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Gun Control for VBE-E

User Guide and Technical Description

Tania E. Wentzell

Canada

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Defence R&D Canada – Atlantic

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Abstract

This paper describes the gun control interface that was added to the Horizon 3 Command and Control (C2) framework, a central component of the distributed experimentation environment used by the Virtual Combat System (VCS) Group at Defence R&D Canada – Atlantic (DRDC Atlantic), for Virtual Battle Experiment – Echo (VBE-E). This interface, in the form of a Horizon plug-in, allows the operator to identify which targets are within firing range, assign targets to the gun, fire the gun, and monitor ammunition inventory. The plug-in was developed with a 76mm gun in mind, to support the requirements of the Technical Cooperation Program's (TTCP) Maritime Systems Group Technical Panel – 1's (MAR TP-1) VBE-E, which took place in October 2006.

The paper is divided into three main sections. The first section describes what an operator using the plug-in needs to know about the interface. The second section is for the scenario developer who wishes to configure an instance of Horizon and an existing Virtual Maritime Systems Architecture (VMSA) federation to include one or more gun controllers. The third section deals with the High Level Architecture (HLA) details of the interface and how it interacts with a gun federate that models the gun itself and the resulting detonations. While any gun model could conceivably be modified to be a VMSA gun federate and communicate with the gun controller, a gun federate was also developed for VBE-E, and it is this federate that will be referred to in this final section.

Résumé

L'article décrit l'interface de conduite d'arme qui a été ajoutée au cadre de commandement et de conduite (C2) Horizon 3, un composant central de l'environnement d'expérimentation distribué utilisé par le groupe Système de combat virtuel (SCV) de R & D pour la défense Canada – Atlantique (RDDC Atlantique), dans le cadre de l'expérience de bataille virtuelle – Écho (VBE-E). Cette interface prend la forme d'un plugiciel Horizon et permet à l'utilisateur d'identifier quels sont les objectifs à portée de tir, de les assigner au canon, de faire feu et d'effectuer un suivi des stocks de munitions. Le plugiciel a été développé pour fonctionner avec le canon de 76 mm afin de répondre aux besoins du programme de coopération technique (TTCP) du Comité technique du Groupe des systèmes maritimes – 1 (MAR TP-1) VBE-E qui s'est déroulé en octobre 2006.

L'article comprend trois grandes parties. La première partie décrit ce que l'utilisateur du plugiciel doit savoir à propos de l'interface. La seconde partie est destinée au développeur de scenarios qui souhaite configurer une instance Horizon et la fédération de l'actuelle architecture de système maritime virtuel (VMSA) pour englober un ou plusieurs contrôleurs de canon. La troisième partie porte sur les détails de l'architecture de haut niveau (HLA) de l'interface et sur la façon dont elle interagit avec le logiciel fédérateur du canon qui modélise ce dernier ainsi que les détonations résultantes. Bien que n'importe quelle modélisation de canon pourrait éventuellement être

modifiée pour devenir un logiciel fédérateur de canon VMSA afin de communiquer avec le contrôleur de tir, un logiciel fédérateur du canon a néanmoins été développé pour le VBE-E, et c'est de ce dernier dont il est question dans la dernière partie.

Executive Summary

Gun Control for VBE-E: User Guide and Technical Description

Wentzell, T.E.; DRDC Atlantic TM 2006-245; Defence R&D Canada – Atlantic; November 2006.

Background

The Horizon 3 Command and Control (C2) framework is a key component of the distributed experimentation environment used by the Virtual Combat System (VCS) Group at Defence R&D Canada – Atlantic (DRDC Atlantic). Horizon provides a display for entities and sensor tracks as well as tools for managing these tracks. The VCS Group's experimentation environment uses the Virtual Maritime Systems Architecture (VMSA), an application and extension of the High Level Architecture (HLA). Until now, the group's work has focused more on sensor modeling than weapon modelling.

Principal results

This plug-in extends the simulation capabilities that can be offered by the VCS Group for demonstration and experimentation purposes to include support for attacks using shipboard guns. It enhances an existing C2 framework by providing an interface for identifying which targets are within firing range, assigning targets to the gun, firing the gun, and monitoring ammunition inventory. The controller interacts through HLA with a gun federate which models the gun itself and determines ammunition detonation locations.

Significance of results

DRDC Atlantic recently led the Technical Cooperation Program's (TTCP) Maritime Systems Group Technical Panel – 1's (MAR TP-1) Virtual Battle Experiment – Echo (VBE-E). The panel's aim was to use a higher fidelity simulation environment with human operators making the decisions in order to validate the Force Defence C2 operations research study carried out by the MAR Action Group 1 (MAR AG-1). Many of the components required to put together such a simulated environment already existed prior to VBE-E. However, a critical component which did not exist was the ability to fire shipboard guns and model detonations. This Horizon gun controller plug-in and the new gun federate address that requirement.

Future work

Future enhancements to this plug-in to support capabilities of specific guns or gun models may be necessary. As well, valuable input was received from VBE-E operators and will be considered for future versions. Possible new capabilities include: changing the ammunition type, un-assigning tracks, displaying the gun's orientation on the map display, firing on air platforms, covering multiple tracks at once, and covering tracks that are not within the gun's range. These are all discussed in greater detail at the end of this paper.

Sommaire

Gun Control for VBE-E: User Guide and Technical Description

Wentzell, T.E.; DRDC Atlantic TM 2006-245; R & D pour la défense Canada – Atlantique; Novembre 2006.

Contexte

Le cadre de commandement et de conduite (C2) Horizon 3 est le composant central de l'environnement d'expérimentation distribué utilisé par le groupe Système de combat virtuel (SCV) de R & D pour la défense Canada – Atlantique (RDDC Atlantique). Horizon permet d'afficher des entités et d'en faire la poursuite au moyen de capteurs, en plus de comprendre les outils pour gérer les poursuites. L'environnement d'expérimentation du groupe SCV utilise l'architecture de système maritime virtuel (VMSA) qui est une application et un prolongement de l'architecture de haut niveau (HLA). Jusqu'à maintenant, les travaux du groupe ont porté plus sur la modélisation des capteurs que sur celle du canon.

Résultats

Le plugiciel accroit les capacités de simulation offertes par le groupe SCV à des fins de démonstration et d'expérimentation et permet de comprendre le support aux attaques avec les armes embarquées. Il améliore le cadre C2 actuel en offrant une interface permettant d'identifier quels sont les objectifs à portée de tir, de les assigner au canon, de faire feu et d'effectuer un suivi des stocks de munitions. Le contrôleur de tir interagit par l'entremise de la HLA avec le logiciel fédérateur du canon qui modélise ce dernier et détermine les emplacement des détonations résultantes des munitions tirées.

Portée

RDDC Atlantique a récemment dirigé le programme de coopération technique (TTCP) du Comité technique du Groupe des systèmes maritimes – 1 (MAR TP-1) VBE-E pour l'expérience de bataille virtuelle – Écho (VBE-E). Le but du comité était d'utiliser un environnement de simulation plus fidèle et de faire prendre les décisions par les utilisateurs de façon à valider les études de recherches d'opérations de Défense Force C2 menées par le Groupe d'action MAR 1 (MAR AG-1). Beaucoup de composants nécessaires pour créer un tel environnement simulé existaient déjà avant le VBE-E. Cependant, l'une des composantes essentielles qui manquaient était la capacité de tirer les armes du navire et de modéliser les détonations. Le plugiciel du contrôleur de tir Horizon et le nouveau logiciel fédérateur du canon répondent à ces besoins.

