Building Towards Coalition Warfighter Training

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ABSTRACT

The Battle Force Tactical Training (BFTT) program brings distributed team training to the U.S. Navy (USN). This program has many similarities with the Royal Australian Navy's (RAN's) Maritime Warfare Training System. Therefore, USN and RAN collaboration is mutually beneficial. A key near-term goal of such collaboration is to enable rehearsal for joint exercises such as the RIMPAC. In the long-term, the overarching goal is to enable conduct of coalition training and mission rehearsal between multiple ships at-sea.

This paper will discuss initial connectivity trials between USN and Australian Defence establishments. Research and operational training issues will be discussed including scenario generation, database requirements, connectivity issues, interoperability among dissimilar simulators, exercise management, coordination, and control, network traffic and latency issues, and use of Computer Generated Forces (CGFs) to enrich the synthetic training environment.
Further, this provides the backdrop for conduct of a live coalition training demonstration at I/ITSEC 2001 including training planning, conduct and after action review (debrief). USN personnel manning a Fleet representative combat system emulation on the I/ITSEC convention floor will conduct a coalition training event with the Royal Australian Navy (RAN) manning a Fleet representative combat system configuration at HMAS Watson, Sydney. A human-in-the-loop research simulator (aircraft cockpit) being flown from the Defence Science Technology Organisation Melbourne will augment the event.

AUTHORS' BIOGRAPHIES

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INTRODUCTION

Global forces are coming together that demand and enable formation of an effective Navy-to-Navy coalition training capability. To this end, Australia and the United States have embarked upon an ambitious collaboration project that will result in a coalition team training capability, with initial interoperability being achieved during this calendar year (2001). I/ITSEC 2001 will serve as the first public showing of this rudimentary capability as a featured Special Event at the Conference.

In the real sense of 'coalition partnership,' a number of organizations and activities will meld their talents to bring this demonstration to fruition under a bi-lateral Project Arrangement (PA). This paper describes the efforts underway to bring Coalition Warfighter Training to a reality and focuses on the associated I/ITSEC demonstration.

BACKGROUND

It is useful for this discussion to have a perspective of the various components (organizations, initiatives, projects and programs) that have aligned to support this collaborative effort both in the near and long term to provide this relevant synthetic training capability to our respective naval forces. Also, it is informative to understand the technological backdrop that influences these components. These components include:

- Battle Force Tactical Training (BFTT) system program (US),
- Coalition Warfare Program Initiative/ Coalition Readiness Management System (CReaMS) (US),
- Joint Air Navy Network Environment (JOANNE) Project (AU),
- Australian Maritime Warfare Training System (MWTS),
- SEA 1412 Project (AU), and
- Australian Virtual Air Environment (VAE).

United States Battle Force Tactical Training System

Currently, the U.S. Navy's premier simulation based shipboard training device is the Battle Force Tactical Training (BFTT) System, managed through the Naval Sea Systems Command, Naval Performance Monitoring, Training & Assessment (PMTA) Program Office, Program Manager Systems (PMS430) [1]. BFTT networks development sites, laboratories, operational shoresite and shipboard training facilities using standard (Distributed Interactive Simulation – DIS) protocols. Present technology enables multiple ships and shore units to interact in the same virtual battlespace even though they are geographically dispersed. BFTT has provisions to extend connectivity to the coalition level as the BFTT system advances from in-port training to a multi-ship, at-sea, 'readiness' system. Following an evolutionary process, the BFTT Program is integrating HLA/DIS Gateway technology with a migration plan to 'go native' HLA in FY 2003.

Coalition Warfare Program Initiative/Coalition Readiness Management System (CReaMS)

The U.S. Congress, in response to a recent Allied Commander's report on Kosovo, established the Coalition Warfare Program Initiative [2]. This initiative directed the U.S. Office of the Secretary of Defence (OSD) to sponsor projects that have the potential to "increase the US coalition warfighter's readiness, effectiveness, and survivability" and those candidates that foster seamless interoperability.

In FY2001, OSD selected four new-start projects. Among the four was Naval Sea Systems Command Performance Monitoring, Training and Assessment Office's candidate: the *Coalition Readiness Management System (CReaMS)* initiative. CReaMS enhances coalition readiness by advancing development of a combined team interoperability training/mission rehearsal capability. The CReaMS project integrates evolving cognitive team learning principles and processes with advanced technology innovations to produce an effective and efficient team-learning environment. An 'effective and efficient-learning environment' consists of a user friendly, reliable system with appropriate technology and a validated learning methodology that supports development of specified team competencies supported by relevant metrics. The

U.S. Navy (USN) will use the Fleet deployed BFTT system as the foundation to build the coalition capability.

