

VR-Forces

Configuration Guide

VT MÄK
A company of VT Systems



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Preface

This manual is written for persons who want to configure or customize VR-Forces® without using the API. The manual assumes that you are familiar with the use of VR-Forces, as described in *VR-Forces Users Guide* and *VR-Forces Scenario Management Guide*.

Please see release documentation for information about changes and updates to VR-Forces since this manual went to press.

How This Manual is Organized

The chapters are organized as follows:

Chapter 1, *Optimizing Performance* describes how to monitor VR-Forces's performance in the Frame Rate Monitor and how to configure VR-Forces to improve performance.

Chapter 2, *VR-Forces Configuration Files* explains the syntax of configuration files and the parameters in the configuration files provided with VR-Forces.

Chapter 3, *Scenario Files* describes the files used to define a scenario and how to edit them.

Chapter 4, *The Object Parameter Database* describes the object parameter database, which contains parameters for entities and control objects, and how to edit it.

Chapter 5, *Using the Entity Editor* explains how to use the Entity Editor to edit entity parameters, systems, and models.

Chapter 6, *Using the OPD Editor* explains how to use the OPD Editor to edit entity and system parameters. The OPD Editor lets you edit all entity parameters, while the Entity Editor only lets you edit some parameters.

Chapter 7, *Configuring Object Behaviors* describes additional configuration files that VR-Forces uses to manage munitions, formations, and joystick use.

Chapter 8, *Using VR-Forces with an External Comms Effects Server* explains how to configure VR-Forces to work with external communications effects servers, such as QualNet.

Chapter 9, *Display Engine Configurations* explains how to configure windows and channels and how to save and load display configurations.

Chapter 10, *Composing Terrains* explains how to build terrain databases by importing elevation data, imagery, and feature data.

Chapter 11, *Mapping Models and Effects* explains how map entity enumerations to the models configured in VR-Forces.

Chapter 12, *Model and Element Definitions* explains how to create and edit model schemas, model definitions, and element definitions.

Appendix A, *Object Parameters* describes the high level parameters used in OPD files.

Appendix B, *Terrain Tutorials* provides step-by-step instructions for creating and saving a terrain database.

Appendix C, *Model Tutorials* provides step-by-step instructions for creating a model and mapping it to an entity enumeration.

Appendix D, *Creating and Editing Key Mappings* explains how to edit key mappings and create new key mappings.

Appendix E, *Configuring the GUI* explains how to configure the menus, toolbars, and dialog box pages that get displayed.

Appendix F, *The WRM Specification* explains the WRM specification for 3D modeling.

Appendix G, *Processing MetaFlight Files* explains how to preprocess MetaFlight files so that VR-Forces can load them.

Appendix H, *Editing Earth Files* explains the syntax of EARTH files so that you can customize them for viewing streaming terrain from terrain servers.

Appendix I, *Configuring Feature Data* explains how to create configuration files for feature data whose attributes use different values than the ones that are preconfigured by VR-Forces.

VR-Forces Documentation

VR-Forces documentation is provided as manuals in PDF format, online help, and HTML class documentation. The PDF files are in the *./doc* directory. The VR-Forces documentation set is as follows:

- *VR-Forces Documentation Center* is your central starting point for accessing the VR-Forces manual set. It has a documentation roadmap, tables of contents for all manuals, and a master index, including the TDB Tool, to help you find references to subjects that are covered in two or more manuals or locate the manual in which a particular topic is discussed. All table of contents entries and index entries are live links to the manuals.
- *VR-Forces Getting Started Guide* is a quick introduction to VR-Forces. It covers the basics of installing VR-Forces, running a scenario, and creating a scenario. It focuses on helping new users avoid common mistakes.
- *VR-Forces Users Guide* describes how to install VR-Forces and configure license management. It explains how to use the VR-Forces graphical user interface to view simulations and how to manage aspects of VR-Forces that are not directly related to creating and running scenarios.
- *VR-Forces Scenario Management Guide* explains how to create and run scenarios.
- *VR-Forces Configuration Guide* explains advanced features for configuring performance and how to edit VR-Forces configuration files. It includes documentation of the Entity Editor, OPD Editor, and Scenario Merge tools. It also explains how to compose terrains and configure 3D models.
- *VR-Forces Migration Guide* collates API migration information for recent releases.
- Online help. The VR-Forces front-end, the OPD Editor, the Entity Editor, and the TDB Tool have online help accessible from the Help menu.
- VR-Forces Developers Guide and API documentation. Class documentation and developers guides in linked HTML pages.
- *VR-Forces Release Notes*.
- VR-Forces First Experience Guide. A brief introduction to the most basic features of VR-Forces. Provides less detail than *VR-Forces Getting Started Guide*.
- VR-Forces *Entity Model Catalog*. A catalog of all of the entities configured in the Entity Editor with basic parameter details and a screen capture of the model.