Recherches futures

Des améliorations futures au plugiciel pourraient être nécessaires afin de supporter les capacités de modèles de canons ou d'armes spécifiques. De même, des informations importantes ont été recueillies auprès des opérateurs du VBE-E et elles seront prises en considération lors du développement des versions à venir. Parmi les nouvelles capacités envisagées, notons la

possibilité de changer de type de munition, l'interruption d'une assignation de poursuite, l'affichage de l'orientation du canon sur la carte, le tir contre des objectifs aériens, le gestion de plusieurs poursuites en même temps et la gestion de poursuites hors portée du canon. Tous ces points sont discutés en de plus amples détails à la fin de l'article.

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1   Introduction

The Horizon 3 Command and Control (C2) [1] framework is a key component of the distributed experimentation environment [2] used by the Virtual Combat System (VCS) Group at Defence R&D Canada – Atlantic (DRDC Atlantic). Horizon provides a display for entities and sensor tracks as well as tools for managing those tracks (e.g., association, fusion, deletion, labelling, filtering, etc.). It is well-suited for use within a research environment as it can be quickly modified to incorporate new ideas or test new concepts using its plug-in architecture. The VCS Group's experimentation environment uses the Virtual Maritime Systems Architecture (VMSA) [3], an application and extension of the High Level Architecture (HLA). The VMSA Federation Object Model (FOM) defines the information and format of information that can be shared amongst various simulation components (federates) in the environment. A VMSA plug-in to Horizon allows Horizon to read in and interpret data created by other VMSA federates (otherwise known as data 'subscription') and pass information back out to the VMSA world for other federates to use (data 'publishing').

DRDC Atlantic led the Technical Cooperation Program's (TTCP) Maritime Systems Group Technical Panel – 1's (MAR TP-1's) Virtual Battle Experiment – Echo (VBE-E) [4] which was run in October 2006. The panel's aim was to validate Force Defence C2 recommendations from the MAR Action Group 1's (MAR AG-1) study [5] which used operational research tools for analysis. For VBE-E, a higher fidelity human-in-the-loop (HIL) simulation environment was used with real operators making the decisions and shaping the outcome of each scenario. While the details of individual VBE-E scenarios varied, each involved two naval ships escorting two High Value Units (HVUs) through a narrow strait, defending themselves and the HVUs against a swarm attack.

The architecture for the simulation environment and many of the required components to support this scenario already existed prior to the conception of VBE-E. However, a critical component of the environment which had not been previously addressed was the ability to fire shipboard guns. The gun controller plug-in described in this document helped satisfy that shortcoming by providing an interface for determining which targets are within firing range, assigning targets to the gun, firing the gun, and monitoring ammunition inventory. The controller interacts through HLA with the gun federate [6] which models the gun itself and determines ammunition detonation locations. The gun controller also receives information about the gun from the gun federate and uses it to determine which controls should be made available to the operator at a particular time. For example, if the gun model indicates that the gun is jammed, the interface should not allow the gun to be fired.

Design ideas for this interface came from a variety of sources: discussions with subject matter experts (SMEs) at DRDC Atlantic, documentation on the 76mm gun onboard Canada's IROQUOIS class destroyers [7], and investigation of the gun control interface in the commercial game, Dangerous Waters [8].

At plug-in design time, the model to be used as the basis of the VBE-E gun federate had not yet been selected. However, the limited time frame meant that at least an initial cut at the plug-in needed to be developed and then model-specific changes could be made afterwards if necessary. For this reason, the gun controller went through various versions before settling for VBE-E at

version 1.5.0, which is the version that will be discussed in this document. In the end, it was decided that the gun federate for VBE-E would be based on the Maritime Asymmetric Engagement Model (also known as DBBT) [9].

The official VMSA FOM (version 3.6.0) is not specific about what information should be sent in a gun fire interaction. Thus, it was decided that the FOM would be modified (through additions only) to include a Gun object and GunControl interaction. For the purposes of VBE-E, the attribute values for the Gun object were set entirely by the gun federate and the parameter values for the GunControl interaction were set entirely by Horizon. Proper use and common interpretation of these attributes and parameters by both the gun interface and gun federate developers were critical to successful integration of the two components.

2 User Guide for the Gun Operator

2.1 Overview

The purpose of this section is to provide the Horizon gun operator with an overview of how gun control in Horizon works. It focuses on the use of two new modular Horizon components (referred to as plug-ins): the 'Target List' plug-in and the 'Gun Controller' plug-in. The gun controller plug-in can be used independently or it can be used in conjunction with the target list plug-in to give the operator an additional level of control over the list of tracks that may be fired upon. The operator can use the gun controller to visually identify which tracks are within firing range, to assign the gun to a track (e.g., a radar track) or to a manually entered position, to fire rounds, and to monitor ammunition inventory.

Prior to an exercise, the scenario developer will decide:

- whether or not the target list plug-in will be used,

- whether or not non-ownship tracks may be targeted and fired upon, and

- what classification of tracks (i.e., any combination of hostile, neutral, and unknown) may be targeted and fired upon.

Details on configuring these items are included later in this document. All diagrams in this document were captured from a Horizon instance which was configured to use the target list plug-in and to include ownship tracks and tracks of all classifications (besides friendly) as possible targets. Any differences that can be expected when other choices are made will be noted.

It may be useful for the user to keep in mind that there is another simulation (a gun federate) controlling the gun. This gun federate controls the movement and state of the gun; Horizon subscribes to the state data and displays the state in the gun status window of the gun controller (e.g., 'Ready for target assignment'). The gun federate tries to perform realistically, so, for example, the gun will not be instantaneously assigned to a track chosen by the operator. Rather it will calculate how long it would take to rotate and aim the gun and will pause that long before changing the gun's status to 'Ready to fire'.

2.2 Target List Plug-in

The target list plug-in gives the operator complete control over which tracks are made available in the gun controller plug-in for firing on. The list is maintained in this separate plug-in so that it can supply filtered tracks to various other plug-ins (e.g., multiple instances of the gun controller plug-in). Figure 1 shows the target list plug-in interface.

Figure 1: Target List Plug-in Interface

2.2.1　Selectable Tracks

The tracks that are available for selection from the drop-down list depend on the configuration that has been chosen by the scenario developer. In Figure 1, the target list has permitted the selection of ownship tracks (i.e., those beginning with 'Frg1_') and non-ownship tracks (i.e., those beginning with 'Frg2_') as well as tracks of any classification (i.e., hostile (red), unknown (yellow), neutral (green)). Thus, the drop-down list includes all tracks in the Horizon system that have not been identified as friendly. Track classification is set by the operator using the 'Track Parameters' plug-in.

If the scenario developer had decided that only hostile tracks from the ownship (i.e., Frg1) should be targeted, this list would be shorter (e.g., Frg2_Radar:5 and Frg1_Radar:14 would not be in the list).

The radio buttons at the top of the plug-in allow the operator to filter out all tracks that are not from the ownship, if desired. Even though the gun controller may allow firing on non-ownship tracks, the operator may not be comfortable doing so.

In the case where the scenario developer has decided not to permit selection of non-ownship tracks at all, the radio buttons will not appear in the plug-in and there will be no way for the operator to select or fire on non-ownship tracks (besides manually entering bearing and range information).

