Coalition Readiness Training for Navy

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Abstract. The pursuit of the "train as we fight, fight as we train" goal continues with the third Coalition Readiness Management System (CReaMS) training exercise conducted during the period 9 – 12 September, 2003. Known as Virtual Coalition Readiness (VCR), this exercise was based on a scenario of a coalition maritime battle group assisting a local ally to defend offshore island regions against an aggressor. Training simulators located in Australia, manned by real ship's crews, were networked with similar simulators in the US, including an operational US Navy ship (USS HOWARD) using Distributed Interactive Simulation as the networking protocol. DSTO, RAN and USN staff collaborated in both simulation-related technical areas such as networking, encryption, data and intelligence links, and Distributed Interactive Simulation (DIS) implementation. In addition, an Objective Based Training system is under development, which will provide a quantitative assessment of the training achieved and crew readiness levels. This paper reports on the VCR and explores the lessons learnt and achievements.

1. INTRODUCTION

Australia and the United States entered into a formal Coalition Readiness Management System (CReaMS) Project Arrangement (PA) in 2001[1], to demonstrate an interoperability training capability, with the long-term goal of establishing a persistent mission planning and rehearsal ability. This effort features the USN Battle Force Tactical Training (BFTT) system, which provides the USN Fleet with an embedded training simulation system for training crews onboard their ship using operational tactical equipment – to train like they fight.

The series of CReaMS simulation exercises have been conducted under the auspices of both the RAN and DSTO, who are collaboratively exploring better and more economical means of increasing the preparedness of Australia's armed forces. Phase One of the CReaMS Project Arrangement, the *Preliminary Interoperability Experiment*, took place in November 2001 between the RAN/DSTO, USN, and Royal Netherlands Navy [2]. This was an unclassified exercise, showcased at the I/ITSEC 2001 conference floor. Phase Two of the CReaMS initiative expanded the network capability to include tactical data links and Command Chat Line, and was conducted over an encrypted network. Involving only USN and RAN operational crews, the *Encrypted Network Exercise* was conducted in February 2003 [3].

The collective objective of Phase Three of the Australian-US Project Agreement was to examine the feasibility of "ship-to-ship" simulation connectivity. The RAN also used the event to prove the Maritime Warfare Training System concept: that effective team training can be conducted over a distributed network and dispersed at locations.

New dimensions of the exercise not previously seen included:

- An operational combat unit (USS HOWARD);
- Task Group Command element – USN Commander Destroyer Squadron 7 (COMDESRON 7)
- Global Command and Control System – Maritime (GCCS-M);
- Link 16 Tactical Data Link;
- RAAF Air Defence Ground Environment Simulator (ADGESIM); and
- After Action Review tool 'Mentor' and facilitated debriefs.

The training simulation systems were manned by operational combat crews (HMA Ships ADELAIDE (FFG) and ARUNTA (FFH), and US Ships HOWARD (DDG) and VIRGINIA (SSN)) undertaking real world training commitments to prepare their platforms for operations. Training support was provided by the Maritime Warfare Training Group at HMAS WATSON, Naval Undersea Warfare Center located at Newport, Rhode Island; the Tactical Training Group Pacific, located in San Diego.

HMAS WATSON, as the Australian hub, coordinated the connectivity to the United States, specifically the Combat Direction Systems Activity (CDSA) in Virginia, which served as the US hub for the simulation. Figure 1 illustrates the exercise network topology.