MÄK Products

VR-Forces is a member of the VT MÄK line of software products designed to streamline the process of developing and using networked simulated environments. The VT MÄK product line includes the following:

- VR-Link® Network Toolkit. VR-Link is an object-oriented library of C++ functions and definitions that implement the High Level Architecture (HLA) and the Distributed Interactive Simulation (DIS) protocol. VR-Link has built-in support for the RPR FOM and allows you to map to other FOMs. This library minimizes the time and effort required to build and maintain new HLA or DIS-compliant applications, and to integrate such compliance into existing applications.

  VR-Link includes a set of sample debugging applications and their source code. The source code serves as an example of how to use the VR-Link Toolkit to write applications. The executables provide valuable debugging services such as generating a predictable stream of HLA or DIS messages, and displaying the contents of messages transmitted on the network.

- MÄK RTI. An RTI (Run-Time Infrastructure) is required to run applications using the High Level Architecture (HLA). The MÄK RTI is optimized for high performance. It has an API, RTIspy®, that allows you to extend the RTI using plug-in modules. It also has a graphical user interface (the RTI Assistant) that helps users with configuration tasks and managing federates and federations.
- VR-Forces®. VR-Forces is a computer generated forces application and toolkit. It provides an application with a GUI, that gives you a 2D and 3D views of a simulated environment.

  You can create and view local entities, aggregate them into hierarchical units, assign tasks, set state parameters, and create plans that have tasks, set statements, and conditional statements. VR-Forces also functions as a plan view display for viewing remote entities taking part in an exercise. Using the toolkit, you can extend the VR-Forces application or create your own application for use with another user interface.

- VR-Vantage™. VR-Vantage is a line of products designed to meet your simulation visualization needs. It includes three end-user applications (VR-Vantage Stealth, VR-Vantage PVD, and VR-Vantage IG) and the VR-Vantage Toolkit.
  - VR-Vantage Stealth displays a realistic, 3D view of your virtual world, a 2D plan view, and an exaggerated reality (XR) view. Together these views provide both situational awareness and the big picture of the simulated world. You can move your viewpoint to any location in the 3D world and can attach it to entities so that it moves as they do.
  - VR-Vantage IG is a configurable desktop image generator (IG) for out the window (OTW) scenes and remote camera views. It has most of the features of the Stealth, but is optimized for its IG function.
  - VR-Vantage PVD provides a 2D plan view display. It gives you the big picture of the simulated world.

  - The VR-Vantage Toolkit is a 3D visual application development toolkit. Use it to customize or extend MÄK's VR-Vantage applications, or to integrate VR-Vantage capabilities into your custom applications. VR-Vantage is built on top of OpenSceneGraph (OSG). The toolkit includes the OSG version used to build VR-Vantage.

- MÄK Data Logger. The Data Logger, also called the Logger, can record HLA and DIS exercises and play them back for after-action review. You can play a recorded file at speeds above or below normal and can quickly jump to areas of interest. The Logger has a GUI and a text interface. The Logger API allows you to extend the Logger using plug-in modules or embed the Logger into your own application. The Logger editing features let you merge, trim, and offset Logger recordings.
- VR-Exchange™. VR-Exchange allows simulations that use incompatible communications protocols to interoperate. For example, within the HLA world, using VR-Exchange, federations using the HLA RPR FOM 1.0 can interoperate with simulations using RPR FOM 2.0, or federations using different RTIs can interoperate. VR-Exchange supports HLA, TENA, and DIS translation.
- VR-TheWorld™ Server. VR-TheWorld Server is a simple, yet powerful, web-based streaming terrain server, developed in conjunction with Pelican Mapping. Delivered with a global base map, you can also easily populate it with your own custom source data through a web-based interface. The server can be deployed on private, classified networks to provide streaming terrain data to a variety of simulation and visualization applications behind your firewall.
- VR-inTerra. VR-inTerra is a C++ API for adding terrain agility to applications. It can load, page, or stream terrain from a wide variety of formats or sources into a single, consistent run-time representation, consisting of a collision graph and vector network.