2.2.1.1　The Effects of Track Processing

Using other Horizon plug-in tools, tracks may be fused, associated, dropped, deleted, un-fused, etc.. When such things happen to tracks in the target list (and gun controller) plug-ins, the following can be expected:

- if a track in the drop-down or target list is fused or associated with another track, the resultant track will replace the original track in the same list,

- if two or more tracks in the drop-down or target list are fused or associated, only the resultant track will appear in the same list after the fusion or association,

- if a fused or associated track in the drop-down or target list is later un-fused or disassociated, all of the component tracks will appear in that same list. It will be up to the operator to remove any that are no longer of concern,

- if a track in the drop-down or target list is dropped, it will be removed from the list it is in. If it is un-dropped, it will reappear in the drop-down list,

- if a track in the drop-down or target list is deleted, it will be deleted from the list it is in, and

- if a track that is in the list is re-classified such that it no longer matches the plug-in requirements, that track will no longer appear in either the Current Target List or the drop-down list.

However, when tracks of different classifications are involved in fusions or associations, the above will only hold true where the resultant or component tracks have classifications that meet the filters set for the plug-in.

2.2.2 Using the Target List Plug-in

The use of this plug-in is fairly straight forward. Select a track from the drop-down list and click the Add button to add it to the Current Target List. To remove a track from the Current Target List, select it in the list and click Remove. It will be returned to the drop down list for possible re-selection.

By default, when a new track is added to the list it appears at the top of the list. The priority arrows to the right of the list allow the operator to organize the tracks by perceived priority. This prioritization will be reflected in the gun controller plug-in. However, it is not necessary to prioritize the tracks; it is simply a tool that may be used if the operator deems it to be useful.

2.3 Gun Controller Plug-in

The gun controller plug-in provides the operator with an interface to the gun. More than one instance of the gun controller plug-in may be used in a single Horizon instance in order to provide control over multiple guns. The user can move from one gun to another by clicking on the appropriately labelled tab. In Figure 2 there is only one tab, labelled '76MM'.
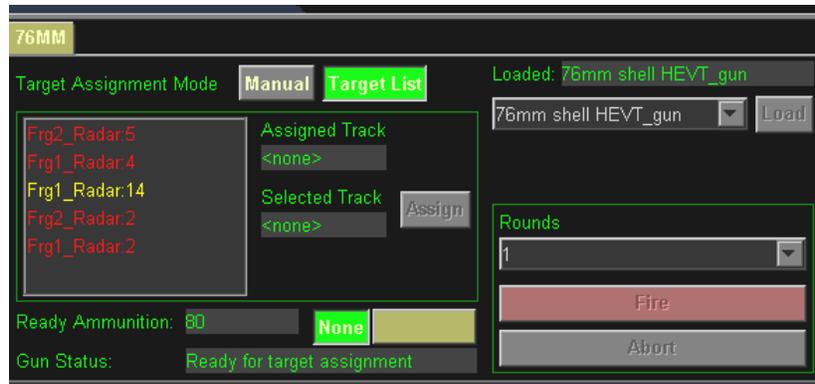
Figure 2: The Gun Controller Plug-in 'Ready for target assignment'

When the gun controller plug-in is used in conjunction with the target list plug-in, the tracks in the gun controller's list are a subset of the tracks in the Current Target List in the target list plug-in, further filtered according to the minimum and maximum range and azimuths of the gun. The order / prioritization of tracks is inherited from the target list plug-in.

When the gun controller plug-in is used independently (i.e., without the target list plug-in), its track list is a subset of all the tracks in the Horizon system, filtered by classification and source (ownship-only or all sources), and further filtered to the minimum and maximum range and azimuths of the gun. Tracks may be reordered / prioritized using the arrows to the right of the list (which only appear when the target list plug-in is not being used).

The gun controller plug-in was used independently for VBE-E, since during the pilot study feedback from operators indicated that there were too many steps that had to be taken before being able to fire the gun. However, during the actual experiment, operators indicated that they would like a way to be able to selectively choose which tracks ended up in the gun controller list, which could have been accomplished with the target list plug-in. So there are advantages and disadvantages to each set-up.

In any case, the list in the gun controller will be continually updated based on the gun's coverage and the relative position of the target to the ownship, so tracks will come in and out of range and pop into and out of the target list when this happens. The rules discussed for the target list plug-in (Section 2.2.1.1) also apply to the track list in the gun controller plug-in.

2.3.1 Viewing Gun Coverage

To view the expected coverage of the gun, click the coloured rectangle next to the None button, and the gun coverage area will appear in the map display. An example is provided in Figure 3. This coverage is valid for surface platforms only. For VBE-E, only surface platforms (besides the UAV) were used, so this was sufficient. Note the existence of a blind arc in the coverage. To hide the coverage, click the None button.

Figure 3: Horizon Map Display with Coverage Arc

When Horizon is configured to use more than one instance of the gun controller plug-in (i.e., when there is more than one gun to control), each gun will have its own coverage area. Multiple coverage areas can be displayed (layered) on the map at one time. Using various colours to shade the coverage areas, it is possible for the operator to relate a coverage area to a particular gun (see also Section 3.2).

2.3.2   Target Assignment

The plug-in has two modes for assigning target information. The first is the Target List mode where the user can assign the gun to a track in the list. The second is a Manual mode, where the operator can assign the gun to a bearing, range and height, or a latitude and longitude. The benefit of assigning the gun to a track rather than a position is that once the gun is assigned to that track, the gun model will continue to adjust its position according to the current information in that track. Alternatively, if a position is entered and becomes out of date, the gun will still aim at that position until a new value is manually entered.

Prior to assigning a track or position to the gun, the gun status will read 'Ready for target assignment' as in Figure 2.

2.3.2.1   Assigning a Track to the Gun

When in Target List mode, the track that is currently highlighted in the gun controller's target list will be displayed on the Selected Track line. At times, particularly when there is a high density of tracks, it may be difficult for the operator to relate a track number (or name) in the list to a track

on the map display. To aid in this, when a track is selected in the list, it will become selected in the map display. Similarly, when a track that is in the list is selected in the map display, it will become selected in the list. This feature was requested by one of the operators participating in VBE-E. Note that the same does not apply for de-selection of tracks.

To assign the selected track to the gun, click the Assign button. The gun status should[1] change to 'Aiming', 'Acquiring', and then 'Ready to fire'. The Assign button will become and remain inactive unless a different track is highlighted in the list. The Fire button will become activated. See Figure 4.
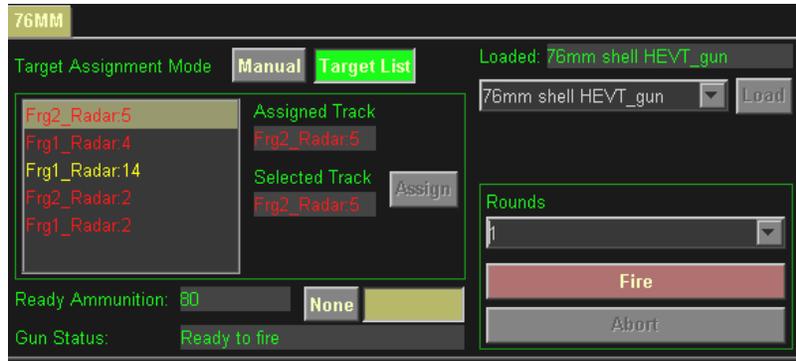
Figure 4: The Gun Controller Plug-in 'Ready to fire'

2.3.2.1.1   The Secret of the Disappearing 'Assigned Track'

In the event that the track that is currently assigned to the gun is modified in some way (fused, associated, un-fused, disassociated, dropped, etc.), the gun assignment will be lost. That is, the gun will not automatically be assigned to the new track. The gun will return to a 'Ready for target assignment' state.

