic Warfare Self Protection (CEWSP) Suite, aircraft installation and structures design and modification, along with the development of Ground Support and Training Systems. Ground Systems are a crucial component in the EWSP capability provided because they:

i) Develop and verify the EWSP programs that function on the aircraft EWSP system;
ii) Provide pre-flight planning and post-mission analysis; and
iii) Provide procedural training on the EWSP system and its maintenance.

This paper provides an outline of the Project Echidna Phase 2A including the Chinook Rapid Acquisition and Blackhawk Interim activities. The paper discusses the high-level aims and objectives of Project Echidna Phase 2A, the Chinook Rapid Acquisition and Blackhawk Interim EWSP systems and the progression towards the Common EWSP System (CEWSP) for the Chinook and Black Hawk helicopters focussing on the Ground System components.

1 Introduction

As reported by media release and on the Defence Material Organisation (DMO) website, reference [1], on the 16th February 2005, the then Defence Minister, Senator Robert Hill announced the awarding of a $135.5 million contract for Project Echidna, Phase 2A, to BAE Systems for the design, development, integration and installation of an Electronic Warfare Self Protection (EWSP) capability for the Army's fleets of Black Hawk and Chinook aircraft. The website also indicates that Project Echidna will improve the survivability of aircraft in combat and in addition to the modified aircraft: "*Project Echidna will introduce a comprehensive EW mission support system and provide modifications to the applicable simulators and other support systems necessary to fulfil operational and training requirements*."

The website highlights that the aims of Project Echidna include:

- *"Maximising equipment commonality across aircraft types;*
- *Minimising through-life support costs;*
- *Minimising project overheads and schedule; and*
- *Maximising quality Australian Industry Involvement (AII), including the introduction of an indigenous EW capability, the ALR-2002."*

These aims are consistent with a key principle of Australia's military capability – self reliance, as discussed in reference [2], the Defence White Paper of 2000 and as the vision as embodied in the Operational Concept Document (OCD), for Project AIR 5416, reference [3], states: "*The centrepiece of ADO EWSP self reliance is Project AIR 5416 Echidna. This vital project impacts all aspects of the self-reliance capability and seeks to equip ADF aircraft with EWSP systems (equipment, people, data, infrastructure) to maintain a capability effective against existing and evolving regional threats to air operations. Self-reliance in the Echidna context also includes the development and maintenance of Australian industry to undertake a range of through life support activities to maintain EWSP systems."*

Echidna Phase 2A is a System-Of-Systems (SOS) comprising:

i) An Integrated Electronic Warfare Mission Support System (IEWMSS) to allow in-country modification and adaptation of EWSP System software and EW Support Packages for Echidna Modified Aircraft;

ii) An EW Data Transfer System (EW DTS), which will use the Defence Communications Network (DCN) to provide (in part) a near real-time secure data communications capability to transfer EW Support Packages from the IEWMSS to Echidna Modified Aircraft home bases and deployed units, and EWSP System Logs from bases and deployed units to the IEWMSS;

iii) An EW Mission Data System (EWMDS) to enable aircrew to develop in-aircraft training scenarios (Training Data Files) for up-load to each Modified Aircraft and aircraft simulator, and subsequently to debrief and playback to aircrew the EWSP aspects of a mission or in-aircraft training session;

iv) The S-70A-9 Black Hawk simulator modified with simulated EWSP to emulate the functions and behaviour of the parent aircraft's EWSP system;

v) The S-70A-9 EWSP System and CH-47D EWSP System incorporating a configuration of the Echidna Common EWSP Suite Architecture and having sensors, effectors, EW Control, Data and Event Recording and Human Machine Interface (HMI) for each aircraft type; and

vi) Training elements including a Part Task Trainer (PTT) for procedural training.

The Echidna Phase 2A systems form a closed-loop operational environment as show in Figure 1 linking mission planning to the mission flight to debrief, for a cycle of continuous improvement and system improvement.

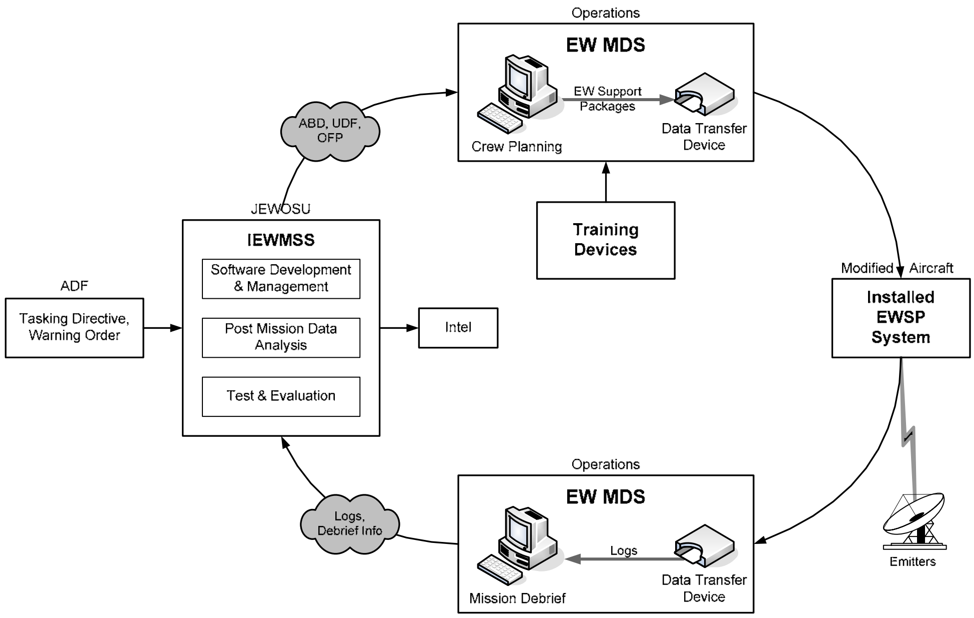

Figure 1: The Echidna Phase 2A closed loop operational environment

The various components of this figure are discussed in this paper with the next section outlining the Installed EWSP System, also known as the Common EWSP Suite (CEWSP).

