Technology Commonality for Simulation Training of Air Combat Officers and Naval Helicopter Control Officers

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Abstract. The (Air Force) Air Combat Officer role and the (naval) Helicopter Control Officer are very different, requiring different skill sets, and which seek very differing objectives within their respective organisations. At face value, simulation training systems for these roles must necessarily incorporate very different functionality to provide role-relevant training for these roles.

Nevertheless, on closer inspection a degree of similarity in the nature of the technology used by these roles becomes evident. Furthermore, similarities in the training process for these roles are also apparent, and these factors suggest that a commonality of simulation training technology may be exploitable.

The application of Cirrus' generic Sensor Simulation Engine (SSE) and associated Simulation Training Network (STN) technology to the rapid development of the Air Combat Officer Training System (ACOTS) and the Helicopter Control Officer Training System (HCOTS) is presented. The manner in which the STN and SSE infrastructure elements enabled the bespoke tailoring to create these two very different systems is considered in detail.

The outcomes in terms of development risk and training capability delivered is reviewed. The relevance of these outcomes to the greater question of whether acquisition of simulation systems to address training needs may be justified in the absence of "off-the-shelf" solutions is presented.

1. INTRODUCTION – A TALE OF TWO ROLES

The RAAF is undergoing significant change as it transitions towards a networked force of geographically dispersed forces interconnected via C3I systems to create competitive warfighting advantage.

Part of this change has been the advent of the Air Combat Officer (ACO) role which encompasses navigation, deployment of sensors and defensive measures.

The ACO role invariably involves operation of technically advanced systems including radar, communications, tactical data link, infra-red targeting, electronic warfare and mission planning and management systems. The ACO must interpret information presented by complex equipment, respond to events and make command decisions at a rate commensurate with the fast tempo of air combat.

To contrast the ACO role, the Helicopter Control Officer (HCO) is a naval role (as defined in certain navies) which has responsibility for the control of the air space in the vicinity of a naval platform.

Typically the HCO will be responsible for managing launch and recovery of rotary wing aircraft from a vessel, management of other aircraft in the controlled airspace, and tactical control of the air assets to accomplish anti-submarine warfare (ASW) and other missions.

The HCO will utilise the ship's radar, associated ship's combat system, communications links and other equipment to accomplish the role's objectives.

The two roles at face value are quite different – with differing objectives, operating at different tempos, and with equipment that reflects the differing cultures of the differing arms of defence within which they operate.

On this basis, it would be reasonable to expect that training needs analyses undertaken for these roles would identify requirements for very different training regimes that address the differing natures of the tasks encompassed by these roles.

By extension, the support provided by simulation training equipment to these training regimes would also be expected to be quite different.

2. SIMILARITIES

Nevertheless, while the roles are very different, there are some similarities which are evident.

Both roles extensively use a radar sensor to monitor contacts, and as a primary source of information from which a tactical picture is developed.

While the user interfaces to the radar and tactical picture compilation systems used by each role will be very different (reflecting the very different organisational cultures), the underlying information flow is equivalent.

As illustrated at Figure 1 (working from left to right), a 'real world' (illustrated as terrain) is observed by a radar sensor, which is controlled by an operator, and which provides track or other tactical data to form a tactical picture (illustrated as a chart).

The green and blue shaded functions are generally provided by equipment, whereas the grey shaded function is provided by personnel.

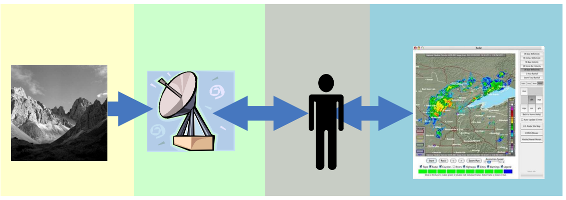


Figure 1 : The use of radar for tactical picture compilation and to aid decision making is common to the ACO and HCO roles.