How to Contact Us

For VR-Forces technical support, information about upgrades, and information about other MÄK products, you can contact us in the following ways:

Telephone

Call or fax us at:	Voice:	617-876-8085 (extension 3 for support)
	Fax:	617-876-9208

E-mail

Sales and upgrade information:	info@mak.com
Technical support:	support@mak.com
VR-Vantage support:	vrv-support@mak.com

Internet

MÄK web site home page:	www.mak.com
License key requests:	www.mak.com/support/get-licenses.html
Product version and platform information:	www.mak.com/support/product-versions.html
For the free, unlicensed MÄK RTI:	www.mak.com/resources/bonus-material/cat_view/16-bonus-materials/24-mak-high-performance-rti.html
MÄK Community Forum:	www.mak.com/community-forum/1-forum.html

Post

Send postal correspondence to:	VT MÄK 150 Cambridge Park Drive, 3rd Floor Cambridge, MA, USA 02140

When requesting support, please tell us the product you are using, the version, and the platform on which you are running.

Document Conventions

This manual uses the following typographic conventions:

`Monospaced`	Indicates commands or values you enter.
`Monospaced Bold`	Indicates a key on the keyboard.
`Monospaced Italic`	Indicates command variables that you replace with appropriate values.
Blue text	A hypertext link to another location in this manual or another manual in the documentation set.
`{ }`	Indicates required arguments.
`[ ]`	Indicates optional arguments.
|	Separates options in a command where only one option may be chosen at a time.
`( | )`	In command syntax, indicates equivalent alternatives for a command-line option, for example, `(-h | --help)`.
/	Indicates a directory. Since MÄK products run on both Linux and Windows PC platforms, we use the / (slash) for generic discussions of pathnames. If you are running on a PC, substitute a \ (backslash) when you type pathnames.
Italic	Indicates a file name, pathname, or a class name.
sans Serif	Indicates a parameter or argument.
➤	Indicates a one-step procedure.
Menu → Option	Indicates a menu choice. For example, an instruction to select the Save option from the File menu appears as: Choose **File → Save**.
	Click the icon to run a tutorial video in the default browser.
	Indicates supplemental or clarifying information.
	Indicates additional information that you must observe to ensure the success of a procedure or other task.

Directory names are preceded with dot and slash characters that show their position with respect to the VR-Forces home directory. For example, the directory *vrforces4.2/doc* appears in the text as *./doc*.

Mouse Button Naming Conventions

An instruction to click the mouse button, refers to clicking the primary mouse button, usually the left button for right-handed mice and the right button for left-handed mice. The context-sensitive menu, also called a popup menu or right-click menu, refers to the menu displayed when you click the secondary mouse button, usually the right button on right-handed mice and the left button on left-handed mice.

Third Party Licenses

MÄK software products may use code from third parties. This section contains the license documentation required by these third parties.

Boost License

VR-Link, and all MÄK software that uses VR-Link uses some code that is distributed under the Boost License. All header files that contain Boost code are properly attributed. The Boost web site is: www.boost.org.

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libXML and libICONV

VR-Link and all MÄK software that uses VR-Link, links in libXML and libICONV. On some platforms the compiled libraries and header files are distributed with MÄK Products. MÄK has made no modifications to these libraries. For more information about these libraries please see the following web sites:

- The LGPL license is available at: http://www.gnu.org/licenses/lgpl.html
- Information about IconV is at: http://www.gnu.org/software/libiconv/
- Information about LibXML is at: http://xmlsoft.org/

Lua

VR-Forces uses the Lua programming language (www.lua.org). Its license is as follows:

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Third-Party Licenses for VR-Vantage Applications

VR-Vantage applications use a variety of third-party libraries. Developers who want to use these libraries may be required to purchase developer's licenses. Please see section 1.2 in *VR-Forces Front-End Developers Guide* for details.