2 Phase 2A – Common EWSP Suite

Echidna Phase 2A will offer significant enhancement to aircrew with the use of a Common EWSP Suite (CEWSP) that integrates the ALR 2002 Radar Warning Receiver (RWR) with the Vicon 78 Countermeasures Dispensing System (CMDS) and EADS MILDS Missile Warning Receiver (MWR) systems. The Common EWSP Suite also has the potential to integrate other Electronic Warfare (EW) components such as Laser Warning Receiver (LWR), Directed Infrared Countermeasures (DIRCM), Active Radio Frequency (RF) Countermeasures and a Towed Decoy, for example.

In Echidna Phase 2A the CEWSP includes in addition to the CMDS, RWR and MWR:

- EW Suite Controller Processor (EWCP)
- EWC Control Panel (CP),
- EWC Support Panel (SP),
- Safing Unit (SFU), and
- EWC Primary Display (EPD).

The EW Controller Processor (EWCP) consists of a hardware processor, software and interfaces to the various EWSP equipment, host aircraft avionics, communication, and control and display subsystems. The EW Controller:

- Integrates the control and display interfaces of the EWSP functions and adapts to the cockpit and symbology requirements of the various Echidna Modified Aircraft;
- Coordinates countermeasure responses of the EWSP functions that might interfere with or degrade the overall effectiveness;
- Has the capability to associate emitter reports from the various EWSP sensor functions, identify the type of threat and determine the most appropriate countermeasure response;
- Requests and receives equipment status from the EWSP functions and reports it to the Modified Aircraft crew. Threat responses may also change as the result of degraded or faulty equipment operation.

Sensor outputs from the MWR and RWR are reported to the EW Controller, where a situation awareness display is formatted and presented to the crew in the cockpit. The EW Controller hardware is provided by GE Fanuc (previously SBS) with software licensed from SELEX and modified under license by BAE Systems Australia.

The EWC Control Panel (CP) has the dual purpose of a power panel and a control panel. In the capacity of a power panel, the CP enables or disables power to the other EWSP components. In the capacity of a control panel, the CP allows an operator (pilot or co-pilot of the aircraft) to control the system, for example, to select the nature of countermeasures response, initiate emergency jettison or Zeroise the system.

The EWC Support Panel (SP) is the mechanism for uploading Operational Flight Programs (OFP), User Data Files (UDF) or Training Data Files (TDF) to the EWCP and downloading EWSP Suite Logs after the mission.

The purpose of the Safing Unit (SFU) is to avoid inadvertent and undesirable dispense of chaff or flares that would pose a safety hazard.

Finally, the EWC Primary Display runs Human Machine Interface (HMI) software developed by BAE Systems Australia using a series of Human Engineering Working Groups (HEWGs) with defence force personnel.

As of the time of writing, the first build of software for the EWCP was in the integration laboratory and successfully showed integration of a prototype Control Panel, prototype Safing Unit, prototype EPD, MWR and CMDS allowing missile threats to be detected, displayed to aircrew and countermeasures initiated. Work was also proceeding on the second build of the software to include the RWR and embedded training functionality. Coding of the second build is expected to complete prior to paper publication. There has also been early integration of the Training Data File Generator (TDFG) capability of the Mission Data System (MDS) with the embedded training functionality, showing the successful read of a Training Data File (TDF) and display of training threats on the HMI display.

3 The Echidna 'Program'

Echidna Phase 2A is a complex systems engineering project and like all such projects faces its challenges. Operational needs of the commonwealth have also necessitated early solutions including:

- Chinook Rapid Acquisition; and
- Blackhawk Interim.

Each of these activities is discussed in a section below. However, it is important to recognise the synergies between these programs and Phase 2A.

3.1 *Chinook Rapid Acquisition*

With the deployment of the Chinook helicopters to Afghanistan, on the 30th of November 2005, the Australian Government initiated a $25 million upgrade to the helicopters as part of a rapid acquisition project. The modifications included integrating the AAR-60 Missile Warning Receiver; day head up display and Countermeasures Dispensing System (CMDS) as part of the Electronic Warfare (EW) upgrades.

Additional weaponry, other ballistic protection and advanced secure communications were also added as reported on the DMO website, reference [4]. The website also notes that the Echidna Phase 2A Program Office "*had to implement innovative contracting methods, establishing a semi contract with BAE Systems attached to the broader Echidna 2A Prime Contract with that company in order to fast track electronic warfare upgrades* …".

There were no new Ground System components including pre-flight planning, post mission analysis or training devices with the Chinook Rapid Acquisition Project. Nonetheless the Chinook Rapid Acquisition project did leverage some of the Phase 2A structures work and provide a good test of aircraft installation. The Chinook Rapid Acquisition Project received a project management award for the modifications to the aircraft, as reported in reference [5].

3.2 *Black Hawk Interim*

The success of the Chinook Rapid Acquisition system initiated in December 2006 a similar upgrade for the Blackhawk helicopters utilising the Thales Vicon 78 CMDS and EADS MILDS AN/AAR60 MWR system. Unlike the Chinook Rapid Acquisition, the Blackhawk Interim Project also introduced a basic Ground System and significant training material in support of the operation of the Ground System. No new pre-flight planning, post mission analysis or training devices have been introduced. The Ground System as illustrated in the figure below incorporated four CMDS buckets and Integrated Test Magazines (ITMs), a Chaff and Flare Dispenser Control Unit (CFCDU) programmed by the Thales C-CAT software, a number of switches to model aircraft devices such as the Safety Disarm Units (SDU) and BAE Systems designed Firing Sequence Measurement Hardware (FSMH) and associated software for measuring inter-expendable timing of firing sequences that worked with the Thales supplied MIST software associated with the ITMs.

