Coalition Fleet Synthetic Training

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Abstract. The Coalition Readiness Management System (CReaMS) was an initiative by the United States Navy to demonstrate advanced training capabilities between coalition partners. This was established by way of bi-nation project arrangements, between the United States and each of Australia, the United Kingdom, Germany, Singapore and the Netherlands. Australian participation in the project resulted in the conduct of three demonstration coalition synthetic training events throughout 2001 and 2003. Development of a persistent and effective in-port and ashore training capability between the Royal Australian Navy and USN was the desired end-state of the CReaMS project arrangement. This end state was achieved in May 2006, with the first of a series of Coalition Fleet Synthetic Training exercises held between the RAN and USN Third and Seventh Fleets.

In each exercise, RAN crews were stationed in operations room simulators at the Maritime Warfare Training Centre at HMAS Watson, Sydney. Operators and commanders were immersed in a virtual battlespace featuring shared ground truth, tactical communications, tactical data link, common operating picture, coalition real-time chat and information exchange. This paper outlines the three training exercises and explores the challenges experienced in establishing and maintaining a persistent training capability, as well as describing the technical lessons learnt throughout the course of exercise planning and execution.

1. INTRODUCTION

The Royal Australian Navy (RAN) and United States Navy (USN) have established a Memorandum of Agreement (MoA) that provides coalition training opportunities to ships in the pre-workup training phase prior to operational deployment. Three Coalition Fleet Synthetic Training Exercises (FSTs) were conducted in 2006. These exercises were sponsored by the USN Commander Pacific Fleet. The training participants included units and warfare commanders of the Fleet Commander (Australia), Commander 3rd Fleet (USN), and Commander 7th Fleet (USN).

This achievement was facilitated through earlier work by the Defence Science and Technology Organisation (DSTO) under the Coalition Readiness Management System (CReaMS) project arrangement [1,2], which explored readiness measurement and technical interoperability between RAN operations room simulators and USN Battle Force Tactical Trainer (BFTT) enabled warships. The success of CReaMS as a technology demonstrator convinced the RAN to move towards "institutionalising" networked simulation as an improved form of pre-workup training. The CReaMS project arrangement officially terminated in October 2006, and the effort has been transitioned under the umbrella of the MoA.

2. USN FST/NCTE AND RAN MWTS

The use of in-port distributed training exercises by the US Navy to provide pre-workup training has seen rapid growth since its inception in the late nineties [3]. This form of collective training, known as Fleet Synthetic Training (FST), enables USN ships (pier-side) and shore based simulators to network with other ships (pier-side) and simulators throughout the Pacific and Atlantic Fleets. The networking infrastructure and technical standards that support this effort are provided by the US Naval Warfare Development Command, under its initiative known as the Navy Continuous Training Environment (NCTE). The Pacific Fleet exercises are hosted by the training command at Tactical Training Group Pacific based in San Diego.

The intended training audience of each FST exercise varies from the crew manning an individual combat unit, through to the warfare commanders, and up to the commander of a battle group. These echelons of training are classified as FST-U, FST-WC and FST-GC respectively. Higher echelons generally engage a greater number of participants and correspondingly greater scenario and technical complexity.

The RAN is developing a similar in-port training initiative, known as the Maritime Warfare Training System (MWTS), which will include nodes at Fleet

Base East and West, and incorporate shore-based and on-board training systems [4]. Both the NCTE and the MWTS are based upon common interoperability protocol standards [5,6]. The current in-service element of the MWTS is operated by Training Authority Maritime Warfare at HMAS Watson, Sydney.

Since May 2006 the MWTS (HMAS Watson) has been a persistent and permanent node of the USN NCTE. This now enables the RAN and USN to conduct fleet synthetic training, connecting from home ports thousands of kilometres distant, prior to operating together live in theatre.

3. COALITION FLEET SYNTHETIC TRAINING EXERCISES 2006

Three exercises were conducted in 2006, the first providing an opportunity for the Commanding Officer of HMAS Anzac to undertake the role of Surface Combatant Commander. The remaining two engaged RAN command teams as task elements of USN carrier strike group organisations.