This equivalence raises the possibility that common simulation technology might offer effective support for the training of both roles.

To facilitate this, a simulation technology with an architecture which is sufficiently flexible and configurable to support adaptation to the very different aspects of the two roles is required.

The following sections describe this technology, and highlight the process by which the technology supports rapid adaptation to differing requirements.

3. A COMMON SIMULATION ARCHITECTURE

The architecture of Cirrus' Simulation Training Network (STN) is depicted at Figure 2.

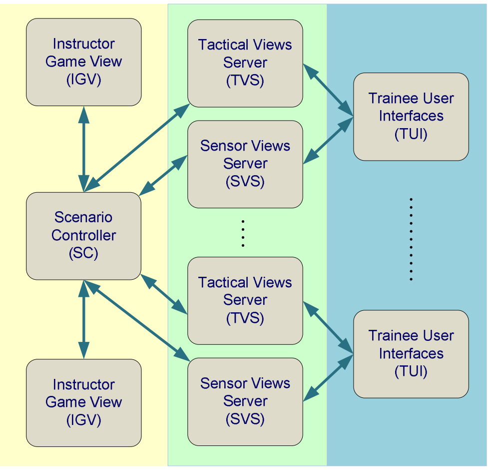


Figure 2 : Architecture of the Cirrus Simulation Training Network (STN).

The core of the STN is a Scenario Controller (SC) which controls the evolution of the real world being modeled. Multiple spokes connect to the SC, including Instructor Game Views (IGV's) which support scenario control and monitoring. Other spokes connect to Sensor Views Servers (SVS) which support the emulation of the behavior and performance of sensors operating within the scenario context.

The SVS themselves connect with Trainee User Interfaces (TUI), to support trainee interaction with the sensors. Typically, such interaction will include controlling the sensors' characteristics, measuring image features, methodologies for extracting tactical information from the sensor imagery, and a means to store and further manipulate this tactical information.

The Tactical Views Server (TVS) provides the means for holding and manipulating tactical data, and the TUI will normally include facilities to support human interaction with such tactical data.

Within the SVS lies the Sensor Simulation Engine (SSE), a powerful technology that is broadly adaptable to mimic the behavior and performance of a wide range of imaging sensors, including radar imaging systems.

By comparison with Figure 1, the SC represents the yellow shaded areas (of Figure 1), the SVS with its associated TUI element represents the green shaded areas, the TVS with associated TUI element represents the blue area, while the grey shaded area is represented by the student trainee.

The elements of the architecture outlined are fully networked via a rich library of inter-application messaging. This messaging is itself adaptable to support differing configurations and needs of specific training applications.

The following section highlights how such adaptation occurs.

4. ADAPTATION OF SIMULATION TECHNOLOGY NETWORK TO SUIT TRAINING FOR DIFFERING ROLES

4.1 Overview

Cirrus has been contracted to supply the RAAF's School of Air Warfare (SAW) with an Air Combat Officer Training System (ACOTS), with delivery occurring in 2011.

Subsequently Cirrus has also been engaged to supply a Helicopter Control Officer Training System (HCOTS) for use in training HCO's for a regional navy.

The following sections provide examples of how the STN and SSE technologies have been tailored to suit the differing training needs for these two simulation training systems.

The nature of the adaptation is highlighted by contrasting the configuration settings of the ACOTS and the HCOTS with each other.

4.2 Aspects of Systems Tailored to Suit Bespoke Requirements

4.2.1 Topology Configuration to Match Required Roles

The ACOTS envisages training of 2 ACO students by 2 instructors, with each instructor monitoring a single ACO. The students interact in a common scenario, but independently develop their own tactical pictures.

As a point of contrast, HCOTS has two instructors who train a single HCO trainee. Each instructor controls differing aspects of the scenario during training, with one instructor acting to control one or more aircraft assets that are under the HCO's control.

Figure 3 illustrates how the STN architecture has been modified for the ACOTS application.