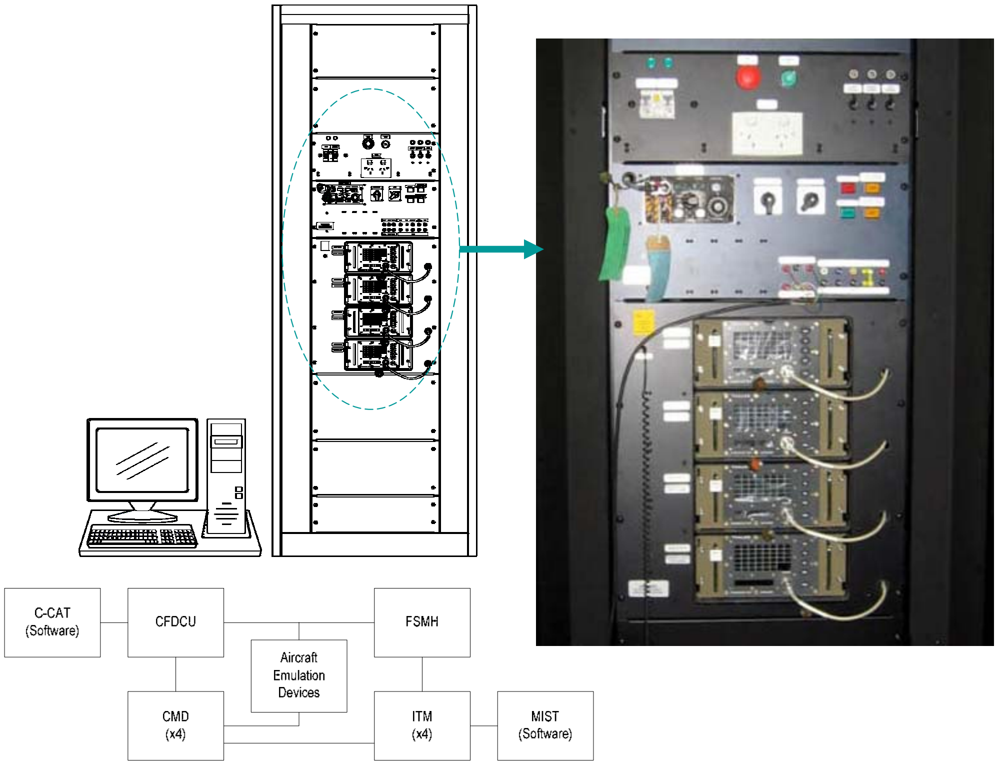

Figure 2: Black Hawk Interim Ground System

The 19-inch rack, power supplies and CMDS panel design were selected to be identical to the Phase 2A design at the time; noting that the Phase 2A CMDS panel design for Phase 2A has since undergone further refinements to offer flexibility with multiple aircraft platforms. The CFCDU is also replaced in Echidna Phase 2A by the Suite Controller. As the time of writing, the Blackhawk Interim Ground System had been installed, providing a good learning opportunity in terms of installation for Phase 2A; the First Article Blackhawk Interim Aircraft was also readying for its first flight test.

3.3 *Phase 2A*

As discussed in an earlier paper by the author, reference [f], the Echidna Ph 2A Ground System comprises three products[1]:

- Integrated Electronic Warfare Mission Support System (IEWMSS),

[1] Echidna 2A also modifies the following existing ground systems: Simulated Aircraft Maintenance Trainer, Maintenance Training Aid, and Full Flight & Mission Simulator. As these are existing systems, they have not been included in this paper.

- Mission Data System (MDS), and
- Part Task Trainer (PTT).

The primary purpose of the IEWMSS is to qualify, using hardware-in-the-loop, EWSP Suite software; Operational Flight Programs (OFP) and User Data Files (UDF). The IEWMSS also provides workflow management of the processes used to produce OFP and UDF, integrating information flow to the maximum extent to reduce data re-entry, minimise errors and reduce cycle time.

The MDS is used by aircrew for pre-flight planning and post-mission analysis. The MDS extends the Pre-Flight Planning Software (PFPS) used by the ADF to handle more complex threats and provide a training mode capability for the EWCP. During a training mission, the EWCP will present threats to aircrew and allow actual or simulated countermeasures responses as appropriate. This training mode can be used anywhere with the inherent advantages over an expensive and restricted dedicated EW training range.

The Part Task Trainer (PTT) is a training tool for familiarisation and procedural training of aircrew on the operation of the EWC Control Panel, EWC Primary Display and Human Machine Interface software. The PTT is a composite of components from the MDS and EW Controller software.

3.3.1 IEWMSS

To contrast the complexity of the Blackhawk Interim Ground System with the Echidna Phase 2A IEWMSS, the Blackhawk Interim Ground System occupies a single 19-inch rack whereas the Echidna Phase 2A solution occupies four 19-inch racks and includes four smaller racks to house the MWR sensors and UV stimulators (Baringas). The Blackhawk Interim Ground System uses a single personal computer with software to analyse the CMDS firing sequence for correctness. In contrast, Echidna Phase 2A comprises three servers and a large number of workstations to manage the OFP and UDF design, development, integration, test and release activities.