The CReaMS initiative provides a framework and vehicle for integrating national components that will 'fast-track' development of a coalition training capability. The goal of CReaMS is to link Australian Defense Forces (ADF) simulation systems with the U.S. BFTT System to demonstrate coalition level warfare training [3]. Joint Air Navy Network Environment (JOANNE) and prototype Maritime Warfare Training System (MWTS) (described below) elements will form the Australian networked components of CReaMS.

Joint Air Navy Network Environment (JOANNE) Project

In Australia, Project JOANNE seeks to demonstrate distributed joint training capabilities using advanced distributed simulation applications to connect Defence Science and Technology Organisation (DSTO) research simulators with a number of ADF training systems at different locations. JOANNE will conduct a series of demonstrations as different ADF training establishments are effectively brought 'on line' to participate in distributed training scenarios. DSTO's Air Operations Division (AOD) leads this development and expects JOANNE to achieve multi-point connectivity using standardized protocols. Additionally, this will be the a Research and Development (R&D) testbed for distributed simulation research which will provide benefits to a number of existing service-sponsored Projects including Australia's SEA 1412, the Virtual Air Environment (VAE), and also includes international linkages to the United States. This is one element of DSTO's modelling and simulation strategic plan [4].

JOANNE/CReaMS Coalition Research Activities: AOD will undertake initial laboratory-to-laboratory tests with BFTT development sites to establish a technical baseline. It is here were traffic rates and latencies will be measured to ensure successful future interaction between the MWTS and BFTT.

A goal of the JOANNE/CReaMS initiative is the conduct of a Virtual Rim of the Pacific (RIMPAC) exercise. RIMPAC is a multinational joint exercise, led by the US Navy that is held biannually near Hawaii that includes the navies of many Pacific Rim nations. Using a coalition-level simulation to provide a virtual operational environment, CReaMS will enable Royal Australian Navy (RAN) and United States Navy (USN) RIMPAC 2004 participants to conduct pre-exercise events including planning and mission rehearsal while in port.

Scenarios and databases to support JOANNE exercises and CReaMS are under development. Credible "real" scenarios based on RAN/RAAF training scenarios, and Australian/United States coalition 'warfighter' scenarios and objectives are being developed. Entities involved include Royal Australian Air Force (RAAF) fighter and surveillance aircraft interacting with RAN surface combatants and BFTT ships/aircraft. Simulators located at ADF training facilities/bases such as RAAF Edinburgh and HMAS WATSON, together with BFTT shore sites will participate with service personnel in a virtual, contextual, training environment.

Participating Coalition Facilities and Assets: A number of organizations within Australia and the United States will be participating in a range of Research and Development activities in the years ahead. Table 1 lists these organisations, together with possible assets and facilities to be utilised.

Table 1: Participating Systems in future JOANNE/ CReaMS demonstrations.

USN	• BFTT Development Facility (Combat Direction System Activity, Dam Neck, Va.) • Joint/Coalition Integration • I/ITSEC demonstration
HMAS WATSON (Shore Training Fac.) **Sydney NSW Australia**	• IOTTF Ship Operations Room Trainer and asset stations • CSTT Ship Operations Room Trainer • BOPC Unit integration
DSTO (AOD) Melbourne Victoria Australia	• Various aircraft cockpits and dome • DIS radio communications • DIS Test Suite • Flying desks • CGF systems such as STAGE • Data recording systems • BOPC Unit integration
RAAF Williamtown NSW	• Phoenix Display System • AOD-developed Flying desk
RAAF Edinburgh South Australia	Operational Mission Simulator for AP-3C
ADSO Canberra, Australia	Stealth viewer station facilities

Proposed Series of Experiments: Figure 1 provides a notional JOANNE scenario configuration with participating systems at AOD, RAAF Williamtown, HMAS WATSON, Nowra, RAAF Edinburgh, HMAS STIRLING, and a USN Battle Force Tactical Training facility.