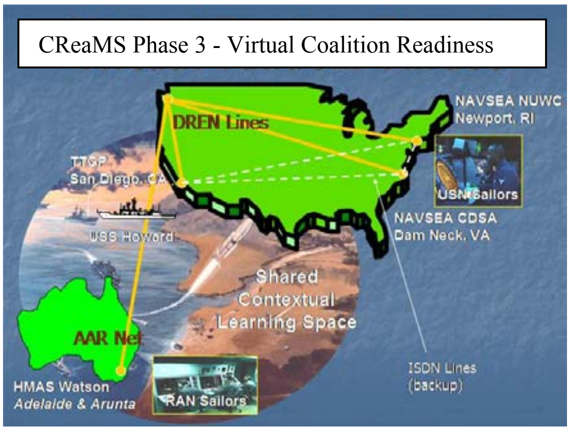

Figure 1: "Virtual Coalition Readiness" Event Topology

2. SCENARIO

Exercise VCR was a four-day exercise run over the period 9-12 September 2003. RAN and USN staff developed the fictional scenario for the training event over a six month period and required almost weekly teleconferences to refine and validate the scenario. A number of multi-tiered training objectives were also developed for the scenario to support the Learning Methodology.

The setting involved Orangeland (hostile) and Purpleland (friendly) in disagreement, and a combined RAN/USN Naval Task Force (Blue) being deployed for maritime operations in a littoral environment. Day one and two involved a serialized based work up program as the task group approached the operating area. Day three and four were conducted inside the area of operation involving a period of increasing hostility that allowed for the task group to operate under a complex set of evolving Rules of Engagement.

Each nation uses Rules of Engagement to govern the application of military power and is determined by each nation's legislation, the internationally recognised Laws of Armed Conflict and the military objective. There are known differences in interpretation of these laws and nations have developed their own Rules of Engagement. This scenario has been partly designed to allow the commander and his assigned assets to achieve an understanding of each set of Rules of Engagement as the scenario unfolds.

3. TECHNICAL OVERVIEW

The primary technical aim of the VCR exercise was to implement a distributed training environment at a classified level. An additional goal was to support the learning methodology process. The VCR exercise allowed the exploration of different technology in the areas of network bulk data transport, network peering and Video Tele-Conferencing (VTC) technology, and refinement of the use of technology from the Phase One and Two exercises. The value of implementing a technical working group and conducting almost weekly teleconference calls cannot be understated. Early configuration testing and management was a critical element of the success of the event. The development of a lessons learnt package and a "how to do cook book" were important outcomes from the exercise.

3.1. Network

The network design comprised a number of systems, each providing quality of service guarantees to its clients, and in turn relying on other network components. The main boundaries were the interface between the simulation systems and the encrypted WAN; the crypto network interface; and the unclassified WAN service provider interface. Additional interfaces were used between the HOWARD and TTGP, namely classified and secure chat lines, and UHF radio communications.

The network encryption interface used for this exercise was the Motorola Improved Network Encryption System (INES). These bulk network encryptors provide a secure connection between a number of sites in a seamless manner, thus providing a virtual dedicated secure WAN link.

3.2. Network Implementation

The simulation systems at HMAS WATSON consisted of the ANZAC Combat System Tactical Trainer (CSTT), the FFG Integrated Operations Team Training Facility (IOTTF), and a portable version of the RAAF ADGESIM. Additional systems were used to monitor and log network traffic.

The earlier CReaMS exercises [2,3] used ISDN links in a star configuration, with the CDSA-Dam Neck operating as the central node. This provided a direct router-to-router serial connection, resulting in an extremely flexible system, as the topology could be changed simply by having the routers dial different telephone numbers. However, costing variations in the international telecommunications market resulted in ISDN calls being expensive, especially when initiated from Australia.

For the VCR exercise, ISDN links were replaced by an IP-based system that tunnels data through pre-existing bulk IP networks. The Australian provider was the Australian Academic Research Network (AARNet), and the US provider the Defense Research and Engineering Network (DREN), which is operated by the US DoD. ISDN lines were used only between HMAS WATSON and the AARNet service provider located in central Sydney. As the operators of these networks purchase large quantities of bandwidth, the price is significantly lower (approximately $350K for Phase One versus $4K for Phase Three).

3.3. Distributed Interactive Simulation (DIS)

The DIS protocol [4,5] was used to convey ground truth between the simulation systems. An enumeration database and classified emitter database were developed specifically for this exercise.