The IEWMSS then is an integrated software environment with hardware-in-the-loop and computer systems infrastructure necessary to perform the mission support function providing the capability for qualified personnel to:

i) Develop and update theatre-specific Project Echidna Ph 2A Modified Aircraft EWSP System User Data Files (UDF);

ii) Develop and maintain the Project Echidna Ph 2A Modified Aircraft EWSP System Operational Flight Programs (OFP); and

iii) Enable the testing of Project Echidna Ph 2A Modified Aircraft EWSP System Software in a “hardware and software in-the-loop” laboratory environment.[2]

[2] Please note, this section of text borrows from reference [6] by the author updating were necessary to give the latest information on progress and challenges.

The following figure illustrates the basic architecture of the IEWMSS.

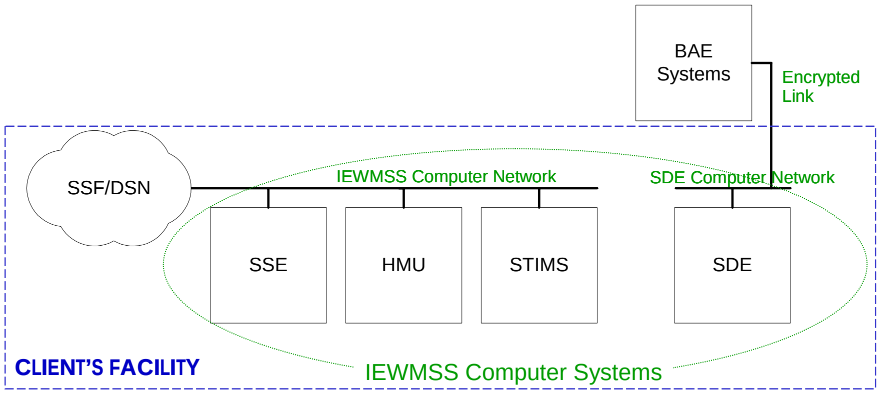

Figure 3: IEWMSS Architecture

The IEWMSS comprises four subsystems:

- Software Support environment (SSE);
- Hardware Mockup Unit (HMU);
- Stimulators Subsystem (STIMS); and
- Software Development Environment (SDE).

The IEWMSS Software Support Environment (SSE) and Software Development Environment (SDE) consist of commercial processing platforms that host the system engineering (e.g. requirements management and design tools), software development (e.g. compilers and debuggers), configuration management and office automation tools.

The IEWMSS Hardware Mockup Unit (HMU) contains the EWSP System hardware and interface emulators to support debug and test of updated EWSP Suite OFP's and UDF's. The HMU integrates with RF and UV stimulators as part of the Stimulators subsystem and includes a motion device to test for the correct angle of missile detection.

The Stimulators provide the capability to develop test scenarios for mission profiles that model threat environments or scenarios to be encountered by the Project Echidna Ph 2A Modified Aircraft and then stimulate the EWSP System equipment to verify the EWSP System Software.

The air gap shown in Figure 3 separates the IEWMSS into two components, the IEWMSS Computer Network (ICN) and the SDE Computer Network (SCN). The ICN connects to the Commonwealth's classified network for seamless integration with intelligence data. The SCN in contrast contains the SDE that will be initially managed by BAE Systems and is used for maintaining the IEWMSS.

The SCN is also physically isolated from all other BAE Systems networks and with a secure link between the client's facility and BAE Systems, the SDE can be located either at BAE Systems in the secure Echidna facility or at the client's facility depending on through-life support needs.

As of the time of writing the ICN and SCN have been constructed and are undergoing Developmental Test and Evaluation (DT&E).

The following figure shows a further decomposition of the IEWMSS subsystems, each of which is then described below.

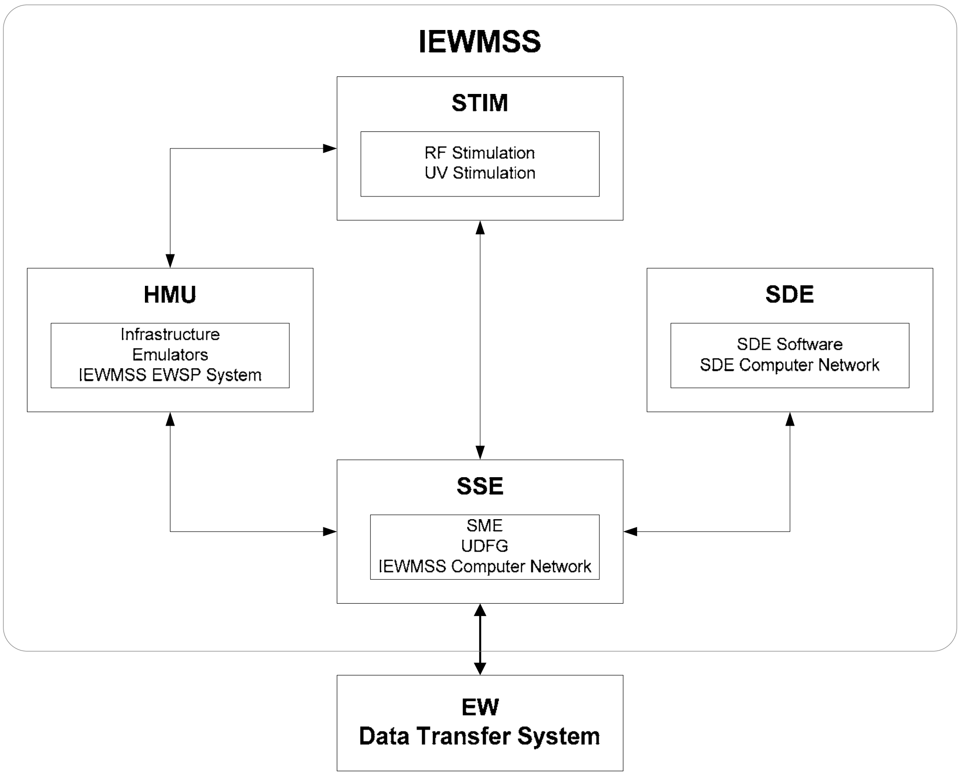

Figure 4: IEWMSS Subsystem decomposition

3.3.1.1 Software Support Environment (SSE)

The Software Support Environment (SSE) subsystem is core to the functionality of the IEWMSS and decomposes into three components:

- Software Management Environment (SME),
- User Data File Generator (UDFG),
- IEWMSS Computer System (ICS).