2.3.2.2   Assigning a Manually Entered Position to the Gun

When the Manual target assignment mode is selected, the gun will not be assigned to a particular track (Figure 5). Rather, the operator must enter in manual values, indicating the expected location of the target. These values can be entered as Bearing/Range/Height or Latitude/Longitude.

This may be useful when there is no track in the system for a known entity, or for firing a warning shot.

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[1] It is possible that the gun will not be able to assign to the requested track. The gun takes into account the velocity of the ownship, target, and proposed ammunition, and if it determines that the target could not be reached, the gun will not assign to that track and will return a 'Ready for target assignment' status.

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When ready, click the Assign button. As in the first case, the gun status should change to 'Aiming', 'Acquiring', and then 'Ready to fire'. The Assign button will become and remain inactive unless a different manual value is entered. The Fire button will become activated.
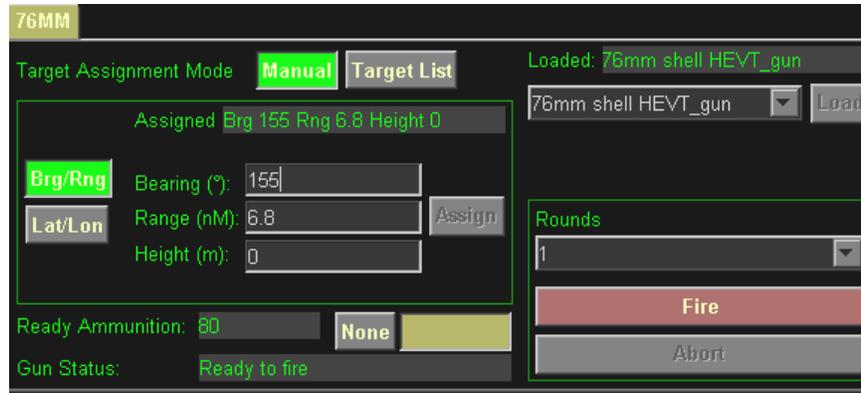
Figure 5: The Gun Controller Interface for Manually Entering Target Information

2.3.3 Selecting the Number of Rounds

The gun can fire a fixed number of shells with one click of the Fire button. Some default burst sizes appear in the drop-down list, but the operator is free to choose whatever burst size is desired. Burst sizes are not limited by the amount of Ready Ammunition. If the operator chooses a burst size that exceeds the amount of loaded ammunition, the gun will fire what's available and then will stop and reload. However, it will not continue to fire after reloading. The Fire button must be clicked again.

2.3.4 Firing the Gun and Aborting Fire

Click the Fire button to fire a burst of the size selected at the target chosen. The number next to the Ready Ammunition text in the plug-in will begin to count down, and will stop when the requested amount of ammunition has been fired. The gun status will read 'Firing' while this is happening (Figure 6).
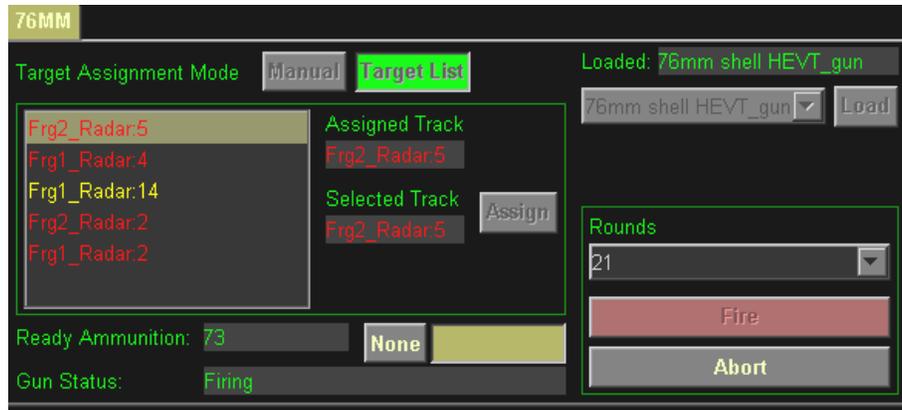
Figure 6: The Gun Controller Plug-in 'Firing'

If it is necessary to interrupt fire, click the Abort button. Note, however, that the result of this action will not be instantaneous. The message to abort fire must reach the gun before the gun can react, and until that time the gun will continue to fire. When the fire or abort action is complete, the gun will remain assigned to the track that it just fired on and the status will read 'Ready to fire'.

2.3.5   Determining Success

With the current (VBE-E) federation set-up, success of an attack can only be inferred. The entities that are being fired at are controlled by another simulation (the Joint Semi-Automated Forces (JSAF)) which does not automatically remove an entity when it is killed. Rather, the entity still exists but it slows down to a near-zero velocity and its visual representation in JSAF changes (though the Horizon operators can not see this). In Horizon, the only way to determine if an entity that was modeled in JSAF has been damaged or killed is to look at the speed estimate for the track(s) on that entity. For VBE-E, all attack vessels came in at approximately 30 knots, so when one of them slowed down to 1 or 2 knots, its destruction was a fair assumption. Of course, it is *possible* an entity could decide to slow down to a stop for other reasons. Radio reports of 'smoking vessels' and 'people jumping overboard' were also provided to the operators to give additional feedback.

2.3.6   Reloading the Gun

Reloading of the gun occurs automatically once ammunition is depleted to zero. No interaction is required from the operator. However, while the gun is reloading, its status will read 'Reloading' and the operator will be unable to assign anything to the gun or to fire it (Figure 7). When complete, the gun status will return to 'Ready for target assignment'. It will not automatically continue to fire ammunition, even if the rounds requested exceeded the loaded ammunition at the time of the request.

Figure 7: The Gun Controller Plug-in 'Reloading'

2.3.7 Repairing the Gun

From time to time the gun may get jammed. This is controlled by the gun model as well and the gun model will automatically begin repairing the gun. The gun status will read 'Repairing' during this time and the operator will be unable to assign to the gun or fire it. When complete, the gun status will return to 'Ready for target assignment'.

2.3.8 Changing the Ammunition Type

The Load button was included in the design of the plug-in to allow the operator to request that the gun change its ammunition type. An initial attempt at implementing this functionality was made, but it was unsuccessful. While this shouldn't be hard to implement, it was abandoned in the interest of getting higher priority functionality working within the VBE-E timeline.

3 Installing and Initializing the Target List and Gun Controller Plug-in

3.1 Software Versions

The gun controller plug-in version 1.5.0 and target list plug-in version 1.1.3 are compatible with Horizon 3 version 3.7.3, VBE-Echo-FOM version 0.5.0 (an extension of the VMSA FOM version 3.6.0), and the Horizon VMSA plug-in, dated 29-September-2006[2]. Both plug-ins have been successfully run using version 3.0.1 of the MAK Run Time Infrastructure (RTI). Compatibility with previous versions of Horizon and other RTIs has not been explored or tested. The gun controller plug-in will not work with any previous versions of the VMSA FOM or VMSA plug-in since they did not handle gun objects and interactions.

3.2 Plug-in Registration

To add a plug-in to Horizon 3 version 3.7.3, it must be registered in the plugin.ini initialization file. This file is used to tell Horizon which plug-ins should to be made available to the particular Horizon instance.

To add the target list plug-in, add this to the plugin.ini file:

```
[Target List]
class = au.com.iscience.navy.horizon.targetlist.TargetListPlugIn
```

One or more instances of the gun controller may be used in a single Horizon instance.

If only one gun controller instance will be used, add the following:

```
[Gun Controller]
class = au.com.iscience.navy.horizon.guncontroller.GunControllerPlugIn
number of instances = 1
multiple instances = false
```

In this case, a file called guncontroller.ini will be used to configure the single gun controller.