Six DIS voice systems were employed across nine voice channels. An ASTi system was used by the IOTFF, CSC's Cooee system by the CSTT, and Marine Digital Voice (MDV) by NUWC's Virginia class submarine simulators. MDV was also used by CDSA for testing and monitoring purposes. Voice going to the HOWARD was received in DIS-format at TTGP by an Improved BFTT Digital Voice (IBDV) unit and converted into analogue signals and then re-transmitted over UHF. BFTT Digital Voice (BDV) was used by TTGP for game control purposes, and the BFTT Operating Processor Console (BOPC) onboard HOWARD. A commercial off-the-shelf system was used by the ADGESIM.

3.4. Virtual Communications Architecture

The architecture enabling a simulated tactical data link between the CSTT and HOWARD employed protocol encapsulation, protocol transformation, and encryption.

The HOWARD employed Link-16 TADL protocols, whereas the CSTT has a Link-11 TADL capability. The configuration at WATSON was identical to that of Phase Two, whereby a Common Connectivity Device (CCD) provided an interface between the CSTT Naval Combat Data System (NCDS) and the secure WAN, whereby Link-11 messages were encapsulated in the Standard Interface for Multiple Link Evaluation (SIMPLE) protocol.

Global Command and Control System – Maritime (GCCS-M) software is used by both the RAN and USN to merge multiple tactical data sources into a common operating picture. Data sources typically comprise ship-based radar, link tracks from other units, and incoming radio reports. A GCCS-M server was used to store, filter and manually adjust the input of tactical data. Tactical information was shared between TTGP and the HOWARD using a separate US DoD network connection. The WATSON GCCS-M was fed ground truth via DIS using a serial link from the IOTTF.

Battle Group Command chat was emulated using PC-based Internet Relay Chat (IRC) software. Use of the Coalition Wide Area Network (CWAN) chat capability was planned for the VCR, as this is an operational system, however not all sites were equipped to access the COWAN.

3.5. Learning Methodology Support

Facilitated debrief software was provided by Calytrix Technologies [6], under contract to the RAN through Novonics Oceania. The software, titled Mentor, ran on a standard Microsoft Windows PC. Mentor analyses DIS traffic in conjunction with data collected by assessors on handheld devices and generates a set of World Wide Web pages for an integrated debrief. The simulation network was used to transfer data collected at TTGP and onboard the HOWARD, to WATSON for processing, and to transfer the debrief presentations.

4. TECHNICAL ANALYSIS

This section provides analysis of how the simulation technology performed during the exercise, and outlines any issues identified.

4.1. Network

The Wide Area Network (WAN), comprising the AARNet and DREN, performed flawlessly during the event, such that the network appeared seamless to the users. The stability of the encryption network required substantial effort to maintain, primarily due to a lack of alignment of the configuration of equipment and a certain element of human error during operation.

4.2. Distributed Interactive Simulation

There were no problems experienced in the use of enumerations present in the agreed enumerations list or the emitter database. However, a number of simulation systems behaved unexpectedly upon receipt of non-standard Protocol Data Units (PDUs), or receipt of enumerations other than those present in the agreed list.

Problems encountered included:

- The network port configuration of a number of systems could not be modified;
- One system would only discard PDUs if the Site ID was greater than a specific value;
- Some systems configurations ignoring DIS version 6 PDUs;
- Generation of rogue non-DIS compliant Emission and IFF (Interrogation Friend or Foe) PDUs by some systems;
- Decreased stability of one simulation system upon receipt of PDUs that were not normally used by the system;
- Possible configuration errors resulting in, for example, an underwater decoy being fired from a P3C entity.

The majority of these interoperability issues were resolved during the testing period using gateway software developed by CDSA and WATSON.