The SME can be viewed as a workflow or change management system for the IEWMSS. Figure 5 shows how the SME integrates change and configuration management with resource management. Requirements management and engineering design tools are also integrated together and with the configuration management system.

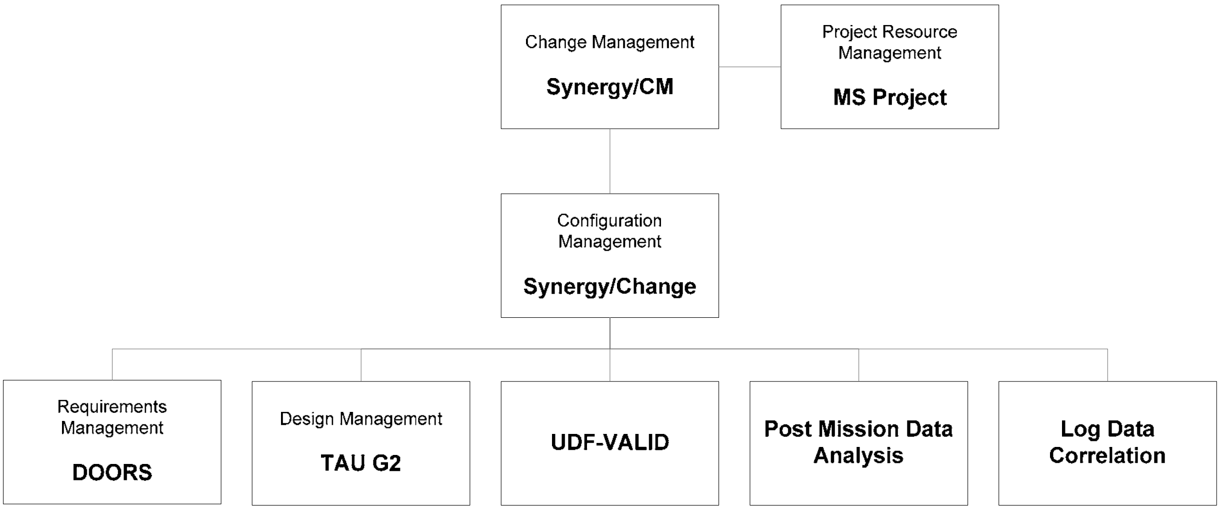

Figure 5: Software Management Environment (SME) functional architecture

The design of the SME is crucial to rapid production of qualified software for the mission, primarily the User Data File (UDF) described below, which is the basis on which the EWCP makes decisions on what constitutes a threat and how to respond.

The functional element UDF Valid, serves as a link between the change and configuration management system and the UDFG and produces as output the Aircrew Briefing Document (ABD) and associated artefacts related to testing/verification activities.

Post Mission Data Analysis provides the capability for detailed analysis of the set of EWSP Suite Logs collected during a mission to assist in resolving software problem reports. Log Data Correlation is a utility tool that can be used by an operator to correlate any of the logs produced by the monitoring equipment in the HMU. The HMU, which is discussed below, provides the ability for an operator to monitor all hardware to hardware, all hardware to software and all software to software interfaces in the IEWMSS.

At the time of writing, development of the SME is nearing completion and the software will soon be deployed onto the target hardware, the IEWMSS Computer Network ready for system integration. The primary challenges in the development of the SME included:

- Integrating the various COTS products;
- Automating the customer’s processes in terms of workflow management and data use;
- The complexity of testing such detailed processes.

The UDFG is the second core component of the SSE subsystem and IEWMSS. The UDFG accepts as input parametric information related to the EW environment and produces as an output a binary User Data File

(UDF) that is used by the EW Controller to fuse the data of multiple sensors and provide coordinated countermeasures responses.

The UDF integrates information for a RWR, MWR, and CMDS and can provide integration of LWR, DIRCM, Active RF Electronic Countermeasures (ECM), and towed-decoy; all growth options for Echidna Phase 2A.

Many previous sensor systems operated independently; whereas an advantage of the Echidna Phase 2A solution is a completely integrated solution. However, more importantly, the Echidna Phase 2A solution in conjunction with the SME substantially reduces the time taken to produce and qualify a UDF or equivalent.

The following figure outlines the basis components of the UDFG – UDF Composition and Generation using EW intelligence information and two wizards that interact with the RF Stimulator for seeding test data and collecting test results. The interaction with the SME is also shown whereby the UDFG provides not only a UDF for configuration control but information to allow the release of the UDF and production of the Aircrew Briefing Document (ABD).