Pacific Coalition FST 06 (PC FST). A three day exercise held in May 2006 networked BFTT equipped US ships, a Ticonderoga cruiser (USS Chancellorsville) from Seventh Fleet based at Yokosuka, Japan, and two Arleigh Burke Destroyers (USS Benfold and USS Halsey) from Third Fleet based in San Diego. These were networked to the FFH, FFG and Command Team operations room simulators at HMAS Watson, with the Captain and Command Team from HMAS Anzac crewing the FFH and Command Team simulators, and a composite crew from HMAS Melbourne and HMAS Watson training staff crewing the FFG simulator. RAAF and RAN aviation personnel manned two role-player asset stations, which were configured to represent an AP-3C and S-70B.

USS John C. Stennis FST-Joint 06 (JCS FST). JCS FST was a pre-deployment operational work-up for the USS John C Stennis Carrier Strike Group comprising a cruiser (USS Antietam), three destroyers (USS Preble, O'Kane and Paul Hamilton), a submarine trainer (USS Oklahoma City), and an aircraft carrier (USS John C. Stennis). The Captain and Command team from the HMAS Parramatta manned the FFH simulator, and a composite crew from HMAS Melbourne and HMAS Watson training staff manned the FFG simulator. The exercise also included US Air Force (USAF) E-3C and US Army Patriot Battery trainers networked into the synthetic environment.

USS Nimitz FST-Joint 06 (NIM FST). The RAN, assisted by DSTO, then participated in the USS Nimitz Fleet Synthetic Training Exercise 2006. The three day NIM FST exercise was held in November and networked BFTT-equipped US warships, an aircraft carrier (USS Nimitz), a cruiser (USS Princeton) docked at San Diego Piers, California, and three destroyers (USS Chaffee, Higgins, and John Paul Jones) docked at Pearl Harbor, Hawaii. These were networked to the FFG simulator at HMAS Watson, which was crewed by the Command Team from HMAS Darwin. Additional participants included a USN E-P3 maritime patrol aircraft trainer, a USAF E-3C trainer, and US Army Patriot Battery trainer.

4. EXERCISE PLANNING

The duration of each exercise, from initial directive to post-exercise review, was approximately nine months. Planning for each exercise was conducted through a series of formal conferences and weekly teleconferences, and facilitated by the following project management products.

Plan of Action and Milestones (POA&M). A list of milestones, along with a target completion date and the assigned authority, was maintained on a POA&M spreadsheet. This spreadsheet was reviewed at the weekly teleconference, and updated accordingly.

Risk management. Known technical risks and their likely impact on the exercise were documented and reviewed at the weekly teleconferences. The intention was to present an overall risk assessment so that appropriate resources could be allocated to mitigate any risks.

System architecture diagrams. Block network diagrams were developed at the main planning conference for each functional area of the training system (functional areas are defined in section 6). These diagrams were updated to reflect implementation details and deviations from the plan, and reviewed at each weekly teleconference.

Daily schedule of events. A detailed schedule of events was developed for each day of the exercise. The goal of this schedule was to institute a battle rhythm, thus focussing support staff in the lead up to, and during, the exercise. The battle rhythm for each exercise week consisted of a pre-commencement teleconference, followed by functional area checks and finally a ready-to-train report from all participants. At the completion of each exercise day, a hot-washup teleconference was held to discuss any problems encountered and their impact on the following day of training.

5. SCENARIOS

The scenario for PC FST shared commonality with the RIMPAC 2006 exercise[1], using Hawaiian geography as the setting for an archipelago occupied by the nations of Green and Orange. Green, an ally of the Pacific coalition nations, is governed by a liberal democracy, but with limited defensive force. Orange is the larger country with a dominant military presence.

[1] Rim of the Pacific Exercise 2006 (RIMPAC '06). For further information visit http://www.c3f.navy.mil/RIMPAC_2006/

The scenario unfolds where Orange has taken an aggressive role within the region, and is under United Nations sanction for human rights violations, harbouring of terrorists and disruption of the international shipping lane. Tensions have increased between the two countries, with coalition forces being put on alert following the release of a United Nations Security Council resolution. Tempo is increased over the duration of the exercise; open hostilities are often only declared in the later portion of the final day of training. The JCS and NIM FST exercises were based on similar geopolitical conflicts, but based on an Asian setting.