1

Optimizing Performance

This chapter explains how you can view performance statistics for the front-end and back-end and how you can optimize GUI performance.

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Optimizing Front-End Performance 1-3
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1.1. Introduction

This chapter describes ways that you can optimize performance through the GUI, the object parameter database, and command line options. You can also optimize performance programmatically.

VR-Forces's overall performance varies based on the following factors:

- Size of the terrain database.
- Amount of memory available on your computer.
- Computer speed and processing power.
- The number of objects (entities and tactical graphics) in the scenario and how active the entities are.
- The number of objects you try to simulate on a given back-end.
- The frequency of the tick rate.
- The number of front-ends and back-ends you run on your computer.

1.1.1. Optimizing Simulation Engine Performance

VR-Forces supports the following methods for optimizing the performance of the simulation engine:

- Adjusting the refresh rates. (For details, please see ("Balancing Visual Quality Against Network Performance," on page 1-12.)
- Turning off processor-intensive features. (For details, please see "Miscellaneous Front-End Performance Configuration Options," on page 1-9.)
- Adjusting the network processing time.
- Specifying the tick rate for an entity or component. (For details, please see ("Setting the Tick Rate," on page 1-10.)
- Specifying a tick rate for the network interface. (For details, please see ("Tuning the Network Interface," on page 1-11.)
- Specifying the VR-Forces sleep time. (For details, please see ("Tuning the Target Frame Rate," on page 1-13.)
- Specifying the number of objects that you expect to simulate in the exercise.
- Optimizing the terrain.
- Using interest management. (For details, please see "Filtering Entities Using Interest Management," on page 1-7.)

1.1.2. Optimizing Front-End Performance

The performance of the front-end depends on:

- Processor speed.
- Video card. (Always use the latest drivers for your video card.)
- Available memory.
- Size of the terrain database.
- The number and complexity of models loaded.
- Number of objects in the simulation and how active they are.

You can display statistics to help you evaluate VR-Forces's performance. For details, please see "Displaying Performance Statistics," on page 1-5.

The following actions can affect performance:

- Increasing the size or density of a cloud layer.
- Displaying performance statistics.
- Use of ground clamping.
- Displaying track histories.
- Displaying height-above-terrain lines.
- Enabling advanced lighting and various lighting effects.
- Enabling dynamic ocean effects. If enabled, enabling wakes, buoyancy models, and spray effects.

The following sections describe options for optimizing front-end performance:

- "Configuring SpeedTree Trees," on page 12-36.
- "Configuring File Caching," on page 10-36.
- "Clearing the Model Instancing Cache," on page 11-6.
- "Setting the Clipping Planes," on page 9-10.
- "Enabling Texture Compression," on page 10-37.
- "Considerations and Limitations for Building Terrains," on page 10-3.
- "Filtering Entities Using Interest Management," on page 1-7.
- Section 10.5.3, "Setting the Ocean LOD Elevation,".
- Section 8.13, "Displaying Wakes and Spray Effects," in *VR-Forces Users Guide*.
- Section 8.14, "Enabling Buoyancy for Surface Entities," in *VR-Forces Users Guide*.
- Chapter 17, *Lighting Effects*, in *VR-Forces Users Guide*.

1.2. Monitoring the Back-end Frame Rate

You can monitor frame rate statistics for each back-end in your session. The Frame Rate Monitor panel lists statistics for each back-end (Figure 1-1).

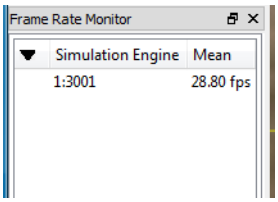


Figure 1-1. Frame Rate Monitor panel

➤ To view the Frame Rate Monitor panel, choose **View** → **Frame Rate Monitor Panel**.

1.3. Displaying Performance Statistics

VR-Forces can display two kinds of performance statistics — OSG statistics (Figure 1-2), and VR-Forces statistics (Figure 1-3).