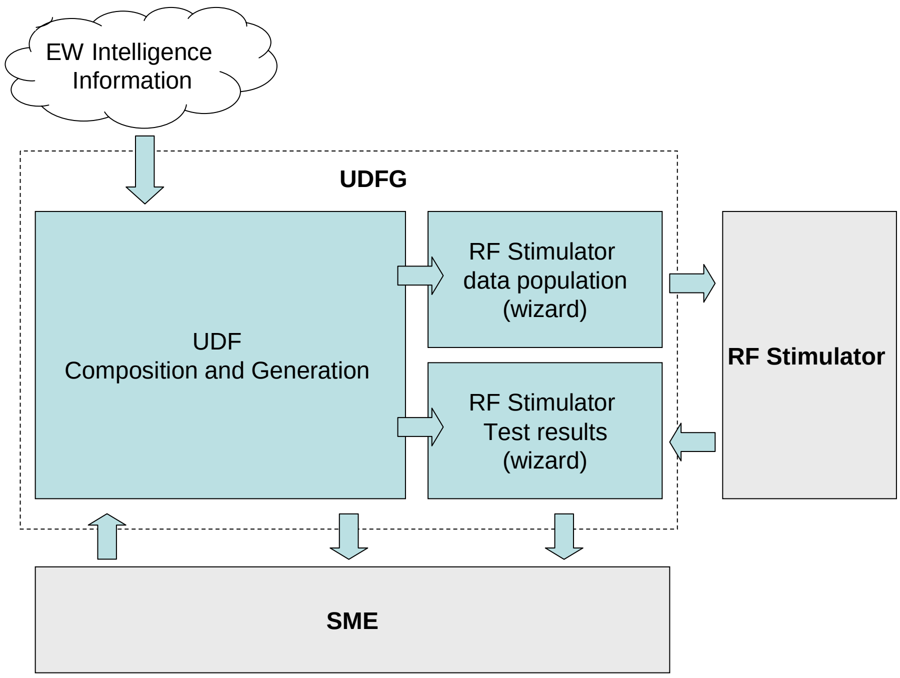

Figure 6: Simplified illustration of the User Data File Generator (UDFG)

Ambiguity analysis tools within the UDF Composition and Generation component are also provided to assist operators in resolving ambiguities while programming the system (creating a UDF) between emitters that may have similar and overlapping characteristics such as frequency or Pulse Repetition Interval (PRI), for example.

The challenges in the development and testing of the UDFG have included:

- Modifying the legacy software on which the UDFG composition and generation component was based;
- Pacing changes in the EW Suite software as the two have to work as a matched pair and be ready at the same time for testing;
- Interfacing with the proprietary RF Stimulator software – this led to an enhancement of the RF Stimulator software;
- Meeting the needs of the SME in terms of automating the production of the ABD and associated artefacts;
- Having to repeat a large number of tests that had been assumed unnecessary as part of another program, from which the code base was drawn, but had to be repeated because of the differences with Echidna Phase 2A.

As of the time of writing, a first version of the UDFG, a Test Support Item (TSI) has been produced to match the first build of the EW Suite software and delivered into the Suite Integration laboratory. The second and final build of the UDFG is well underway and testing activities have been paralleled and prioritised to maintain schedule.

3.3.1.2 Software Development Environment (SDE) Subsystem

The SDE subsystem provides a subset of development tools, processes and associated hardware utilised by BAE Systems for the generation of EWSP system and IEWMSS software products.

The SDE subsystem consists of the following components:

- SDE Software; and
- SDE Computer Network.

The SDE subsystem comprises a number of distinct software development environments (eg compilers, linkers, debug tools), with separate operational and logistical needs within each. At the time of writing the SDE Computer Network (SCN) had been constructed and the client/server software installed and tested for the transfer of information across the air-gap to the SSE. The first component SDE for the interface emulators was also about to be deployed on the target hardware.

Finally, the SDE is an important component of support and at the time of writing BAE Systems was undertaking a study to explore the combination of the Echidna, ALR 2002 (RWR) and PRISM SDEs. The Echidna SDE is envisaged as forming the basis for an integrated SDE.

3.3.1.3 Hardware Mockup Unit (HMU) and Stimulators Subsystems

The Hardware Mockup Unit (HMU) and Stimulators provide hardware in the loop to test EWSP software. The HMU is functionally equivalent to the aircraft and contains all aircraft Line Replaceable Unit (LRU) components and as appropriate, exact replicas of aircraft cables.

Figure 7 illustrates the basic design of the HMU. The figure shows four racks with the Suite components (EWC, RWR, CP, SFU and EPD) and CMDS in racks 1 and 2. Rack 3 primarily contains the monitoring computers and software. Rack 4 likewise, primarily the interface emulator computers and software. Rack 2 contains the power supply units (28 Vdc and 115 Vac) and circuit breakers.

The design of the HMU complies with MIL-STD 1472F for human factors and Handbook 454 for electronic assemblies as well as the relevant Australian standard for electrical safety, AS3000.