4.3. DIS Voice

Throughout all CReaMS exercises, successful voice communications have been the most challenging task. This is primarily due to the vagueness of the DIS standard regarding the population of Transmission PDU fields. Some systems require only the frequency field to be set, whereas others require the modulation parameters to be set. Systems such as the Cooee (used in the CSTT) more faithfully replicates the way a ship board communications system operates and therefore requires higher fidelity information. The DIS standard does not explicitly define how simulated-crypto is to be implemented, nor does it describe the use of global communications conventions. As a result, each voice system is built to a different interpretation of the standard.

These difficulties can be summarized as:

- Voice traffic from the MDV systems at NUWC and CDSA was not received by the ASTi voice system (used in the IOTTF), but received by other systems. CDSA identified the cause of this problem following the exercise: DIS traffic sent by MDV contained non-zero values within the PDU padding fields, whereas the ASTi default configuration causes such PDUs to be ignored.
- In the final week of testing, the CSTT Cooee system developed a fault where the system was not receiving voice traffic from any of the other voice systems, including the IOTTF in the encrypted mode. As a work-around, the operators switch to and from secure communications to reset the configuration. This had a positive effect, and communications were available for the event week.
- Intercom voice traffic from the IOTTF was unnecessarily sent to all other sites. The average bandwidth consumed by these intercoms was approximately 250kbps. Along with the intercom traffic, additional voice traffic on non-games channels was found to be generated by the IOTTF and CSTT. Examination of the voice traffic showed the Signal PDUs to contain ambient noise, suggesting that the radios were left unmanned in voice-on-transmit mode.
- Whilst all nine voice channels were transmitted over the secure WAN, only four were transmitted securely over UHF radio, between TTGP and the USS HOWARD.

Given the issues experienced, it would be desirable for communications systems to have an “interoperability testing” mode, which gives the operator notification when transmissions are being sent on the channel, but are discarded due to incorrect modulation or crypto settings. This would assist with testing, to rule out common usage error. Gateway software would also facilitate DIS Voice system interoperability. For example, the IOTTF intercom traffic could have been filtered, prior to being sent over the secure WAN.

4.4. Virtual Communications

Virtual command chat net performed well throughout the testing build-up and event week. The major problem faced by the WATSON crews was that in addition to Internet Relay Chat (IRC), the American sites were using an operational US DoD secure chat capability and this was not available to the RAN. Additionally, there is no automated means to integrate the IRC chat messages into the after action review process. The development of an “chat message to DIS Comment PDU” gateway was considered for Phase Three, but not implemented.

5. LEARNING METHODOLOGY

Another objective for exercise VCR was to validate a learning methodology that combined the use of Objective Based Training (OBT) and Team Dimensional Training (TDT) for coalition team training. The OBT deals more with the warfare or outcome, and associated warfare processes. Predominately objective data was collected and assessed against a set criterion for the outcome of an event. Additionally, expert subjective data was collected mainly on the warfare process or where judgement was required to balance to requirements of different warfare environments. Team Dimensional Training provides a methodology to assess the performance of a team and a team of teams in the warfare environment. Only subjective data can be collected against the dimensions of teamwork as described by TDT.

Learning objectives and the learning process in military simulation environments have been previously identified in research which reflected the development of LM theory, key elements derived from theory, a conceptual model of the learning environment, and the LM process model [7].

5.1. Training Models

Two models guided the approach to training for exercise VCR: Objective Based Training, and Team Dimensional Training.

The OBT model highlights the development of objective-based assessment, which is based upon task lists and training objectives. This approach reflects how teams learn and also encourages continuous improvement of team performance. Each successive cycle enables a higher level of performance, as the team meets and overcomes various obstacles and challenges. It promotes a learner-centred approach, whereby team members are active participants in the planning, execution, evaluation and reflection of the learning process [8, 9].

TDT is an instructional strategy which aims to develop the dimensions of teamwork within teams. The model emphasises the importance of four dimensions of teamwork; information exchange, communication, supporting behaviour, and team leadership. TDT incorporates guided team self-correction to develop key knowledge and skills amongst team members. Its design is such that teams can gain the greatest value from self-correction [10]. The TDT approach describes three stages in team training. The *pre-brief* emphasises the four teamwork dimensions; the *exercise* is conducted and teamwork behaviours assessed; and a *debrief* is conducted that emphasises guided team self-correction.