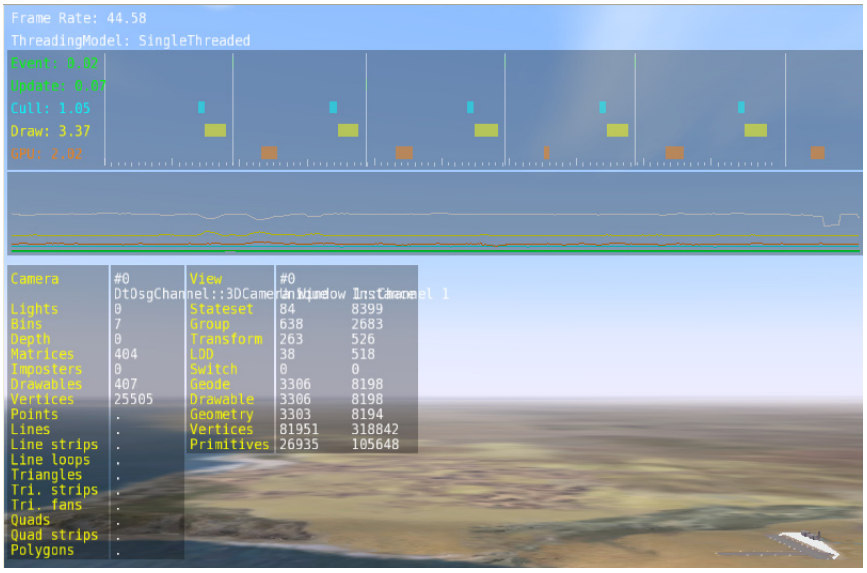


Figure 1-2. OSG performance statistics



Figure 1-3. VR-Forces performance statistics

Displaying performance statistics may affect performance. Displaying OSG statistics may affect performance more than VR-Forces statistics.

To display VR-Forces performance statistics:

1. Choose **Settings** → **Display**. The Display Settings dialog box opens.
2. Select the Render Settings page (Figure 1-4).

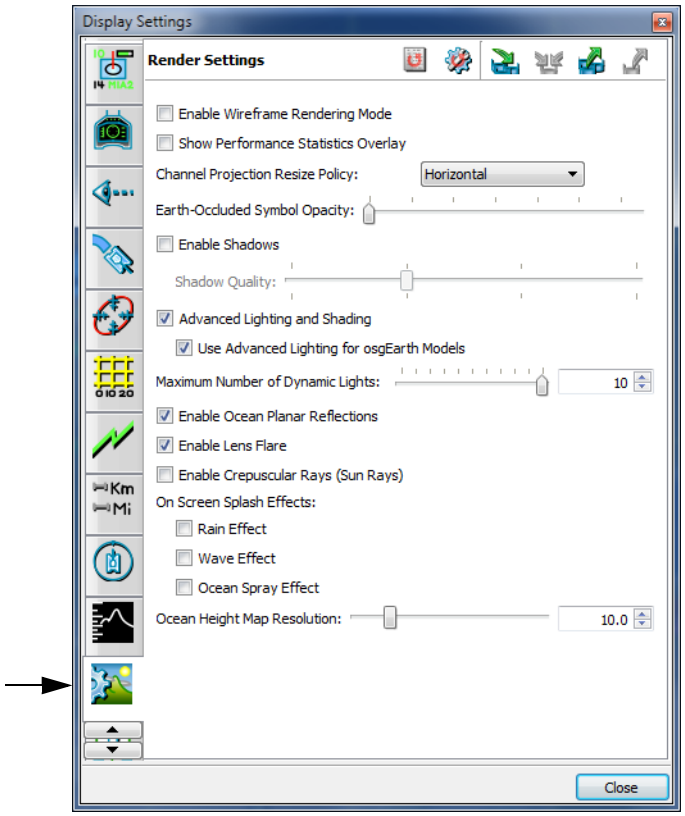


Figure 1-4. Render Settings page

3. Select the Show Performance Statistics Overlay check box. A statistics display is added to the window (Figure 1-3).

To display OSG performance statistics:

1. Press F2. The frame rate is displayed.
2. Continue pressing F2. Additional statistics are displayed. When all statistics are displayed, pressing F2 closes the display.

1.4. Filtering Entities Using Interest Management

VR-Forces can use interest management to improve front-end performance in simulations that have high entity counts. Interest management is an implementation of HLA data distribution management (DDM). When interest management is enabled, VR-Forces filters out all entities that are more than a specified distance from the observer.