JOANNE Participating Systems

Figure 1: JOANNE Scenario Participants

JOANNE Research Activities: The following Australian issues will be investigated experimentally:

- The use of the DIS Test Suite (DTS) as a component of the Australian VV&A process [5];
- Accreditation of DIS interfaces for in-service ADF simulators such as the AP-3C Operational Mission Simulator (OMS) and the new Australian - New Zealand Frigates (ANZAC) Combat Systems Team Trainer;
- Interoperability of On-Board Training Systems (OBTS). The RAN's Guided Missile Frigate (FFG) and ANZACs are being upgraded to include OBTS' which will include DIS interfaces;
- Compatibility of the representations of the synthetic natural environment (SNE) among various simulators;
- Development, testing and evaluation of a suitable Joint Training Scenario. This will require interaction among the respective training communities;
- Investigate WAN requirements for the Maritime Warfare Training System (MWT) Projects and other ADF distributed training systems;
- Investigate requirements for encryption across networks.

It is anticipated that these experiments will continue in the following years as the RAN develops its Maritime Warfare Training System.

Australian Maritime Warfare Training System

Through Project "SEA 1412", RAN is seeking to develop the MWTS which will initially link several existing surface warfare trainers to provide enhanced command team and tactical training for the Australian Navy into the 21st century [6].

In later phases of the project, an Australian wide-area maritime simulation network will be established. This system could include ships pier side at the Fleet Bases, linked via their on-board training systems with a future wargaming system and ship models at HMAS WATSON in Sydney, as well as other ADF simulators, such as RAN helicopter simulators, RAAF Patrol (AP-3C), Fighter/Attack (F/A-18) and Airborne Early Warning & Control (AEW&C) aircraft simulators. In parallel with "SEA 1412" development, the FFG Upgrade Project will provide Australian FFG ships with a multiple, at-sea / pier side, embedded training capability comparable to the U.S. BFTT equipped ships. Further, the ANZAC ships will also acquire OBTS similar to the current FFGs. Project "SEA 1412" will also provide the network infrastructure to link the shore based trainers at HMAS WATSON, fleet bases and potentially other ADF and allied simulation systems.

For the first stage of "SEA 1412", the networking architecture will be Distributed Interactive Simulation (DIS), which will provide the required level of interoperability for different systems in the Australian context. Later an interface to High Level Architecture (HLA) will be considered as this technology matures.

Australian Virtual Air Environment

The VAE is an Australian Defence Department initiative, which aims to provide embedded training capabilities for the Australian Air Defence System [7]. The VAE concept combines real and virtual systems, using distributed simulation to selectively stimulate core operational systems. VAE is a joint activity between the RAAF and DSTO to determine what is possible with current and emerging technologies.

Technology Backdrop

In the information age, technology is evolving at an ever-increasing rate with capabilities meeting and exceeding the promise of faster, smaller cheaper. CReaMS strategy is to define the desired capability end-point and exploit technology as it evolves to meet these requirements. Examples of technology support the CReaMS Strategies follow:

Standards for Interoperability: The most commonly used methods of carrying out advanced distributed simulation exercises specify the use of either DIS or HLA. DIS is the current mature standard for simulation interoperability with over 10 years development whereas HLA is a potential replacement upon maturity.

Distributed Interactive Simulation: DIS is a networking protocol standard which provides a means of communicating entity information among simulators through Protocol Data Units (PDUs) to create a synthetic environment. These PDUs contain data packets that are broadcast over the simulation network. DIS standards were developed under the guidance of the DIS Coordinating Committee and utilised the IEEE Standards approval process [8]. The final DIS version, IEEE-1278.1a, was released in April, 1998 [9].

High Level Architecture: HLA is a methodology designed to support distributed simulation exercises [10]. HLA designates simulations *federates* and a set of participating federates a *federation*. Each federate has an associated *Simulation Object Model* (SOM) which describes its data modeling requirements; similarly, a federation has a *Federation Object Model* (FOM) identifying the attributes and interactions supported by the federation. Various *Reference FOMs* have been proposed to assist with conversion of DIS-compatible systems to HLA and to further promote interoperability. The Real-time Platform Reference (RPR) FOM is a HLA description of the DIS protocols [11]. The currently available RPR-FOM 1.0 supports DIS IEEE 1278.1 and is now a Simulation Interoperability Standards Organisation (SISO) standard [12]. Under development is RPR-FOM 2.0 (draft version 6 under review), which will support DIS IEEE-1278.1a-1998 functionality.