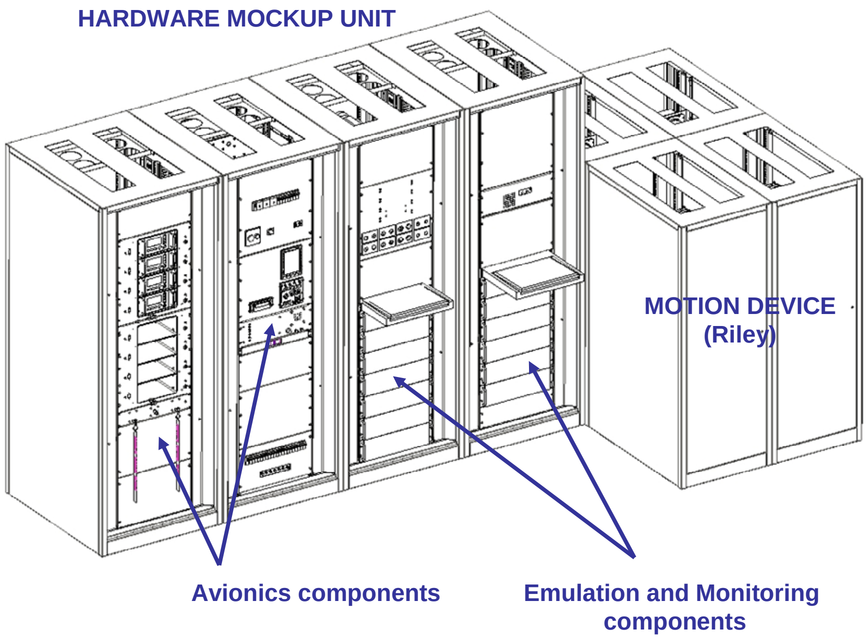

Figure 7: Hardware Mockup Unit

Adjacent to the HMU is the Motion Device (also known as Riley) that contains the MWR sensors. Each MWR sensor is mounted on a Pan Tilt Unit (PTU) and aligned with a UV stimulator (a Baringa). The RF Stimulator can trigger a Baringa during a programmed mission scenario to mimic a missile launch. The PTU move the MWR sensors as a coordinated set, under software control, to mimic an angle of missile attack on the aircraft.

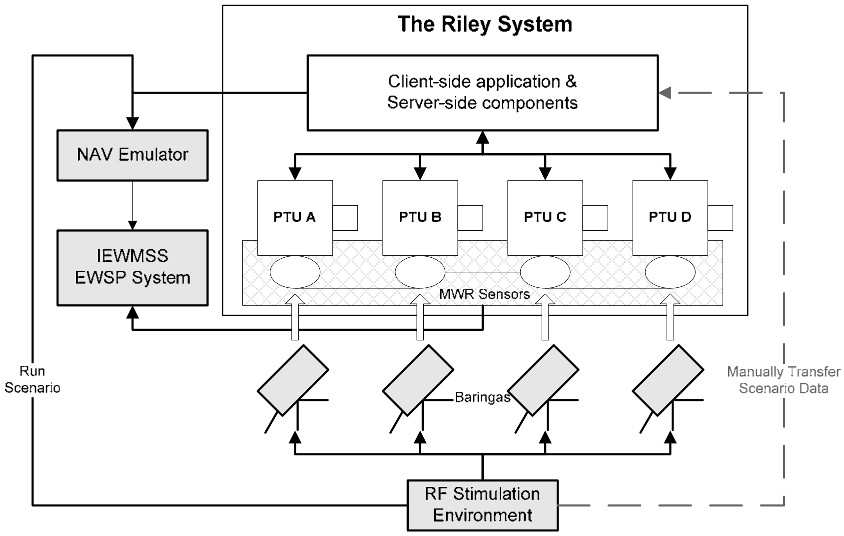

Figure 8: Representation of the Motion Device (Riley) connectivity

The RF Stimulator is also fed the raw parametric information to allow testing of a UDF with the results collected by a Test Scenario Run Analyser tool; a part of the UDFG.

The RF Stimulator is provided by the vendor EW Simulation Technology Limited and is a Dual Channel Four DF (Direction Finding) Port Threat Simulator. The RF Stimulator operates over the frequency range 0.5 to 18.0 GHz and can generate up to 258 signals at one time. The RF Stimulator is controlled by a Graphical User Interface (GUI) Based Software Package for programming emitters, platforms and scenarios.

In Echidna Ph 2A, the UDFG integrates with the RF Stimulator software for automatic population of emitter and platform information. Emitter and platform information is then used as part of a scenario programmed into the RF Stimulator. In the context of the IEWMSS, as the scenario in the RF Stimulator executes, signals are generated to stimulate the RWR and MWR. Upon stimulation the RWR, MWR and EWCP will combine to initiate a countermeasures response based on the UDF loaded into the EWCP. The objective of the IEWMSS then is to provide a system that allows the UDF and desired operation of the EWSP to be verified.

Interface emulators can also replace any of the EWSP (aircraft) components and include interface emulators for:

- Aircraft Interfaces – the discrete inputs such as Weight on Wheels and Fuel Dump, for example;
- MWR;
- RWR;
- EWCP;
- CP; and
- Navigation.

The HMU provides the ability to monitor all hardware to hardware interfaces, hardware to software interfaces and software to software interfaces between EWSP components.

A major challenge with HMU has been to keep pace with the aircraft avionics design and changes. The Ground System relies on the aircraft design but must ready at the same time as the aircraft is about to fly, posing the challenge of neither getting too far in front nor too far behind. As of the time of writing the HMU was in the construction phase and readying for testing. A six level testing strategy building from components up to the HMU in total has been developed and work is preceding on the development of the test procedures. The strategy with the Interface Emulators has likewise been to integrate with the EW Suite software as early as possible to identify and correct any integration issues.

3.3.2 IEWMSS Integration

As the subsystems of the IEWMSS near completion the challenge moves to integration. The approach adopted for integration of the IEWMSS is to integrate as early as possible allowing interface issues to be identified and corrected early. The approach also follows the guidance of the Capability Maturity Model Integrated (CMMI) Level 3 Process Area (PA) for product integration, as discussed in reference [7] with the specific practises of:

- SG1- Prepare for product integration;
- SG2 – Ensure interface compatibility; and
- SG3 – Assemble the product components and deliver the product.

An internal questionnaire previously used by auditors has been adopted to guide the process. For example, under SG1 and SP1.1 ‘*Determine the product component integration sequence*’, the following questions are asked:

- Have the product components to be integrated been identified
- Have the product integration verifications to be performed during the integration of product components been identified?
- Have alternate product-component integration sequences been identified (defining any specific tools and test equipment to support the product integration)?
- Has the best integration sequence been selected?
- Is the product integration sequence periodically reviewed and revised as needed?
- Is the rationale for decisions made and/or deferred recorded?