1.4.1. Enabling Interest Management

To use interest management:

- You must use HLA (DIS does not support interest management).
- If you are using the MÄK RTI, you must use MÄK RTI 3.4a or later.
- You must configure your RTI to support DDM. (If you are using the MÄK RTI, you can configure your system to use *ddm-rid.mtl*, which has DDM enabled.)

➤ To enable interest management, start vrfGui from the command line and include the `--useGeographicDdm` command line option with the HLA configuration commands, for example:

```
vrfGui -s 1 -a 3004 --hla -x VR-Link20017-1
  --rprFomVersion 2.0017 -F VR-Link20017-1.fed
  --useGeographicDdm
```

1.4.2. Configuring Interest Management

Interest management works by filtering out all entities beyond a specified distance from the observer. You can configure this distance (DDM region size) and you can configure the threshold for observer movement (region update threshold) before VR-Forces recalculates which entities should be displayed.

VR-Forces uses a geographic DDM scheme. The earth is divided into two dimensional regions, with X pointing north and Y pointing east. When you specify a DDM region size, you specify the length of one side of a region.

The region update threshold is a percentage of the distance from the center of the region to a side. When the observer moves beyond the threshold, the region is recalculated. For example, if the region size is 1000 meters, the distance from the center to a side is 500 meters. If the region update threshold is 50%, when the observer moves more than 250 meters from the center of the region, VR-Forces recalculates the display region.

DDM regions use a two-dimensional grid, so the altitude of the observer is not considered when filtering entities. However, in 3D observer modes, you usually cannot see entity models once the observer is a certain distance above the terrain (although you can see entity labels). Therefore, you may want to filter out entities based on the observer's altitude, thereby increasing performance.

To configure interest management:

1. Choose **Settings** → **Display**. The Display Settings dialog box opens.
2. Select the Interest Management Settings page (Figure 1-5).

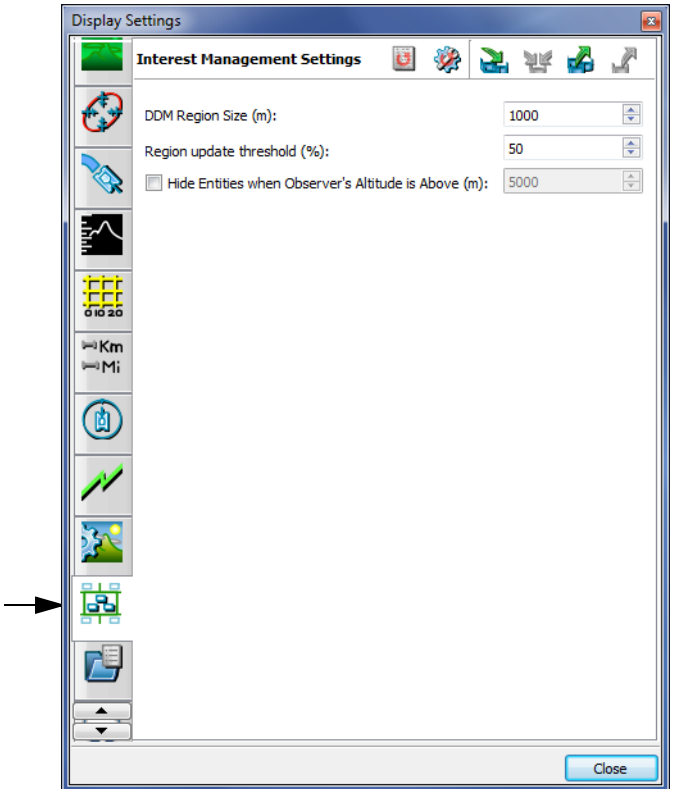


Figure 1-5. Interest Management Settings page

3. In the DDM Region Size box, type a value, in meters, for the region size.
4. In the Region Update Threshold box, type a value, as a percentage, for the update threshold.
5. Optionally, filter entities based on the observer's altitude, as follows:
   a. Select the Hide Entities When Observer's Altitude is Above check box.
   b. Specify the observer altitude at which to hide entities.
6. Click OK.

1.5. Miscellaneous Front-End Performance Configuration Options

You can improve front-end performance by limiting use of display features, as follows:

- Turn off track histories.
- Limit use of object transparency.
- Limit use of spot reports.
- In DIS, use asynchronous I/O.