If more than one gun controller instance will be used, use the following format to add the required number of instances (there are three instances in this example):

```
[Gun Controller]
class = au.com.iscience.navy.horizon.guncontroller.GunControllerPlugIn
number of instances = 3
multiple instances = true
params 1 = guncontroller-1.ini
params 2 = guncontroller-2.ini
params 3 = guncontroller-3.ini
```

---

[2] Unfortunately, no versioning convention has been applied to the Horizon VMSA plug-in. Versions can only be differentiated by their dates of modification.

In this case, files called guncontroller-1.ini, guncontroller-2.ini, and guncontroller-3.ini will be used to configure the three gun controller instances.

If the VMSA plug-in is not already registered, add the text below to the plugin.ini file:

```
[Horizon VMSA Plugin]
class = au.com.iscience.navy.trackfusion.federate.VMSAPlugIn
number of instances = 1
```

This Horizon VMSA plug-in does not have a Graphical User Interface (GUI) like the other two plug-ins. It works behind the scenes, passing information back and forth between the gun controller and the HLA world.

Also, a new plug-in container format was created for the gun controller and must be added to the plugin.ini file. It uses coloured tabs (see Figure 8) to allow the user to move from one plug-in instance to another. (In the case of the gun controller, the colours correspond to the colours of the gun's coverage area, making it easy to decipher which area goes with which gun.)

So the final item that must be included in the plugin.ini file is:

```
[Colour Tab Container]
class =
au.com.iscience.navy.trackfusion.gui.eguimanager.ColourTabbedContainer
```
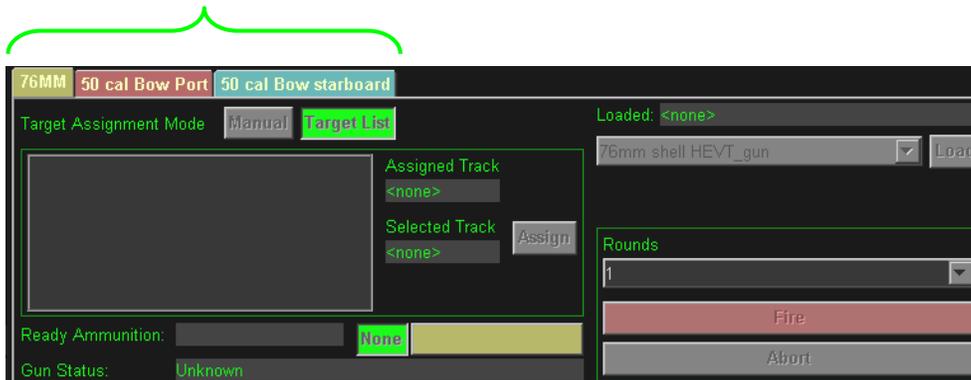

Figure 8: Coloured Tabs to Select Gun Instance

3.3   GUI Configuration

The Horizon display consists of a number of sockets that can display the GUI of various plug-ins. The 'main' plug-in socket typically displays a map or time-bearing chart which can be manipulated using other plug-ins in 'standard' and 'wide' sockets. The 'wide' sockets are twice as wide as the standard sockets. The target list plug-in is of standard size, but the gun controller plug-in is wide and requires more effort to configure.

3.3.1 The GUI Manager (gui.xml)

The XML-based GUI Manager (gui.xml) needs to be informed that the new plug-ins with GUIs should be included in Horizon configuration, and of the type of sockets that they require.

The target list plug-in is standard size, so add the following under `<contentgroup id="StdSktPlugins">` in the gui.xml file:

```
<content name="Target List"/>
```

The gun controller plug-in is wide and uses a new layout, so add the following layout to the gui.xml file:

```
<layout id="WideSkt1">
  <container id="SP" name="Colour Tab Container">
    <property id="tabBackgrounds"
            value="1=0xff7f7f40"/>
    <content name="Gun Controller" instance="1"
              label="76MM"/>
  </container>
</layout>
```

The string `0xff7f7f40` indicates the colour of the tab[3]. The `label` is the textual description that will appear on the tab. If more than one instance of the gun controller plug-in is wanted, then use the following format (in this example, there are three instances):

```
<layout id="WideSkt1">
  <container id="SP" name="Colour Tab Container">
    <property id="tabBackgrounds"
            value="1=0xff7f7f40,2=0xff7f4040,3=0xff407f7f"/>
      <content name="Gun Controller" instance="1"
              label="76MM"/>
      <content name="Gun Controller" instance="2"
              label="50 cal Bow Port"/>
      <content name="Gun Controller" instance="3"
              label="50 cal Bow starboard"/>
  </container>
</layout>
```

3.3.2 The GUI Manager Roles (guiManageRoles.ini)

Typically, four standard plug-ins, or, one wide plug-in and two standards plug-ins, are displayed in the plug-in area at the bottom of a Horizon display. There are buttons to the left of these plug-ins that allow the operator to move between predefined sets of plug-ins, and more importantly to change from a configuration with four standard sockets to one that includes a wide socket. One

---

[3] Each colour is defined using an 8-digit hexadecimal code, RRGGBB, where RR, GG, and BB represent the red, green, and blue components of the colour. Each colour code is prefixed with '0x' to inform the programming language parser that a hexadecimal number follows.

of these buttons must lead to a wide socket that can display the gun controller plug-in. Add a 'preset' to the guiManagerRoles.ini as follows:

```
[PRESET 4]
  title = Tracks
  1/Primary/SOUTH/SOUTH/MenuSplit2/P3 = Wide Sockets$1
  1/Primary/SOUTH/SOUTH/MenuSplit2/P3/WideSockets/StdSockets1/WS.2 =
      WideSkt1$1
  1/Primary/SOUTH/SOUTH/MenuSplit2/P3/WideSockets/StdSockets1/WS.2/
      WideSkt1/SP = Gun Controller$1
  1/Primary/SOUTH/SOUTH/MenuSplit2/P3/WideSockets/StdSockets4/
      StdSockets5/WS.3 = StdSkt3$2
  1/Primary/SOUTH/SOUTH/MenuSplit2/P3/WideSockets/StdSockets4/
      StdSockets5/WS.3/StdSkt3/SP = Track Identification$1
  1/Primary/SOUTH/SOUTH/MenuSplit2/P3/WideSockets/StdSockets4/
      StdSockets6/WS.4 = StdSkt4$2
  1/Primary/SOUTH/SOUTH/MenuSplit2/P3/WideSockets/StdSockets4/
      StdSockets6/WS.4/StdSkt4/SP = Track Parameters$1
```

This looks more confusing than it really is (or needs to be). Just copy this text and change any (or none) of the following:

- the preset number (e.g., 4), depending on how many other presets were already defined,

- the title (e.g., Tracks) – this is the text that will appear on the button, and/or

- the two other default plug-ins (e.g., Track Identification, Track Parameters).

3.4   Target List Plug-in Initialization File

The target list initialization file allows the developer to identify which tracks should appear in the plug-in's drop down list and the label type used to identify the tracks. Specifically, the parameters in this file are:

- **include ownship tracks only** – a Boolean value to indicate whether or not tracks with a source platform other than ownship will be available for selection,

- **track label type** – tracks in Horizon have various labels associated with them. They may be numeric, textual, or both. Valid entries for this parameter are: DisplayID, RawID, MasterID, DefaultID, and Full. A brief description of these and other track label options can be found in Annex A,

- **allow hostile tracks** – a Boolean value to indicate whether or not hostile tracks should be available for selection,

- **allow neutral tracks** – a Boolean value to indicate whether or not neutral tracks should be available for selection, and

- **allow unknown tracks** – a Boolean value to indicate whether or not unknown tracks should be available for selection.