5.2. Scenario Development and Development of Training Objectives

Training a complex organism such as a Task Group provided a challenge to the training objective developers. The Task Group is organized along two different lines. Firstly, material assets (ie ships) are commanded and controlled through the task group organization. Task Groups are composed of Task Units, which in turn are composed of Task Elements, which can be one or two ships. Task Groups themselves are members of Task Forces and are composed or decomposed depending on the mission. Secondly, the conduct of the maritime battle is managed through the Composite Warfare Commander concept. The commander of the Force/Group/Unit is the warfare commander for that formation and delegates to various subcommanders the responsibility for the conduct of particular warfare environments such as Air, Surface or Sub Surface. The commander resolves conflicts between his subcommanders for resources to conduct and achieve his mission. All platforms contribute to each warfare environment (air, surface etc) as appropriate to that platform's capability in that environment. Therefore, platforms are controlled through task organizations but fight within the composite warfare concept.

To cater for this environment, two categories of training objectives were developed. Firstly there were task-type objectives aimed at the mission or warfare environments, being Commander of the Task Unit (CTU) and his mission objective, warfare commander and the conduct of warfare in that environment, and the individual ship level. This also reflects the task group organization and composite warfare commander concept normally employed by maritime forces. Secondly, there were the integrated team objectives that transcended the warfare environments and command structures. An event grid was created to manage the different levels of training objectives for each targeted event.

In accordance with the TDT model, training objectives were targeted at each of the four team dimensions of communication, information exchange (proactive communication), supporting behaviour, and initiative/leadership. Critical thinking is another dimension of the team being examined as an indicator of team performance. For VCR, the critical thinking dimension was focused towards rules of engagement and how this dynamic element was managed by the command teams.

5.3. Data Collection Strategy

The limited number of assessors available prescribed a limitation in the depth of material to be gathered. The ability to predict air warfare events (i.e. when aircraft were probing or attacking the ships) from the scenario and the richness of data associated with these vignettes, it was decided to focus the data collection effort in the air warfare environment. Data was also collected for the other warfare environments but lacked granularity to provide meaningful feedback to the trainees.

A Naval assessor was located at each site to assess the performance of the CTU, warfare commanders, and ship level teams, against the relevant training objectives. Two assessors were required onboard the HOWARD, one to assess the ship's team and another to assess the Air Defence Commander. For each objective, the assessors provided a rating of 0 (below standard) to 4 (above standard). This is the same rating scale that is currently used by WATSON for daily assessments of command team training.

Data was collected from several sources. Subjective data was provided by the assessors on OBT and TDT objectives using either hand held devices or a laptop computer spread sheet. The selected training objectives were identified in the training grid and presented on an observer assessment form, which was replicated on the Hand Held Device or the spread sheet. The electronic version of the assessment form facilitated the presentation of material for the After Action Review.

Objective data was collected from the simulation data streams and the combat systems. This outcome data incorporated measures such as the number of correct detections, classifications, reports, and engagements. When correctly time stamped, the data can be merged with the subjective data to provide a multi-media after action review tool by which a meaningful facilitated debrief to the different levels of teams can be undertaken. The objective was to merge the relevant data within 30 minutes of the completion of the exercise to debrief the participants.

An attitude survey was conducted at WATSON to gauge the participants perception of the value of training being undertaken.

5.4. Facilitated Debrief

A key tenet of the TDT and OBT approaches is the facilitated debrief [7,11]. These debriefs were conducted for each level of team, namely ship, task group and the commanders. Unfortunately technical difficulties with the VTC equipment did not permit a full multi-media debrief to be conducted at the task group level. Adhoc arrangements were implemented to achieve the facilitated coalition debriefs over a simulation radio network. Ship debriefs were conducted in the training simulator or onboard ship and the commanders, led by COMDESRON 7, was done by teleconference.