1.5.1. Limiting Use of Spot Reports

Use of spot reports can degrade performance. You may want to limit the number of entities for which they are generated or disable spot reports entirely. For details about using spot reports, please see Section 10.1, "Displaying Entities Based on Spot Reports," in *VR-Forces Scenario Management Guide*.

1.5.2. Using Asynchronous I/O for DIS Exercises

By its nature, DIS generates a lot of network traffic. Therefore, you may experience problems with dropped packets and entities may time out. You can mitigate this problem by using asynchronous I/O. To use asynchronous I/O, start with the `--useAsyncIO` command line option or select Use Asynchronous I/O in the Simulation Connections Configuration dialog box.

1.6. Setting the Tick Rate

VR-Forces lets you tune performance by varying the tick rate of components, state repositories, and network interfaces. By decreasing the frequency with which some entity components are ticked, you make more CPU time available to other entities. For example you could decrease the tick rate for slow moving entities such as dismounted infantry entity or a command post, making more CPU available for entities such as aircraft or missiles.

Variable tick rates are determined by a minimum tick period and a minimum tick period variance. The minimum tick period parameter specifies the shortest period of time, in seconds, that can elapse between ticks of an entity's components. VR-Forces may tick the components less frequently (due to heavy CPU load), but it will never tick the entity's components more frequently than specified.

To reduce the frequency that a component can be ticked, increase the minimum tick period value. To increase the frequency that a component can be ticked, reduce the minimum tick period value.

The minimum tick period variance argument specifies an amount of variance allowed around the minimum tick period. Specifying a minimum tick period variance value helps prevent the spikes in CPU usage that would result if all components tried to tick at the same time. Calculation of the time to tick a component using minimum tick period variance is as follows (the example uses the entity component arguments):

If the current time is t_0 and the next scheduled tick is t_{next} then:

$$t_{next} = t_0 + \text{min-tick-period} +/- \text{rand(min-tick-period-variance/2)}$$

If you insert some sample values (in seconds), you get:

$$t_{next} = .1 + .05 +/- \text{rand(.05/2)}$$

This means that the next tick will be no sooner than the current time plus .15 seconds plus or minus a random value between 0 and .0125 seconds.



If the next tick time calculated by this formula is less than the current tick time, it is set to the current tick time, which results in the component being ticked on the next tick.

1.6.1. Specifying the Tick Rate for Components

In the object parameter database, you can specify a **min-tick-period** and **min-tick-period-variance** for each entity and for individual entity components. The component-level settings, if any, override the entity-level settings. You can update these parameters in the OPD Editor.

1.6.2. Tuning the Network Interface

You can tune the local and remote network interface subcomponents. Specify the **net-interface-min-tick-period** and **net-interface-min-tick-period-variance** parameters in the local and remote subcomponents blocks. If you reduce the rate at which the network interfaces are ticked, you can limit how often VR-Forces needs to do coordinate system conversion from network (geocentric) to database coordinates.



Reducing the frequency which which you tick network interface components could delay the discovery of objects in remote front-ends and back-ends.

1.6.3. Tuning the State Repository Tick Rate

You can tune the frequency with which state repositories get ticked. Specify the **state-repository-min-tick-period** and **state-repository-min-tick-period-variance** parameters in the local and remote subcomponents blocks. These parameters control how often VR-Forces recomputes the bounding volume of an object based on object geometry.

1.7. Balancing Visual Quality Against Network Performance

VR-Forces allows you to tune performance by adjusting dead-reckoning thresholds. The primary benefit of this feature is to improve the appearance of entities in 3D visualization programs such as VR-Vantage and the VR-Forces 3D view. Reducing thresholds improves the accuracy of entity movement and reduces jumpy movement. However it does so at the expense of network performance, because a lower dead-reckoning threshold results in more packets being sent for each entity.

When you change thresholds at runtime, VR-Forces sends a message to all back-ends in the scenario to change their default thresholds for translation and rotation. The new thresholds remain in effect until the back-ends are closed. They apply to any scenario run during this time and they override thresholds set in *vrfSimSettings.xml*. Changes to the default thresholds get saved in *vrfSimSettings.xml*.

If your exercise sends periodic updates, such as a DIS heartbeat, the thresholds evaluate changes since the most recent heartbeat.