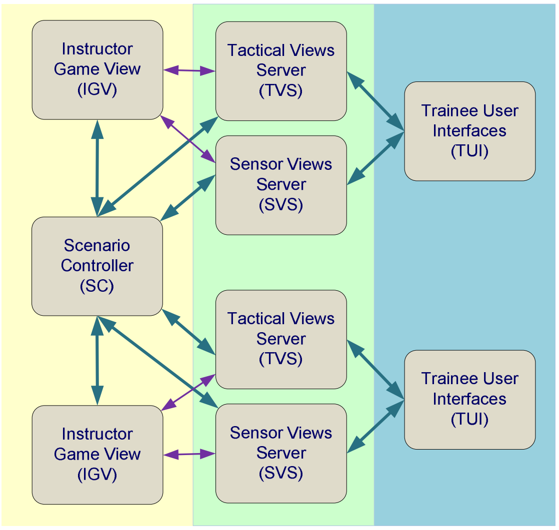


Figure 3 : STN architecture tailored for ACOTS. Each ACO develops an independent sensor and tactical view from a common game.

This may be compared to the configuration used for HCOTS (refer to Figure 4).

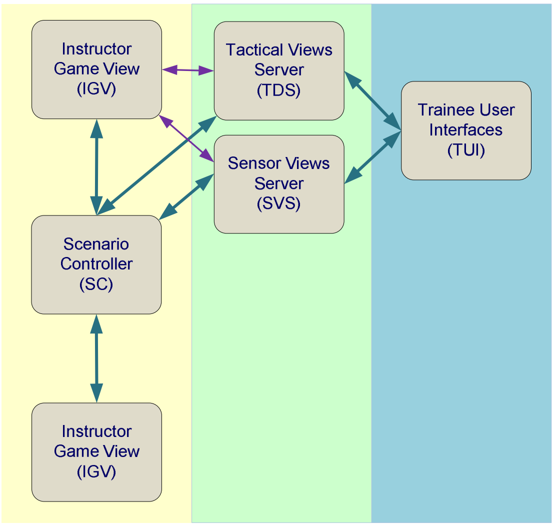


Figure 4 : STN architecture tailored for HCOTS. Two instructors control differing aspects of the scenario while training an individual HCO.

4.2.2 How Instructor Views & Controls World

As a RAAF tool, the ACOTS is required to present the instructor with a map based view of the scenario truth (location of entities etc.).

For the purposes of controlling an HCO training scenario, a vector shoreline chart is the appropriate backdrop for the information presented to the instructor.

However, an integral aspect of HCOTS is that one (or both) of the instructors may act to control the flight of one or more aircraft within the scenario in accordance with the directives provided by the trainee HCO. Accordingly, the HCOTS IGV provides additional facilities to enable an instructor to 'fly' scenario aircraft.

Figure 5 and Figure 6 illustrate the differing IGV's provided for the instructors of these training systems.

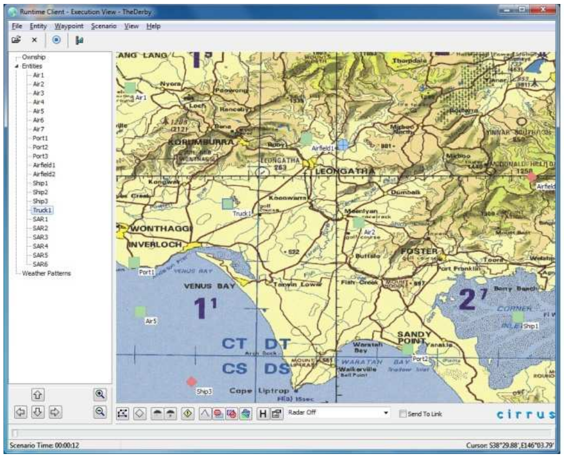


Figure 5 : The ACOTS IGV provides scenario 'truth' against a map background.