6. TECHNICAL INTEGRATION

The technical objective of each exercise was to provide a training environment with sufficient realism to engage the training audience, namely the Action Information Organisation of each participating vessel. Although the training systems used within each exercise were individually well established, they varied considerably in terms of their capabilities and limitations. Technical effort was required to integrate these systems into an effective distributed training environment.

When analysed from a topological perspective, this integration required linking disparate training systems over a secure communication network. Each training system also presented multiple functional areas to the training audience. These areas are: modelling and simulation, information exchange, real-time text-based chat (or text messaging), tactical communications, tactical data link and common operating picture. The intention, implementation and lessons learnt for each functional area are described below.

6.1 Communications Network

The communications network forms a critical foundation of any distributed training capability, and bears all data exchanged by each functional area. In the authors' experience, installing this infrastructure is the single biggest, and underappreciated, risk in establishing a distributed training capability.

Multiple network enclaves were necessary in each FST exercise to accommodate security requirements imposed by each functional area. These network enclaves included: **BLACK**, an unclassified network for the purpose of clear tactical voice communications; **BLUE**, a secure allied-releasable network for simulation ground truth, secure tactical voice communications, tactical data link and common operating picture; **RED**, a secure US-only network for simulation data, for the same purpose as BLUE; **CFE**[2], a secure allied-releasable network for operational information exchange and chat; and **SIPRNet**[3], a secure US-only network for information exchange. This list does not encompass other local networks specific to the participating training systems.

Due to the existence of varying levels of security, network guard technology was used to permit legal exchange of data between the RED and BLUE networks.

6.2 Distributed Modelling and Simulation

Distributed simulation refers to the exchange of ground-truth information between sites in order to stimulate sensors attached to, or modelled by, the participating training systems. Examples of ground truth, in the context of these exercises, are entity position and identification, radio frequency emitters, and secondary radar responses.

In each exercise there was a diverse range of training systems employed, including shore-based trainers for the Adelaide and Anzac class frigates, and BFTT onboard trainers for Aegis Combat System and Ship Self Defence System (SSDS). The training systems were able to interoperate using the Distributed Interactive Simulation (DIS) protocol [5,6], however the capabilities and limitations of each system were different. These differences need to be accommodated at either a technical level, or in the scenario, to ensure a 'fair-fight' and deliver useful training. Differences in capabilities included maximum entity count (some simulations can process a greater number of entities than others), entity enumeration mapping, and emitter regeneration.

The Joint Semi Automated Forces Navy Training Baseline (JSAF NTB) has been adopted by NCTE as both a standard scenario generator, and common modelling and simulation medium through which to interface training systems. This medium is known as the High Level Architecture (HLA) Navy Training meta-Federation Object Model (NTF). Separate instances of the JSAF DIS/HLA gateway were used to integrate each training simulator into the common medium. The configuration of each gateway was tailored to accommodate, and make best use of, the capabilities and limitations of the target training system.

6.3 Tactical Communications - Voice

Tactical communications refers to radio voice circuits used to exchange tactical information between the units within the exercise. Both virtual and live radio circuits were present in each exercise, and these systems were bridged together using the H.323 protocol as a common medium. H.323 is one of two primary standards for Voice-over-Internet-Protocol (VoIP) telephony [7].

A number of conference call facilities were established to "simulate" voice communication channels. VoIP-to-DIS-Radio and VoIP-to-Live-Radio gateways were

[2] Combined Enterprise Regional Information Exchange System (CENTRIXS) Four Eyes (CFE)

[3] US Secret Internet Protocol Router Network (SIPR)

used to bridge virtual and live radio frequencies into the conference call. Participants with access to neither a virtual nor live radio were able to monitor a circuit using a VoIP telephone handset.

There are advantages and disadvantages to using VoIP technology over the existing DIS radio communications standard.