A sample targetlist.ini file is as follows:

```
[Default]

  include ownship tracks only = true
  track label type = raw ID

  allow hostile tracks = true
  allow neutral tracks = true
  allow unknown tracks = true
```

3.5   Gun Controller Initialization File

The gun controller initialization file allows the developer to configure the gun and its ammunition types. When a Horizon instance is only using one instance of the gun controller, the initialization file by default is called guncontroller.ini. In the case where multiple instances of the gun controller are being used, there is an initialization file for each gun controller and the names of the initialization files will be set in the plugin.ini file in the [Gun Controller] category (e.g., guncontroller-1.ini, guncontroller-2.ini, etc.).

3.5.1   General

The following parameters are found within the General category:

- **name** – the name of the VMSA gun object with which the plug-in instance should communicate,

- **description** – a textual description of the gun instance which can be displayed at the top of the plug-in window. The coloured navigation tabs are also labelled (see Section 3.3.1), so this additional description would only be useful if a more detailed or alternative description was required,

- **show description** – a Boolean value to indicate whether or not the description (above) will appear in the plug-in. This value has been set to 'false' for all figures in this document,

- **include ownship tracks only** - a Boolean value to indicate whether or not tracks with a source platform other than ownship will be available for selection,

- **use target list plug-in** – a Boolean value to indicate whether or not the target list plug-in will be used to feed track names to this plug-in,

- **burst sizes** – default values to appear in the 'rounds' drop-down box (e.g., 1, 5, 21, 50),

- **track label type** – tracks in Horizon have various labels associated with them. They may be numeric, textual, or both. Valid entries for this parameter are: DisplayID, RawID,

MasterID, DefaultID, and Full. A brief description of these and other track label options can be found in Annex A,

- **coverage line colour** – the colour used to outline the gun's coverage area in the map display (e.g., 0xff7f7f40),

- **coverage fill colour** – the colour used to shade in the gun's coverage area in the map display. The simplest way to set this is to leave the default of 0x40000000, which will result in the fill being a semi-transparent version of the coverage line colour,

- **coverage filled** – a Boolean value to indicate whether or not the gun's coverage area should be shaded in,

- **allow hostile tracks** – a Boolean value to indicate whether or not hostile tracks should be available for selection,

- **allow neutral tracks** – a Boolean value to indicate whether or not neutral tracks should be available for selection, and

- **allow unknown tracks** – a Boolean value to indicate whether or not unknown tracks should be available for selection.

3.5.2   Ammunition

All categories (indicated by square brackets, [ ]) besides the General category are assumed to be types of ammunition. The category name (i.e., the text in square brackets) is the name that will appear in the gun controller's ammunition list.

The gun model is responsible for setting the ammunition that is loaded at the start of a scenario. Horizon will match the loaded ammunition (i.e., the fuse, warhead and munition type) to one of the ammunition types in the gun controller initialization file and the corresponding category name will show in the Loaded box of the gun controller.

The ability to change ammunition type has not yet been implemented, so clicking the Load button currently has no effect. To prevent the Load button from becoming active and causing confusion for the operator, only the type of ammunition that is loaded at the start of the simulation should be placed in the gun controller initialization file (i.e., there should be nothing to change to) until the loading functionality is implemented.

Each ammunition category includes the following parameters:

- **FuseType** – the DIS enumeration for the fuse type,

- **WarheadType** – the DIS enumeration for the warhead type, and

- **MunitionType** – the DIS enumeration for the munition type.

The following is an example of an initialization file for the gun controller plug-in:

```
[General]
  name = 76MM_Frigate1
  show description = false
  description = 76MM
  include ownship tracks only = false
  use target list plugin = true
  burst sizes = 1, 5, 21, 50

  coverage line colour 1 = 0xff7f7f40
  coverage fill colour = 0x40000000
  coverage filled = true

  track label type = raw ID

  allow hostile tracks = true
  allow neutral tracks = true
  allow unknown tracks = true

[76mm shell HEVT_gun]
  FuseType = 3500
  WarheadType = 1670
  MunitionType = 2.6.225.2.3.4.0
```

3.6   Defining the Gun to Control

At this point the Horizon side of the gun set-up is complete. However, unless there is a gun object defined in the VMSA world for the Horizon gun controller to control, the controller will be of no use. Guns are defined in the Virtual Maritime Systems Execution Manager (VMSEM) script file. The following information is placed in the VMSEM script file with respect to the gun:

- name (this name should match the name in the gun controller initialization file),

- initial FuseType, WarheadType, and MunitionType,

- number of shells in the magazine at start up,

- name of the parent composite entity (identification of the ship that the gun is on),

- relative position and orientation (with respect to the parent entity), and

- maximum, minimum, and rest azimuths (used to determine which tracks are within range)

A sample definition of a gun in the VMSEM script file is included in Annex B.

Also, don't forget to add the gun federate to the federation, by including:

```
<ParticipatingFederate Name="Gunnery"/>
```

with the other participating federates in the VMSEM XML script file.

4   The HLA Details

The gun controller plug-in itself does not communicate directly with a VMSA federation. All communication between Horizon and any VMSA federation occurs through the Horizon VMSA plug-in. The VMSA plug-in already existed prior to the implementation of the gun controller, but it had to be extended to handle the requirements for gun control. Prior to VBE-E, the VMSA plug-in could subscribe to surface, subsurface and air entities, as well as track objects created and updated within a VMSA federation. It could publish fused tracks back into a VMSA federation and also publish itself as a command and control entity. It could publish LaunchControl interactions when firing torpedoes with the torpedo launcher plug-in [10].

Prior to VBE-E, the VMSA FOM did not support guns or gun control interactions. A new object (Gun) and interaction (GunControl) were therefore added to version 3.6.0 of the VMSA FOM, resulting in the VBE-Echo-FOM version 0.5.0.

4.1   Additions to the VMSA FOM

The gun component entity that was added to the FOM has the attributes shown in Table 1, not including those inherited from the ComponentEntity class. The gun control interaction that was also added has the parameters shown in Table 2, not including those inherited from the ControlMessage class. Exact data formats of the attributes and parameters can be found by looking at the XML version of the FOM. However, sample values are provided.

The VMSA plug-in subscribes to the Gun object and publishes the GunControl interactions. The gun entity is owned by the gun federate and all of the values in the gun object's attributes are filled in by the gun federate. The gun controller (through the VMSA plug-in) uses these attribute values to:

- fill in information in its interface (rounds remaining, type of loaded ammunition, gun state, current target track or position),

- to determine which tracks should appear in its target list and where to draw the coverage arc (minimum and maximum range, minimum and maximum azimuth), and

- to determine which buttons should be available for selection (based on the status attribute).

All gun control interactions are published by the gun controller (through the VMSA plug-in), and instigated by the operator clicking one of the buttons (Assign, Fire, Abort) in the gun controller.

Note that the gun controller does not currently offer a way to un-assign an assigned track, so the UnassignTarget interaction is not used at this time. Future plans include the addition of such functionality. Also, as mentioned previously, the SetAmmunitionType interaction (which would be instigated by clicking the Load button) is not currently implemented.