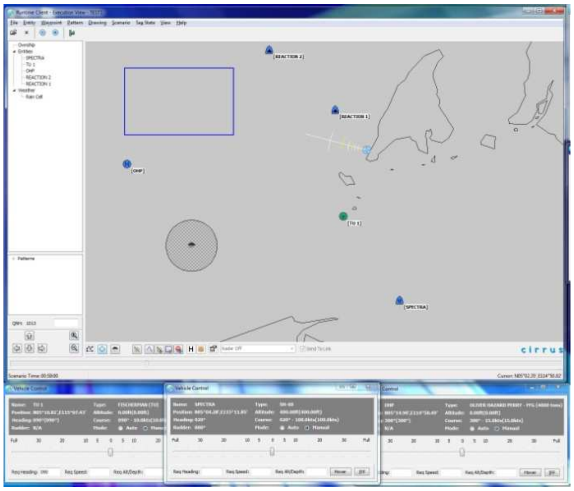


Figure 6 : The HCOTS IGV. Scenario truth is provided against a vector shoreline backdrop, with three asset control windows visible.

4.2.3 Entity Behaviours Controlled Within the Simulation

The ACOTS is required to present opposing forces for differing types of engagements, including ground, sea and air contacts.

As applicable, these entities may require motion against pre-programmed routes and way-points.

Certain entities are required to be able to act as hostile emitters, and for their emissions to be controlled within the scenario. The own-ship platform's motion is not controlled by the ACOTS, but rather it is slaved to either a real aircraft (King Air) or an external flight simulator.

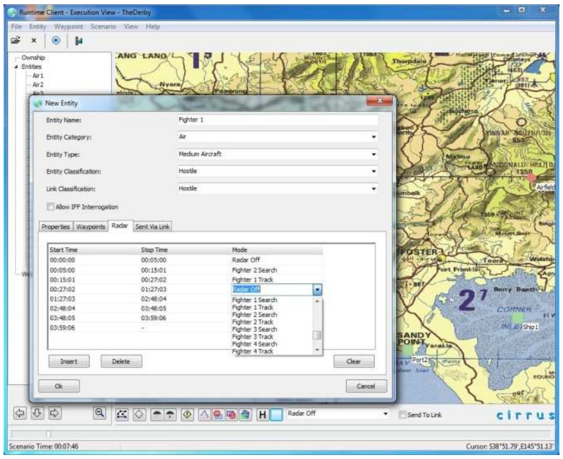
For HCOTS, own ship's motion is controlled by the simulation itself.

While a variety of simulation-controlled aircraft may be introduced into the scenario, what is of particular importance are the friendly aircraft entities which are under the cooperative control of the HCO trainee.

HCOTS provides for an instructor to provide flight control of these aircraft, with HCOTS simulating the flight response of these platforms in the prevailing environmental conditions.

These modifications are captured within the SC and the communications messages across the STN.

Figure 7 illustrates entity attributes which the ACOTS instructor may control, and Figure 8 illustrates the flight controls which the HCOTS instructor may use to 'fly' an aircraft within the scenario.



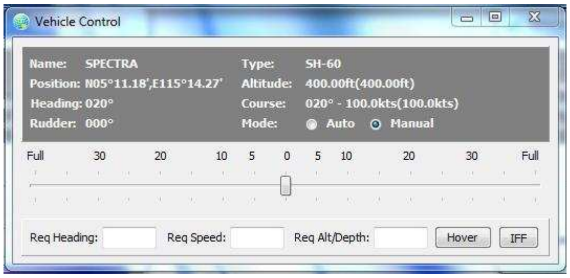
Entity Name: Fighter 1
Entity Category: Air
Entity Type: Medium Aircraft
Entity Classification: Hostile
Link Classification: Hostile
☐ Allow IFF Interrogation

Start Time	Stop Time	Mode
00:00:00	00:05:00	Radar Off
00:05:00	00:15:01	Fighter 2 Search
00:15:01	00:27:02	Fighter 1 Track
00:27:02	01:27:03	Radar Off
01:27:03	02:48:04	
02:48:04	03:48:05	
03:48:05	03:59:06	
03:59:06	-	

Scenario Time: 00:07:46

Cursor: S38°51.79',E145°51.13'

Figure 7 : The ACOTS IGV enabling editing of an entity's radar emission modes and intervals.