- There is a diverse range of VoIP devices available, resulting in a mature communications standard. The DIS radio communications standard, which most virtual communications systems support, was developed to model the radio frequency environment, including spectrum utilisation, and modulation and propagation effects.
- There are fewer voice communications available to support the DIS standard, resulting in a less mature and interoperable standard. However, efforts have been made to rectify this through amendment to the standard [8].
- The H.323 protocol does not carry radio frequency information, thereby providing a perfect and error free tactical communications environment.
- The VoIP architecture relies upon a central audio switching and phone directory computer, which therefore introduces a central point of failure. A switching computer failure was experienced in the PC FST exercise, resulting in a momentary loss of all secure tactical voice communications.

6.4 Tactical Communications – Real-time Chat

Real-time text-based chat has become an essential tool in the exchange of free-form tactical information between USN vessels [9]. Coalition chat channels were operated on the CFE network, as this was the only network common to all participants. Supplementary chat channels were operated on SIPRNet; these were available only to US participants.

The provision of two chat systems caused some problems throughout each exercise, as there was an unnecessary reliance by the USN participants on the use of the SIPRNet chat over the CFE. This impeded the flow of information between USN and RAN units, and was recognised at the daily debrief on more than one occasion.

6.5 Tactical Data Link

Tactical Data Link (TADIL) provides exchange of real-time machine-readable tactical information between naval combat data and airborne mission systems. Data link terminal emulators, which allow TADIL messages to pass over Internet-Protocol networks, were used to integrate each mission system into the data link network.

These terminal emulators do not model the radio frequency environment, thus providing each combat unit with continuous and error-free data link connectivity. Despite this, some technical problems were encountered in establishing the data link network. These included:

- Operator competency;
- Equipment stability, and
- Equipment incompatibility – not all terminal emulators are alike.

Operator competency and equipment reliability are issues that may be encountered operationally and therefore add somewhat to the realism of the training (even if unintended). Equipment incompatibility is a technical planning problem, and as such degrades the training usefulness.

6.6 Information Exchange

The US Navy Collaboration At Sea (CAS) website, hosted on the CFE network, was used to exchange mission planning information throughout the task group organisation.

Initial teething problems, such as webpage replication delays (documents posted in Australian were not available in American until four hours later) and network stability, were experienced in the PC FST exercise. These problems were not anticipated, but in retrospect should have been incorporated into the exercise risk management document, given that this was the first trans-Pacific use of the CAS website for many of participants.

6.7 Global Command and Control System - Maritime

The Global Command and Control System – Maritime (GCCS-M) is an application suite that provides a common operating picture between coalition units. In these exercises the GCCS-M computer at MWTC was networked to GCCS-M computers onboard the USN vessels, and those stimulated from the JSAF simulation environment.

6.8 Video Teleconferencing

Whilst not an explicit function of the training simulation, Video Tele-Conferencing (VTC) was used in the PC FST exercise to support the debrief at the end of each day of the exercise. In this exercise a secure three-way VTC was established between the shore facilities at Sydney, San Diego and Yokosuka. It was not possible to use the existing VTC equipment that was fitted to the larger American warships, as this equipment was operated separately from the BLUE network, and would have required the installation of another network. VTC was not used in the subsequent JCS and NIM FST exercises, but was supplanted by secure voice-only teleconferencing. It will be used to support exercises in 2007.

6.9 Technical Problem Analysis

Technical problems were encountered in each exercise for the majority of the listed functional areas. A final teleconference was held in the week following each exercise to discuss significant technical problems. This provided an opportunity to compare performance against the risk management documentation (prepared prior to the exercise), and to discuss potential improvements for subsequent exercises.

Data concerning the occurrence of technical problems, their impact on the training audience, and their resolution, was captured by DSTO and has been reported internally within the Australia Defence Organisation. Figure 1 shows both the number of reported problems and the functional areas where the problems occurred. The trend is clearly one of diminishing technical problems, which supports the statement that the RAN and USN have established a persistent training capability, and that the capability is maturing. This data may also prove beneficial for the planning of additional MWTS nodes, as it gives guidance as to what to problems to expect.