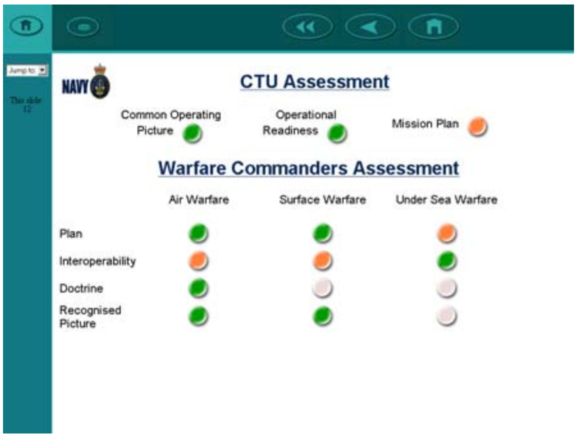

Figure 2: Warfare commander level assessment as displayed in the debrief software

Figure 2 shows an example of part of an assessment for the Air Defence Commander. The debrief product used both in Australia and the US is prototype software developed by Calytrix Technologies [6]. For this exercise, green represents satisfactory or very good performance (a rating of 2, 3, or 4 in accordance with the established WATSON rating system), amber represents barely satisfactory performance (a rating of 1), and red represents below standard performance (a rating of 0). White indicates no data was collected.

The figure shows that training objectives relating to interoperability (communication skills, information exchange, leadership, initiative and critical thinking.) were not performed satisfactorily. The facilitator was then able to access the information behind this judgement to lead the trainees through a journey of exploration of why it occurred and how it maybe remedied in future training events. This iterative process demonstrated an overall improvement of individual and team performances throughout the VCR exercise. Another important outcome of this process is that the personnel involved at the low levels become aware of how their actions and performance impacts upon the overall performance of their ship's team, the environmental warfare team and the task group as a whole.

5.5. Achievements

VCR achieved its coalition objective of demonstrating meaningful training to the pier head (i.e. onboard a ship). The RAN objective was also proven in that meaningful training was conducted over a distributed and dispersed training environment. Examples of the benefit of this form of training are illustrated by the comments made by the commanding officers of ARUNTA and ADELAIDE at Table 1.

Table 1: Comments made by Commanding Officers at WATSON after Day Four of training

Comments from CO HMAS ADELAIDE
It takes practice to work with different Navies, as they have different procedures and ways of describing things. In coalition operations there's about 70% commonality (in op procedures), leaving about a 30% difference. This training irons out those differences , and it's down to about 10% difference now [post-training].
Regarding the facilitated debrief, it was helpful to have others view your individual and team performance, so here we had someone else looking over, and we got their view of life which may be quite different from the CO's perspective. That is, it's an advantage that the debrief was facilitated by a third party.
Final comment – Knowing what I know now, I would have brought my ship's team here, knowing now the benefit that would be provided to them.
Comments from CO HMAS ARUNTA
We were able to see the higher layers of management (i.e., CTU) that we don't normally get. It was a great opportunity to work within that structure. At sailor level the interaction with CTU was not that apparent, more for the COs. What the sailor does didn't change much except that some reporting procedures were different.
There are interoperability issues with the USN, in communications procedures, accents, speed of speech, etc, and this is a good opportunity to resolve these.
It was training at all levels. Individual sailors benefit from conventional CTT, COs get the CTU level training. It helped to see where you sit, as part of CTU, and ironed out communications procedures.

The prototype after action review tool, Mentor, was used to great effect during the facilitated debrief, significantly increasing the benefit of the training event.

The use of AARNet dramatically reduced the cost of conducting these training events. A comparison was also made between using operational units at sea with supporting assets and the use of a synthetic environment. The cost to the RAN to conduct such an event off Sydney was approximately $8M. The total cost to the RAN for VCR was $50K, thereby demonstrating the significant savings possible in simulation. However, the ships still need to go to sea to maintain mariner skill and this capability is not meant to replace sea time but to augment it.