Table 1: New VMSA Gun Object

ENTITY	ATTRIBUTES	EXPLANATION	EXAMPLE
ComponentEntity. Gun	State	The current status of the gun.	0 (Ready)
	RoundsRemainingIn Magazine	The number of rounds left in the currently loaded magazine.	80
	MaximumRange	The maximum range of the gun.	5000 m
	MinimumRange	The minimum range of the gun.	50 m
	MaximumAzimuth	The maximum traversal angle of the gun.	2.356 radians
	MinimumAzimuth	The minimum traversal angle of the gun.	-2.356 radians
	MaximumElevation	The maximum elevation angle of the gun.	1.483 radians
	MinimumElevation	The minimum elevation angle of the gun.	-0.007 radians
	CurrentTargetObject InstanceName	If an object (including a track) is the target, then this must be filled in.	Frg1_Radar:7
	CurrentTargetPosition	If the target is a manually-entered position, then this must be filled in.	2050708.7270788176 m (X), -3944124.874331929 m (Y), 4558405.84524933 m (Z)
	LoadedAmmunition	The type of ammunition currently loaded.	3500 (FuseType), 1670 (WarheadType), 2.6.225.2.3.4.0 (MunitionType)

Table 2: New VMSA GunControl Interactions

INTERACTION	SUBCLASS	PARAMETERS	DEFINITION	EXAMPLE
ControlMessage. GunControl	AbortFire		Used to interrupt the firing of a gun.	N/A
	Fire	RoundsToFire	Used to tell a gun to fire on the current target with the loaded ammunition.	50
	SetAmmunition Type	AmmunitionToUse	Used to tell a gun to change its loaded ammunition type.	3500 (FuseType), 1670 (WarheadType), 2.6.225.2.3.4.0 (MunitionType)
	AssignTarget	TargetInstance	Used to assign a target track to a gun.	Frg1_Radar:7
	UnassignTarget		Used to remove a gun's target.	N/A
	AssignTarget Position	TargetPosition	Used to set a target position for a gun to fire on.	2050708.7270788176 m (X), -3944124.874331929 m (Y), 4558405.84524933 m (Z)

4.2   Further Additions to the VMSA Plug-in

In addition to adding the capability to publish gun control interactions and subscribe to gun objects, the VMSA plug-in was also modified to allow for automatic publishing of datums, fused tracks, and system tracks. Prior to VBE-E, only fused tracks could be published and this was only accomplished by the operator manually clicking a button to initiate the publication. Since it is necessary for the gun federate to have knowledge of any track that the operator may choose to assign the gun to, all tracks that are created within Horizon (as opposed to those created outside of Horizon and subscribed to by Horizon, such as raw radar tracks) must be published from Horizon. The operator can create a datum when there is no existing track in a location for which a contact exists. The operator can also choose to fuse two or more tracks together (creating a new fused track) or to associate two or more tracks (creating a new system track).   Since any of these tracks could be assigned to the gun when within range, the gun federate must be aware of them. Therefore all of these tracks need to be published, and it needs to happen automatically with no operator input.

To activate this feature, add this to the plugin.ini initialization file:

```
[Auto Publication]
  class = au.com.iscience.navyhorizon.publication.
          AutomaticPublicationPlugIn
  number of instances = 1
  default params = VMSA Publisher
```

and in the autopublication.ini file set the publication flag to '4' and all other options to true:

```
[VMSA Publisher]
  publication type = 4
  FUSED = true
  SYSTEM = true
  DATUM = true
```

Also, be sure to set Horizon's Simulation Object Model (SOM) to publish RelativeSystemTracks and RelativeFusedTracks. (Datum tracks are published as RelativeSystemTracks.) This is easiest to do by opening the SOM file with the Object Model Development Tool (OMDT) and checking the 'Publish' tick box for both types of tracks.

5   Future Enhancements

While the gun controller in its current form was acceptable for VBE-E, there are numerous enhancements that could be made to it. Some of these were part of the original design that had to be dropped due to time constraints, some are not functionality changes but are recommended for clarity, and others are suggestions made by the Canadian naval operators that participated in VBE-E. It is important to note, however, that to implement many of these would mean changes to the gun federate in addition to the gun controller plug-in.   Here is the list of possible enhancements, and a few thoughts on what would be involved to implement them:

- **Default values in manual mode** – Currently, if a track is assigned to the gun and the user switches to manual mode, the Assigned box will display '<? no current ownship record>' and the Bearing/Range/Height boxes are set to 0 by default. It could be more useful to have the Assigned box as well as the Bearing/Range/Height boxes to default to the current values for the track that is assigned to the gun. However, until the user clicks the Assign button, the track (rather than a position) would remain assigned to the gun. The user could edit the default values as desired before clicking the Assign button. In the case where no track or position has been assigned to the gun, the Assigned box should be blank and the Bearing/Range/Height boxes should default to values that are set in the gun controller configuration file. This change does not affect the gun federate in any way.

- **Clarify the method for showing gun coverage** - In the original design for this plug-in, there was a check box with text next to it that read 'show coverage'. Somehow through various modifications to this plug-in, the coloured push button appeared and the text vanished, resulting in a very non-intuitive feature. This should be modified in a future version. This change does not affect the gun federate in any way.

- **Un-assign a track** – Currently, once a track is assigned to the gun, the only way to un-assign it is to assign another track or position to the gun. For this enhancement, an Un-Assign button should be added to the gun controller (in both the target list and manual interface) which becomes active whenever the gun status is 'Ready to fire' (i.e., when a track or position has been assigned to the gun). When the operator clicks the Un-Assign button, the VMSA plug-in sends an UnassignTarget interaction (already built into the FOM) and the gun federate removes its current target from its 'CurrentTargetObjectInstanceName' or 'CurrentTargetPosition' attribute and sets its status to 'Ready for target assignment'. The gun federate is already programmed to deal with the UnassignTarget interaction.

- **Display the gun's orientation** – the VBE-E operators indicated that it would be helpful if a (blue) line was shown on the map display, originating from the ownship and extending in the direction of the of the gun's orientation. There is already an attribute in the Gun entity called RelativeOrientation.   This attribute is inherited from the super-object class, ComponentEntity, and so is not displayed in Table 1. The gun federate already fills in this attribute with the relative orientation of the gun barrel with respect to the ship. So, the gun controller would need to obtain this information from the VMSA federation (through the VMSA plug-in) and draw the line according to the value in the RelativeOrientation attribute. A check box should also be added to the interface to turn this feature on and off.

- **Cover two tracks at once** – VBE-E operators indicated that normally they would be able to 'cover' two tracks at a time. The gun controller interface, the FOM, and the gun federate

are currently only set-up to allow the operator to assign the gun to one target at a time. To add this functionality could require changes to all of these. Even if multiple tracks could be chosen, it seems they would have to be given priorities so that the gun would know where to point. The operators also mentioned being able to fire at each of these targets back to back with a single click of the 'Fire' button. These changes are not minimal and thus would require a fair bit of thought to implement.

- **Change ammunition** - the gun controller can already handle filling its list box with various types of ammunition and the Load button becomes active when a type of ammunition that differs from the loaded ammunition is selected. However, clicking the Load button currently has no effect. So, the gun controller plug-in must be modified so that when the button is clicked, a SetAmmunitionType interaction is sent. The gun federate is already programmed to subscribe to this interaction and change the LoadedAmmunition attribute of the gun accordingly.

- **Fire on air platforms** – Currently, both the gun federate and the gun controller assume that the platforms that will be fired upon are surface platforms. The coverage areas shown in Horizon are based on this assumption. Given Horizon's 2-dimensional interface, it would not be feasible to show coverage based on all elevations. Beyond this, the gun controller is responsible for providing Horizon with the values to define these areas, and adding elevation into the mix would clearly mean a lot more work for this federate. However, this could be looked at further if there is a requirement to fire guns at air targets using this interface and model. In this case, not showing coverage and not limiting what can be fired upon may be a simple first implementation.