Name: SPECTRA
Type: SH-60
Position: N05°11.18',E115°14.27'
Altitude: 400.00ft(400.00ft)
Heading: 020°
Course: 020° - 100.0kts(100.0kts)
Rudder: 000°
Mode: ● Auto ◉ Manual

Figure 8 : The vehicle control window of the HCOTS IGV, enabling an instructor to 'fly' an aircraft according to the trainee HCO's directives.

4.2.4 Trainee View of Sensor Processor

The training concept for the ACOTS is to present the ACO trainee with a representation of a generic modern radar display housed in a multi-function display (MFD). This has been achieved by developing a GUI application with a visual layout representative of an MFD, and with 'soft' buttons operating a menu system with a function hierarchy appropriate for task.

Examples include buttons which control radar tilt, display gain, range etc (refer to Figure 9).

By comparison, the HCOTS provides an HCO trainee with a user interface designed to represent the look and feel of a naval radar combat system (refer to Figure 10).

The displays include the radar display, with integrated tactical picture compilation tools overlaid over the radar video imagery.

Communications systems to enable the HCO to select communications channels to aircraft being controlled are also simulated.

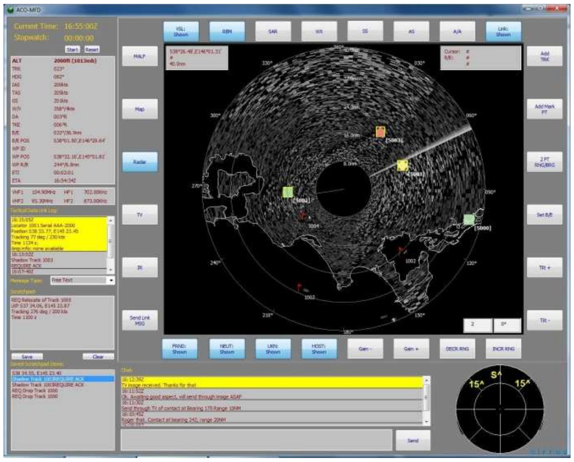


Figure 9 : The ACO display presents a representative multi-function display with embedded radar and other displays.

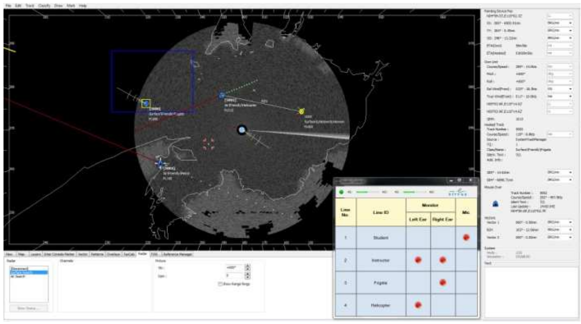


Figure 10 : The HCOTS trainee interface, which presents trainees with a radar and communications displays representative of a naval combat system.

4.2.5 Tactical Picture Compilation

The ACOTS is required to enable ACO students to access a "moving-map" display within the MFD.

This display is where all contacts, tracked by both on-board (radar, TV and IR) and off-board (NCW link) contacts are displayed, and subject to further ACO management (e.g. updating of classification marking, transmission off-board to other platforms etc.).

Additionally, the moving map display is used by the ACO to learn how to manage his/her mission file and associated artifacts prepared within Falconview. The ACO may select from a wide range of chart types to serve as the map background.