Naval Training Meta-FOM*:* The Naval Training Meta-Federation Object Model (NTMF) Project has as its objective the attainment of meaningful interoperability through the coalescing of Navy simulation/stimulation (trainer) systems brought together to form a federation under HLA. The overall purpose of the NTMF is to achieve meaningful US Navy, Marine Corps, Joint and Coalition interoperability training using individual trainers federated to form a training federation.

The NTMF is being developed using a system engineering approach that employs a Use Case methodology. Three US Use Cases are under development, which include scenarios representing Littoral Operations, Coordinated Anti-Submarine Warfare (ASW) and Strike Warfare. In addition, Australia is contributing a coalition Use Case, facilitated by a coalition based Royal Australian Navy and the US Navy initiative [13].

Terrain Databases: DSTO is developing a visual database called NADINE (North Australian Database for Interactive Networking Environments), which will contain considerable sea area to the west of Darwin and sufficient landmass for combined air/maritime operations. Further, it will provide high feature detail in the Darwin coastal region. A section of this database is shown in Figure 2.

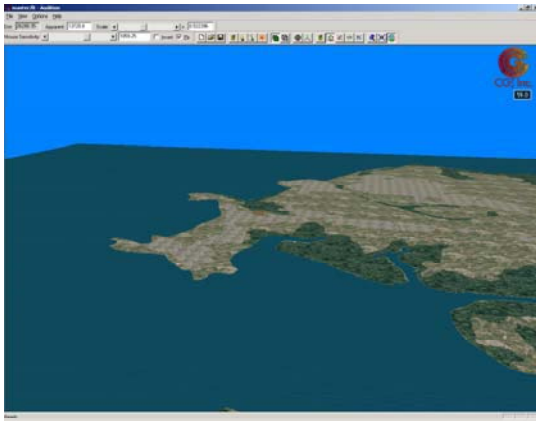

Figure 2: Section of Darwin database

As an alternative to this approach, the widely available Fort Hunter Liggett terrain database is also available. A RIMPAC terrain database in the Hawaiian region, which would be a more relevant geographic location for a US/Australia coalition exercise is being investigated. For the I/ITSEC demonstration, however, a sea only (no land) database will be used.

COALITION COLLABORATIVE PROGRAM

CReaMS Objectives

The CReaMS objective in the first year is to establish a working relationship and, as appropriate interoperability/connectivity with, the Royal Australian Navy (RAN), Royal Navy (RN), and Royal Netherlands Navy (RNLN). This objective was specially called out in the authorization document with provisions to include other coalition partners as appropriate.

Cooperation Strategy

The initial CReaMS activity will consist of developing separate bilateral programs/agreements with the USN as the parent in each case. The overarching strategy is to work with coalition partners at their appropriate comfort level (concept, architecture or system) to achieve interoperability at the outer ring (Figure 3) via DIS, HLA, and/or gateways with supporting Federated Object Model (FOM).

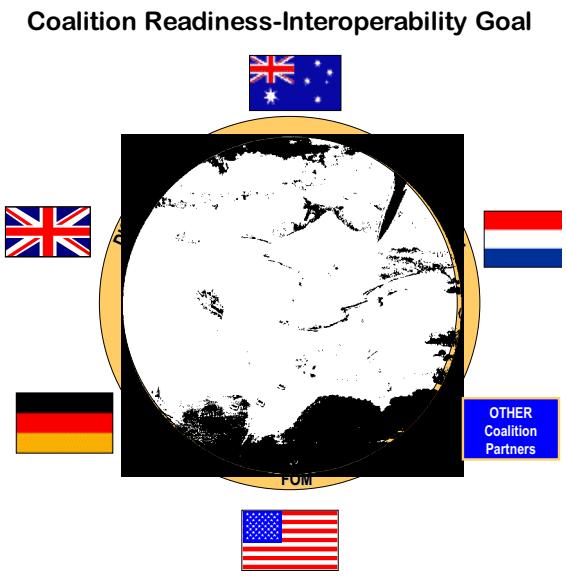

Figure 3: Coalition Readiness – Interoperability Goal

The outer coalition interoperability ring represents a physical international Wide Area Network (WAN). Collaboration and cooperative participation within the synthetic environment will be used to resolve WAN interoperability issues such as latency.