6. FUTURE ACTIVITIES

The RAN will continue with the development of Mentor to mature its capability. Enhancements will include preparation activities such as scenario development and automation of data collection plans.

The RAN, supported by DSTO, will continue to examine options to improve the capability demonstrated by the CReaMS activities and to provide an operational readiness capability that includes training, system performance, capability development and experimentation. In March 2004, WATSON participated in a demonstration involving the USN Strike Force Interoperability Testing system and sites in the US that examines combat system performance. In the future this capability or like will be integrated with the training capability.

7. SUMMARY AND CONCLUSIONS

This complex Virtual Coalition Readiness training event completed the initial goals and objectives of the

CReaMS Project Arrangement. The encrypted simulation included tactical link data and voice links; Battle Group internet-like "chat" circuits; air, surface and subsurface "contacts"; and the ability to manoeuvre and conduct realistic operations. Immersed in this synthetic maritime warfare environment, the officers and sailors undertaking training solved problems, made decisions, took actions, and relied on other coalition team members, just as if they were at sea. The objective to prove meaningful team training was possible in a dispersed and distributed synthetic environment was achieved.

The architecture developed around AARNET and DREN was reliable, provided an appropriate level of quality of service and was cost effective. Further cost savings will be achieved by providing a direct link into AARNET from WATSON. The encryption devices were a source of concern, and more robust and dependable cryptographic equipment is required.

Through the CReaMS series of exercises, numerous DIS interoperability issues and ambiguities within the standards documents have been identified. These have since been reported to the Simulation Interoperability Standards Organization (SISO) DIS Specialist Group, for further investigation. It has been recommended that the standards publication be revised in line with the outcomes of this and similar advanced distributed simulation demonstrations.

The methodology used to plan, conduct and analyse such coalition training events is based on a similar learning methodology to that adopted by the US Navy in its BFTT system and involves a cyclical activity of planning, conduct, and assessment of a training and readiness event. During the conduct of the exercise, events, actions and decisions were logged and recorded by both RAN trainers and DSTO research staff. At the end of the event, this data was digitally stored and assembled in support of the assessment phase. During assessment, data collection products were used to assist with combat system console command chronology, time-tagged voice reports, "ground truth" and "perceived truth" visualisation, and individual performance assessment. As meaningful training was undertaken by both the RAN and USN, it was concluded that this methodology is appropriate and will meet the warfare team training requirements for RAN internal and coalition operational readiness.

The success of the event can be attributed to a number of process activities undertaken well in advance of the event. Establishing working groups early to address technical, scenario and learning methodology issues was pivotal. Developing a level of trust between the members of the groups, fostering an attitude of success and training the trainers all contributed.

VCR demonstrated a capability ready to be transitioned into operational service for coalition training. Further work is required to develop and integrate the systems performance and experimentation capabilities into a holistic coalition readiness capability. The on-going goal of this endeavour is to answer the Coalition Battle Group Commander's question, "Are we ready"?

8. ACKNOWLEDGEMENTS

The authors wish to thank members of the Royal Australian Navy, including CAPT Peter Murray (TAMW), CMDR Larry Menon, LCDR Chris Straughan, CPOCSM Peter Jones, and Maritime Warfare Training Group staff of HMAS WATSON. The COs of HMAS ARUNTA and ADELAIDE are also acknowledged for granting permission for their crews to be to surveyed daily and for their willingness to participate in a post-exercise interview with DSTO staff

The DSTO team of Mr Andrew Robbie (establishing the network communications); Dr Michael Lenné (LM Working Group); Dr Lucien Zalcman (interfacing the ADGESIM); Mr Denis Hourigan (visual terrain database); and Boeing Engineering at Fishermans Bend for the construction of 3D visualization models are also acknowledged for their contributions.

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