The HCOTS provides a point of comparison, with the naval combat system being represented providing tactical picture compilation functions in an integrated fashion with the radar imagery.

As illustrated at Figure 10. airspace management tools, such as velocity lead vectors, anchored lead points and tactical boxes are overlaid over the radar imagery.

One aspect of the HCO's role which has particular importance is the direction of Ship's Controlled Approach (SCA) and Emergency Low Visibility Approaches (ELVA). These activities are supported by combat system tools, as illustrated at Figure 12.

The tactical picture operations are conceptually equivalent, but differ in the details of the specific tactical tasks required by each role and the corresponding differing user interface features presented by each system.

Figure 11 : The ACO moving map display presents, and facilitates management of contact information overlaid against selectable chart types.

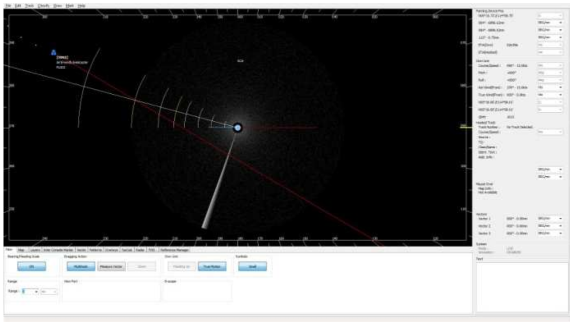


Figure 12 : The HCOTS trainee interface, with combat system tools for Ship Controlled Approach.

4.2.6 Sensor Engine Configuration

In addition to the various differences between the training requirements of the ACOTS and HCOTS, the radar sensors being simulated in these systems are quite different, with one being airborne and the other being mast mounted.

The differing needs of sensor simulation trainers to simulate sensors with divergent designs and behaviours (such as this case) is supported by appropriate configuration of the SSE.

In the case of the ACOTS, the intent is to emulate a 'representative' radar sensor with either a "wedge" or "donut" beam foot-print shape. The overall imagery is formed by a simulated swept mechanically steered beam, with the characteristic beam edge evident.

Imagery is formed with appropriate range, azimuthal field of view and resolution characteristics, vertical beam shapes and other typical radar characteristics.

The HCOTS by contrast emulates a representative naval surface search and air search radar.

These (and many other) characteristics of these imaging sensors are captured as deterministic and stochastic parameters used by the SSE within these systems.

Typically, the instructors (i.e. the end users of the sensor simulation system) will be involved in the adjustment of the large number of imaging parameters within the SSE which may be configured.

This process is generally conducted 'live', with the instructors providing feedback on the imagery as it is being generated in real time, and while parameters are being adjusted. In this fashion, the SSE may be tailored so that the imagery simulation is fit for the training purpose, as intended by the instructors.

In addition to different configurations, the differing level of fidelity required for the simulation of terrain returns differs for the two systems. As the HCOTS radar is primarily imaging the ocean surface and adjoining airspace, this system does not need detailed rendering of terrain returns. This compares to ACOTS which has requirements for high fidelity rendering of ground clutter returns to enable navigation training.

The consequence of this is that HCOTS operates entirely effectively with DTED level 0 fidelity terrain imagery, whereas ACOTS utilises DTED level 2 and VMAP image fidelity.

5. OUTCOMES AND CONCLUSION

The flexibility inherent in the STN architecture and the SSE enables bespoke sensor simulation training systems to be rapidly developed against requirements.

The ACOTS was produced using this approach, with the product completing FAT (December 2010) within 7 months of contract execution (May 2010), and with HCOTS produced in 5 months (June 2011 through to FAT completion in October 2011).

These examples of successful completion of simulation projects involving even extensive software re-engineering, within schedules of under a year is something of an outlier in the defence sector.

Noting that ACOTS and HCOTS address requirements that are mutually divergent, the schedule outcomes achieved on these projects testifies to the suitability of the STN and the associated SSE technology to the rapid generation of sensor simulation trainers.