The CReaMS integration and interoperability strategy is layered in several evolutionary phases:

1. Establish a 'laboratory-to-laboratory' linkage to facilitate Federation Object Model development, DIS/HLA compatibility test and laboratory system integration;
2. Transition laboratory efforts to training facilities to effect legacy system integration and interoperability functionality testing, and introduce the warfighter to the developing capabilities;
3. Conduct 'training facility-to-training facility' operational testing, verify employment definition and procedures, introduce objective based training development concepts, and initiate training classes;
4. Move the capabilities from the training facility to satisfy the goal of "Train Where You Fight" by taking the CReaMS synthetic, contextual environment to the warfighter's on board action stations (Ship-to-ship).

US-AU Collaboration

It is in both Australia's and the United States' interests to collaborate. Ultimately, this will ensure Australian and US Navy training systems both at sea and ashore will be able to attain material and cognitive team interoperability. Once interoperable, RAN and USN forces will be able to maximize participation and benefits derived from M&S supported coalition-training exercises.

A principal goal of warfighter collaboration is to develop coalition cognitive team interoperability and build integrated teams. An objective of this relationship is to achieve a virtual RIMPAC capability such that initial workups between coalition partners could be achieved prior to a country's ships leaving port. This reduces the underway "socialization time" currently required for coalition navies to understand how each of their coalition partner's ships operate. Further this allows participants to proceed directly to more complex interoperability situations and "scheme of manoeuvres" readiness issues.

Through the CReaMS initiative, Australia and the US will collaborate under a bilateral Project Arrangement (PA), which calls for operator/trainer, research scientist and engineer participation. This requires that each nation's established experimental and development programs come together and through collaboration, establish an effective/efficient maritime coalition training and readiness capability in a cost-effective way.

To date, the cooperation and coordination between DSTO, RAN and the USN has been enormously successful, permitting phases 1 and 2, and indeed elements from phase 3, to be demonstrated at I/ITSEC 2001.

In the near-term, CReaMS provides an opportunity to bring the MWTS and BFTT communities together for collaboration and the conduct of a series of meaningful demonstrations leading to the development of an in-port coalition training capability. As previously indicated, this will allow the conduct of a virtual RIMPAC where ships in San Diego and Hawaii, and ships in Sydney are connected in a virtual training environment. In the long term, CReaMS seeks to integrate the MWTS and BFTT into a seamless coalition-training environment that leads to an on-demand, on-the-way mission rehearsal capability which will enhance coalition readiness.

The I/ITSEC 2001 Conference provides an opportunity to demonstrate the projected capabilities to a cross-domain, diverse audience and thereby, raising the community's awareness and obtaining valuable feedback.

I/ITSEC DEMONSTRATION

The I/ITSEC 2001 CReaMS demonstration provides an opportunity for the public to observe first-hand long-

haul networking Australian and US Naval team interoperability initiatives. Interoperability-training demonstrations will be conducted throughout the three days of the conference. Each 45 minute event will showcase the actual learning process, facilitated by active duty USN and RAN personnel. RAN Teams will man FFG and ANZAC combat systems located at HMAS WATSON, Sydney and conduct representative (unclassified) coalition operations with a USN team manning AEGIS platform combat system emulators located in the PMS430 Booth #1376. The PMS 430 Booth will interface with other I/ITSEC booths as appropriate to provide additional participants such as the NAWC TSD F-18 'man-in-the-loop' trainer. Geographically distributed Australian and US networked sites will augment the training evolutions by injecting relevant M&S entities. Combat Direction System Activity, Dam Neck, VA will provide both friendly and hostile air and surface ships, including a Surface Action Group and Carrier Battle Group. Naval Undersea Warfare Center, Newport, RI will provide friendly and hostile submarines. DSTO Melbourne will provide computer-generated forces and a man-in-the-loop aircraft simulation.

Demonstration Objective

The demonstration objective is to provide the I/ITSEC audience with insight into how innovative use of technology can be used to provide the Warfighter with the tools needed to increase coalition combat system team competencies and there by enhancing coalition readiness.

Network Configuration

Perhaps the most critical issue in distributed simulations is connectivity. In this us case, connectivity will be established between Australia and the US via a Wide Area Network (WAN) (ISDN Bridge). Participating in the network will be HMAS WATSON, PMS430 I/ITSEC Booth, CDSA Dam Neck, NUWC, Newport and DSTO Melbourne (See Figure 4).