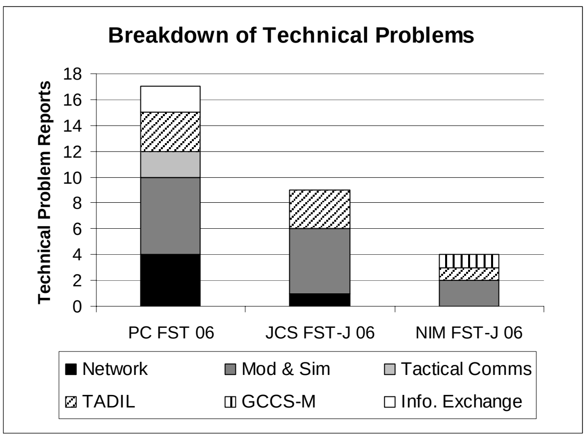

Figure 1: Summary of technical problems reported

7. ASSESSMENT TOOL DEMONSTRATION

A systematic approach to learning, known as objective based training, was evaluated incrementally throughout the CReaMS demonstration events [10, 11]. This work has led to the acquisition of a training support system known as the Maritime Assessment Training and Evaluation System (MATES). The objective of MATES is to improve the management of operational readiness, by linking high-level mission tasks lists to lower-level individual and team training objectives, and providing Navy with consistent scenario development, performance assessment and reporting tools that are aligned to these objectives.

The performance evaluation tool, which forms one component of MATES, was used during PC FST to demonstrate the technology to visiting Naval seniority. The tool was operated by instructor subject matter experts, and facilitated the collection of subjective performance measures of the HMAS Anzac command team. Two daily reports, a team traffic light report and detailed report card, were generated from the data collected. These reports were presented as part of the local daily debrief. The assessment tool demonstration did not directly involve the USN training participants.

Although a demonstration, some observations were made concerning the suitability of the tool. In previous training exercises the measurement tool program had been installed on ruggedised Personal Digital Assistant (PDA) computers. These were substituted in the PC FST exercise with A4-sized Tablet PCs. Despite the increased screen size and hand writing recognition abilities offered by the Tablet hardware, their battery life and weight were found to be inadequate, as six hours of training were programmed for each day of the exercise. A compromise between the PDA and Tablet computer is sought.

8. CONCLUSIONS

The success of the Coalition Readiness Management System (CReaMS) as a technology demonstrator, convinced the RAN to move towards "institutionalising" networked simulation for training, which has resulted in the conduct of three Fleet Synthetic Training exercises between the RAN and USN in 2006. The CReaMS Project Arrangement officially terminated in October 2006 and has be succeeded by a MoA between both Navies.

In each of these FST exercises, the role of DSTO, under the Air Maritime Team Training Task, has been to provide scientific and technical leadership to the RAN. DSTO has provided assistance establishing, testing and trouble-shooting coalition simulation networks; solving interoperability issues; developing and applying terrain databases; and, during the exercises, on-line monitoring and analysis. Post-exercise, DSTO's role has been to analyse the exercise data both from a technical perspective to baseline performance requirements, and a learning methodology perspective to establish training outcomes and effectiveness measures.

All three FST exercises conducted in 2006 have been successful training events that presented an opportunity for RAN command team staff in a coalition environment. Although the exercises were not without technical challenge, they have proven the utility of the persistent training capability. In 2006, the RAN twice funded DSTO staff to travel to the Tactical Training Group Pacific (TTGP), San Diego, to participate as technical liaison officers.

The RAN's next virtual coalition training exercise, planned for May 2007, will have an amphibious theme, and will extend the Australian participants to the Joint level with the inclusion of an Australian Army landing force, together with a new Navy amphibious operation room trainer at HMAS Watson. In the future it is planned to include an upgraded Guided Missile Frigate alongside at Garden Island, being stimulated by the synthetic exercise, using its newly installed DIS-networkable On Board Training System (OBTS).

DSTO's efforts over the past six years to incorporate Advanced Distributed Simulation into the training, mission rehearsal, and operational readiness abilities of the RAN, are enabling the preparation of Australian forces to not only integrate and be interoperable with US forces, but to be able to operate 'seamlessly' with such forces. Similar efforts are intended over the next few years with the RAAF to integrate Hornet F/A-18 simulators and Airborne Early Warning & Control (AEW&C) Operational Mission Simulators into a Joint Synthetic Battlespace.

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