- **Cover a track that's not in range** – the VBE-E operators indicated that even if a track is not in range, they may wish to cover it so that they can be ready to fire at it when/if it comes into range. This would also be non-trivial to add given that the current implementation of the gun controller assumes that you would not target a track unless it was within range. And similarly the gun federate will not currently allow the gun to be assigned to a target if it determines its ammunition could not reach it. These restrictions could potentially be removed from both models, but the implications would need to be considered.

There are no doubt many changes that could make this plug-in more realistic, more flexible, and more complete. However, with each 'enhancement' there is additional complication to the interface (which has a limited screen area to be displayed in to begin with) and it is important to make sure that the benefit of the changes that are undertaken are not outweighed by the lack of (or perceived lack of) intuitiveness of the resulting plug-in.

References

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[4]   Hazen, Mark G., et al., *TTCP MAR TP-1 VBE-E: Swarm Attack C2 Issues*, Version 4.3, DRDC Atlantic TM *in draft*, 2006.

[5]   Marland, Peter, et al., *Net Centric Maritime Warfare – Countering a 'Swarm' of Fast Inshore Attack Craft*, 10th International Command and Control Research Technology Symposium, Paper 053, April 2005.

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[8]   *Dangerous Waters Software*, Sonalysts Combat Simulations, 2004.

[9]   Crawford, M.G.A., *Manual on Using Maritime Asymmetric Engagement Model (DBBT) Version 6*, MARLANT ORD Research Note RN-02/2004.

[10]   Wentzell, Tania E. and Lisa Goold, *Horizon 3 Torpedo Launcher Plug-in: User Guide and Technical Description*, DRDC Atlantic TM 2005-209, December 2005.

Annex A   Horizon Track Label Formats

TRACK LABEL TYPE	DESCRIPTION
DisplayID	The ID assigned to the track by Horizon when it enters the system.
RawID	The data source and track ID in the form "dataSource:trackID", e.g., Frg1_Radar:1.
MasterID	An optional ID set by the operator (e.g. RHIB).
DefaultID	The MasterID, if valid, otherwise the DisplayID, if valid, otherwise, the RawID.
Full	One of the following, depending on the available data: MasterID (DisplayID), DisplayID, MasterID (RawID), RawID.
brg/rge/cse/spd Ownship relative	The bearing, range, course and speed, where bearing and range are relative to the Ownship. Invalid values are displayed with a '?' and all values are displayed using the value type's current units of measure.
brg/rge/cse/spd source platform relative	As above, but with bearing and range relative to the position of the track's source platform.
members	A comma-delimited list of the track's association or fusion members.

Annex B   VMSEM Script File Excerpt

```
<!-- START 76MM GUN -->
<ComponentEntity Type="Gun" Name="76MM_Frigate1"
   FederateName="Gunnery">
   <ComponentEntityAttribute AttributeName="FuseType">
      <AttributeEntry AttributeValue="3500" AttributeType="i"/>
   </ComponentEntityAttribute>
   <ComponentEntityAttribute AttributeName="WarheadType">
      <AttributeEntry AttributeValue="1670" AttributeType="i"/>
   </ComponentEntityAttribute>
   <ComponentEntityAttribute AttributeName="MunitionType">
      <AttributeEntry AttributeValue="2.6.225.2.3.4.0"
      AttributeType="s"/>
   </ComponentEntityAttribute>
   <ComponentEntityAttribute AttributeName="ShellsinMagazine">
      <AttributeEntry AttributeValue="80" AttributeType="i"/>
   </ComponentEntityAttribute>
   <ComponentEntityAttribute AttributeName="ComponentName">
      <AttributeEntry AttributeValue="76MM_Frigate1"
      AttributeType="s"/>
   </ComponentEntityAttribute>
   <ComponentEntityAttribute AttributeName="GunType">
      <AttributeEntry AttributeValue="76MM" AttributeType="s"/>
   </ComponentEntityAttribute>
   <ComponentEntityAttribute
      AttributeName="ParentCompositeEntityObjectInstanceName">
      <AttributeEntry AttributeValue="Frigate1" AttributeType="s"/>
   </ComponentEntityAttribute>
   <ComponentEntityAttribute AttributeName="RelativePosition">
      <AttributeEntry AttributeValue="25" AttributeType="d"/>
      <AttributeEntry AttributeValue="0" AttributeType="d"/>
      <AttributeEntry AttributeValue="5" AttributeType="d"/>
   </ComponentEntityAttribute>
   <ComponentEntityAttribute AttributeName="RelativeOrientation">
      <AttributeEntry AttributeValue="0" AttributeType="d"/>
      <AttributeEntry AttributeValue="0" AttributeType="d"/>
      <AttributeEntry AttributeValue="0" AttributeType="d"/>
   </ComponentEntityAttribute >
   <ComponentEntityAttribute AttributeName="MaxAzimuth">
      <AttributeEntry AttributeValue="2.36" AttributeType="d"/>
   </ComponentEntityAttribute>
   <ComponentEntityAttribute AttributeName="MinAzimuth">
      <AttributeEntry AttributeValue="-2.36" AttributeType="d"/>
   </ComponentEntityAttribute>
   <ComponentEntityAttribute AttributeName="RestAzimuth">
      <AttributeEntry AttributeValue="0.0" AttributeType="d"/>
   </ComponentEntityAttribute>
</ComponentEntity>
```

List of symbols/abbreviations/acronyms/initialisms

C2	Command and Control
DBBT	Maritime Asymmetric Engagement Model
DRDC	Defence R&D Canada
FOM	Federation Object Model
GUI	Graphical User Interface
HIL	Human-in-the-Loop
HLA	High Level Architecture
HVU	High Valued Unit
JSAF	Joint Semi-Automated Forces
MAR TP-1	Maritime Systems Group Technical Panel – 1
SMEs	Subject Matter Experts
SOM	Simulation Object Model
OMDT	Object Model Development Tool
RTI	Run Time Infrastructure
TTCP	The Technical Cooperation Panel
VBE	Virtual Battle Experiment
VCS	Virtual Combat Systems
VMSA	Virtual Maritime Systems Architecture
VMSEM	Virtual Maritime Systems Execution Manager

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This paper describes the gun control interface that was added to the Horizon 3 Command and Control (C2) framework, a central component of the distributed experimentation environment used by the Virtual Combat System (VCS) Group at Defence R&D Canada – Atlantic (DRDC Atlantic), for Virtual Battle Experiment – Echo (VBE-E). This interface, in the form of a Horizon plug-in, allows the operator to identify which targets are within firing range, assign targets to the gun, fire the gun, and monitor ammunition inventory. The plug-in was developed with a 76mm gun in mind, to support the requirements of the Technical Cooperation Program's (TTCP) Maritime Systems Group Technical Panel – 1's (MAR TP-1) VBE-E, which took place in October 2006.

The paper is divided into three main sections. The first section describes what an operator using the plug-in needs to know about the interface. The second section is for the scenario developer who wishes to configure an instance of Horizon and an existing Virtual Maritime Systems Architecture (VMSA) federation to include one or more gun controllers. The third section deals with the High Level Architecture (HLA) details of the interface and how it interacts with a gun federate that models the gun itself and the resulting detonations. While any gun model could conceivably be modified to be a VMSA gun federate and communicate with the gun controller, a gun federate was also developed for VBE-E, and it is this federate that will be referred to in this final section.

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