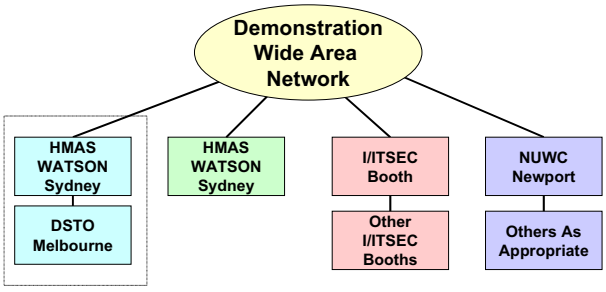

Figure 4: Global Communications Plan for I/ITSEC Demonstration

Scenario Development

A coalition collaborative working group is established to develop of the demonstration scenario. The RAN training staff at HMAS WATSON leads the effort by defining the basic scenario. USN working group members are focused on expanding the basic scenario to encompass US areas of interest and integrate the Objective Based Training (OBT) process [14].

Demonstration Scenario Story Line: The demonstration scenario is based on a hypothetical political-economic situation involving two island nations whose boundaries define a major international shipping lane and trade-zone. Island-nation *Orange* has "threatened" island-nation *Blue*, if they refuse to join the *Orange economic federation*, with "dire consequences" including the potential of armed conflict.

Australian Defence and United States Forces form a coalition endeavor to increase their level of readiness and demonstrate the coalition's resolve to maintain freedom of international trade/shipping routes and sovereign territory of independent countries. Several phases (or levels of intensity) are planned to increase the 'coalition forces' readiness, in anticipation of potential 'real-world', escalation. Additionally, this will provide the special event demonstration various "levels of maturity" that will accommodate our interoperability integration progress and serve as a risk mitigation mechanism.

Demonstration Scenario Description: Australia and the US have treaties with Blue, a small island country that is strategically located in the Pacific Rim. Blue has been under increasing pressure from Orange to join their economic federation or face the consequences, which may include armed intervention. Due to its proximity to international shipping lanes, Blue's independence represents a national interest to both the US and Australia (AU). In preparation for a 'worst-case' scenario, Australia and the US agree to conduct coalition-training exercises at increasing levels of potential conflict activity to enhance their interoperability readiness in a mission relevant environment.

Force Commanders assigned representatives to plan and carry out this training evolution. The Team defined the following training script, objectives:

Phase 1 will encompass the initial joining of coalition forces at sea in international waters, near the Oblue Straits (the straits between the two countries) and the subsequent assignment and execution of warfare area of responsibilities. (For the purposes of this exercise, the Hawaiian Islands will serve as the geographical

backdrop in this 'field of play.') This phase addresses the "sociality" issues of a newly formed Battle Group and basic cognitive Operations Room/Combat Information Center and Bridge team coordination skills of communication and situation awareness while conducting task related functions of detecting, reporting, identifying and tracking air, surface and sub-surface contacts.

Phase 2 commences after escalation of tension between Blue and Orange with the Orange potentate withdrawing their Ambassador from Blue and the declaration that the Oblue Straits will "rightfully revert to Orange territorial waters within 24 hours." A thinly veiled threat of "serious consequences will befall those 'violating' Orange's 'sovereign waters'." US/AU declares a "Right of Innocent Passage" in international waters and commences a transit through the Oblue Straits. Aggressive Orange "shouldering" tactics result in an at-sea collision of an Orange and Blue patrol missile boat. During this period one of Orange's two submarines puts to sea and air surveillance of the AU/US/Blue coalition Battle Group (BG) is heightened with provocatively close encounters of coalition P-3C maritime patrol aircraft.

Phase 3 establishes a moving 'Corridor Sanitaire' about the published coalition BG Position of Indicated Movement (PIM) with a radius of 150 nautical miles. A Blue coastal freighter sinks after being struck by a powerful underwater explosion presumed to be from a submarine torpedo strike - a periscope sighting was reported prior to the sinking. Orange patrol boats open fire on Blue neutral shipping in the Oblue Straits. Blue invites AU/US air assets to use their airfields for a combined "Tactical Air Readiness Exercise." Additionally, a US Carrier Battle Group is repositioning to participate.

Phase 4 is punctuated by AU/US self-defense and retaliatory measures-- hostility phase. This phase will be described in a separately proposed "Game Plan".

Phase 5 may be depicted as a surveillance and 'return to normalcy' phase upon the sinking of a number of Orange's antagonist units, a political coup that deposed the Orange potentate, and a successful conclusion of intense diplomatic pressure from the Pacific Rim and World governments.