A view of the dynamic operation of the IEWMSS, showing the interfaces between components along with tracking of their maturity has guided the development of the integration sequence and alternatives depending on when certain components are ready. Other activities focus on the procedures for the verification of interfaces and the rationale for all decisions related to integration will be maintained in the living integration plan – the product integration sequence is designed in a way to account for slippage of dependencies and the approach is continually reviewed and refined to account for these changes. While the sheer complexity of the IEWMSS means integration will be a challenge, the CMMI process area provides good guidance for the approach. Under SG2 – '*Establish Interface Compatibility*' and SP2.1 – '*Review interface descriptions for coverage and completeness*', the team is tracking the multiple facets of every interface to ensure compatibility and completeness. Each interface may contain software to software, software to hardware, hardware to hardware, hardware to physical and physical to physical interfaces. Analogies may be drawn here with the International Standards Organisation (ISO) Open Systems Interconnection (OSI) model as used in telecommunications, see for example, reference [8]. This early and on-going review of the compatibility and completeness of interfaces has already identified and addresses a number of incompatibilities and gaps in definition.

The preparation activities for integration also touch on some of the generic practises of the process area, for example, G2.5 – '*Train the people performing or supporting the product integration process*' and G2.8 – '*Monitor and control the product integration process against the plan*'. The former has involved training the team on the CMMI approach and establishing a training plan for the components that need to be integrated and have been supplied by other teams external to the IEWMSS team, the aircraft components for example. In the case of the aircraft components the training will leverage the training plan and course material under development by the Integrated Logistics Support (ILS) team who are responsible for training as part of the Echidna project. In terms of monitoring the team employ Earned Value Management (EVM), see for example reference [9] and the Cost Schedule Analyst that assists the Product Manager is part of the integration team meetings.

4 Concluding remarks

The Echidna Phase 2A solution will offer a gain in EWSP for the platforms on which it is deployed because of the Common EWSP Suite approach. In addition there is the opportunity to add additional EWSP components such as a Laser Warning Receiver (LWR) or a Directed Infra-red Countermeasures (DIRCM) in the future. These extra components will require additional aircraft installation effort but the basics of the Echidna Phase 2A architecture and majority of elements can remain unchanged or minimally changed.

The major Echidna Phase 2A ground system, the IEWMSS, will also play a key role in improvement through the integration and automation of the system that leads to a major reduction in the time required to produce qualified software for the aircraft. The IEWMSS also offers the opportunity to progressively expand to include other aircraft platforms and legacy ground systems. This paper has discussed the current state of the IEWMSS and the approach for the next phase – integration. The paper has shown how the learning from earlier activities, in particular the Blackhawk Interim program has and will benefit Phase 2A. Electronic Warfare and Electronic Warfare Self Protection are often colloquially described as providing the best return on investment for a defence force (for example Adamy at reference [10]) and the Common EWSP Suite and Ground Systems designed and developed under Echidna Phase 2A will support this statement.

References

[1] AIR 5416 - Project Echidna Electronic Warfare Self Protection for ADF Aircraft, Media Release, available at http://www.defence.gov.au/dmo/esd/air5416/air5416.cfm, accessed October 21, 2007.

[2] Defence 2000 Our Future Defence Force Australia's Defence Policy (White Paper), December 2000 available at http://www.defence.gov.au/whitepaper/, accessed October 21, 2007.

[3] Project AIR 5416 Phase 2: Electronic Warfare Self Protection for ADF Tactical Aircraft: Operational Concept Document (Classified)

[4] http://www.defence.gov.au/dmo/news/ontarget/Jun06/nb1.cfm, accessed October 21, 2007.

[5] "RA 10 Chinook Rapid Acquisition - Defence Materiel Organisation - 2006 PMAA Results: Presidents Award" http://www.aipm.com.au/html/2006_qld_dmo_ra_10_chinook_rapid_acquisition.cfm, accessed November 26th, 2006.

[6] Rogers D., "Project AIR 5416 – Electronic Warfare Self Protection: Design and Development of the Ground and Aircraft System." 12th Australian International Aerospace Conference, 19-22 March, 2007, Melbourne, Australia.

[7] Chrissis, M., Konrad M., Shrum S., "CMMI: Guidelines for Process Integration and Product Improvement", Addison-Wesley, USA, 2003.

[8] Tanembaum A., "Computer Networks", Fourth Edition, Prentice Hall, USA, 2006.

[9] Solomon, P., Young R., "Performance-Based Earned Value", IEEE Computer Society, (John Wiley and Sons), 2007, USA.

[10] David Adamy, advisor to the US Government and author of several books at an Electronic Warfare training course, Adelaide, South Australia, 2006.

Acknowledgements

Dr Rogers kindly acknowledges and thanks the Defence Materiel Organisation (DMO), Echidna Project Office for both their comments on and approval to publish this paper; that is much appreciated.

Biography

Dr Derek Rogers is the Product Manager for Ground, SIL and Training Systems for Project Echidna Phase 2A with BAE Systems in Adelaide, South Australia. Dr Rogers is also an adjunct senior research fellow with the Defence and Systems Institute, University of South Australia; an adjunct senior lecturer with the Department of Electrical and Electronic Engineering, University of Adelaide; and visiting lecturer with the University of Canterbury, New Zealand in the area of Engineering Management. He holds four degrees, is a Fellow and Chartered Professional Engineer with the Institution of Engineers Australia, and Senior Member of the Institute of Electrical and Electronic Engineers. He has worked in industry for approximately 13 years and published over 30 papers. Dr Rogers has received a number of prestigious awards including the inaugural IREE Neville Theile Award and a rare leadership award from the University of Texas at Austin. His team has also received an award within BAE Systems for improvements to the software engineering process.