The rationale of the phased approach is to provide a relevant and achievable level of play dependent upon the level of maturity and robustness gained during the pre-demonstration integration and 'work-ups'

Objective Based Training. The training process will follow the Objective Based Training (OBT) methodology and make maximum use of available modelling and simulation (M&S) capabilities to create a shared virtual battle space. The OBT process model is provided in Figure 5.

Objective Based Training Process Model

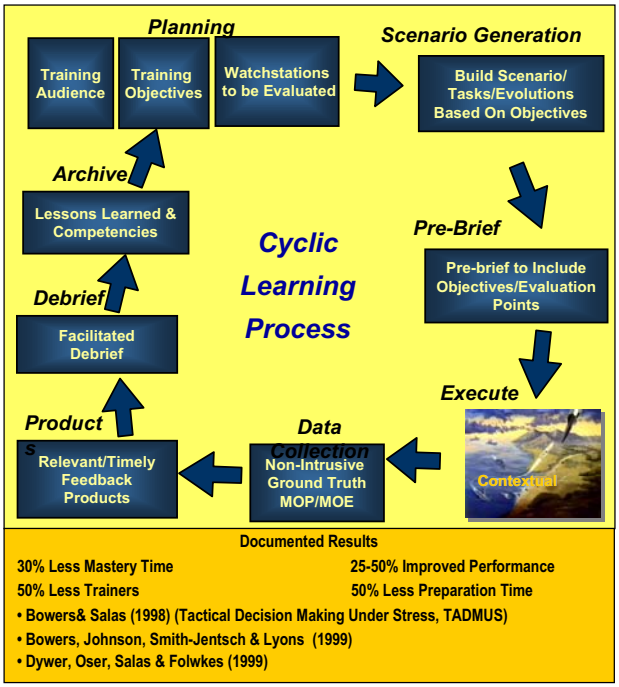

Figure 5: Objective Based Training process model and the distinct components required to produce a meaningful learning experience.

Debrief/After Action Review. At the conclusion of each exercise phase, a Debrief/After Action Review (AAR) will be conducted within 15 minutes. Non-intrusive processes will be utilized to collect Ground Truth and Measure of Performance (MOP) (Perceived Truth) data. Data will be used to produce products, which aid the team in the reflective dialogue process. Through interactive dialogue supported by the debrief products, the team elevate their situational awareness and access their performance relative to defined standards. It is here were the individual and cognitive team 'learning' takes place. However, to be effective this mentored debrief/AAR must be timely and relevant to the training audience. This pivotal step completes the Team Learning Model as described below in Figure 6.

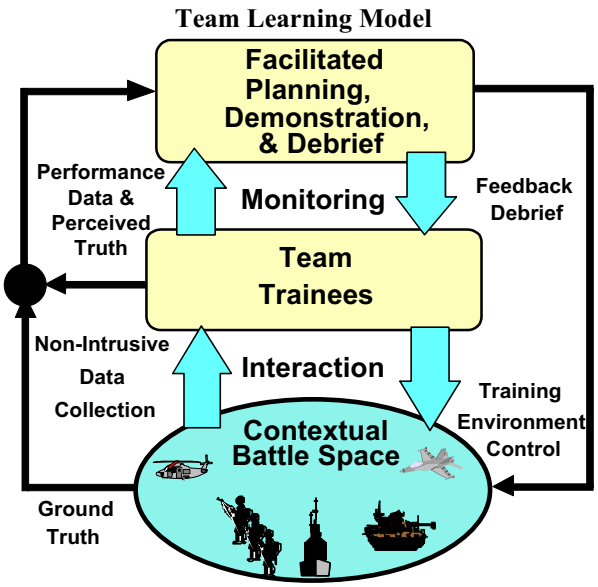

Figure 6: The Team Learning Model shows the trainee immersed in a mentored environment with passive data collection nodes that surrounds and records his actions.

The above Objective Based Training Model and the Team Learning Model will be discussed in greater detail in companion papers and literature at the I/ITSEC Conference [15].

SUMMARY

In summary, the two main concepts addressed in this paper: collaborating at the international level and improving coalition Warfighting readiness through innovative training technology have both proven to be viable approaches to meeting the 21st century challenges. I/ITSEC provides a valuable forum in which to demonstrate early on the results of applying these concepts whereby a diverse audience can observe and interact with the developers. Through this process and the associated dialogue both the public and the developer are benefactors. The developers are provided an opportunity to measure progress with cross-domain feedback. The community at large is provided insight on how innovative use of technology can address problems brought on by the new millennium.

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