Changes made at runtime have no effect in the following cases:

- If a back-end joins the scenario after the thresholds are sent. It uses the default VR-Link thresholds, or the values in the *vrfSimSettings.xml* file, if specified.
- If an object was instantiated with a customized VR-Link *DtThresholder*.

To configure performance options:

1. Choose **Settings** → **Application**. The Application Settings dialog box opens.
2. Select the Performance Options page (Figure 1-6).

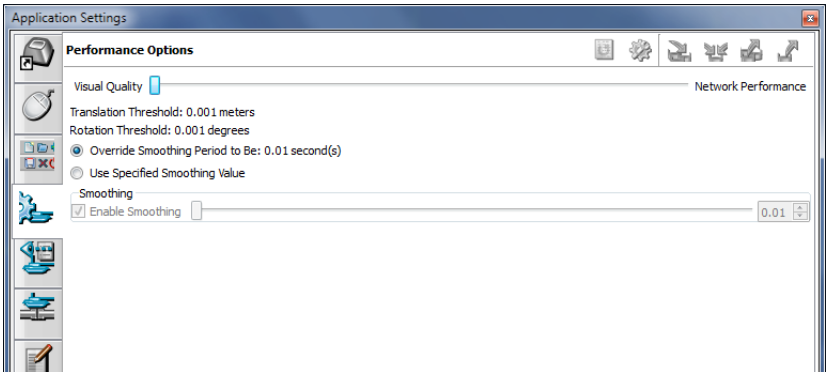


Figure 1-6. Performance Options page

3. Adjust the Visual Quality slider to your desired preference for visual quality versus network performance.
4. To override the default smoothing period and set it to a value calculated to work best with the performance setting, select Override Smoothing Period.
5. Click OK.

1.7.1. Enabling Configuration of Performance Options

The **dr-allow-gui-overrides** configuration parameter, specified in each OPE file, determines whether a given entity type can have its translation and rotation thresholds overridden by the value set by the Performance Options page.

1.8. Tuning the Target Frame Rate

The `--targetFrameRate` command line option and *vrfSim.mtl* parameter allow you to specify the mean frame rate above which the VR-Forces back-end should begin to sleep in order to give up CPU time to other processes. This parameter is only applicable to variable frame mode; the fixed frame modes already have a built in sleep that gives up unused time. Increasing the target frame rate will only prevent the back-end from sleeping if it cannot achieve that rate – ultimately it is up to the operating system to determine how much CPU time each process receives.

1.9. Configuring VSync

By default, VR-Forces enables VSync (vertical synchronization), which synchronizes VR-Forces's frame rate with your monitor's refresh rate. This prevents a visual anomaly called tearing, in which parts of two frames of data can be visible at the same time. Use of VSync can also significantly improve terrain and feature data streaming performance.

In some cases, if the frame rate cannot quite keep up with the refresh rate, VSync can force the frame rate to a noticeably lower rate. To avoid this problem, we recommend that you enable triple buffering for your video card. You must do this in the video card's configuration application; VR-Forces cannot do this for you.

If you prefer not to use VSync, you can disable it at startup with the `--noVSync` command-line option, or you can configure your video card to force it to be off.

2

VR-Forces Configuration Files

This chapter introduces the configuration files used by VR-Forces and describes the syntax of VR-Forces MTL files.

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Adding a New DI-Guy Animation 2-10
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Using Environment Variables in an MTL File 2-13
Specifying Lists of Lists 2-14
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2.1. Introduction

VR-Forces uses many different configuration files to manage element definitions, model mapping, back-end configurations, menus, and so on. Almost all of the configuration files for the front-end are XML files that get created and updated through the Display Settings dialog box, Terrain Settings dialog box, and the other front-end configuration dialog boxes. Although you could edit these files with text editors, we recommend that you not edit them by hand and we do not document their contents and syntax. When you save settings, they are saved to files with the correct extension.



Developers may need to create and edit configuration files using the VR-Forces Front-End API. Please see *VR-Forces Front-End Developers Guide* and the class documentation for details.

The back-end configuration files mostly use the MÄK Technologies LISP (MTL) syntax. The major back-end configuration file is *vrfSim.mtl*. It is described in this chapter. Other files are described throughout this manual in the appropriate section. MTL syntax is described in "MÄK Technologies Lisp (MTL) Files," on page 2-13.

2.2. The vrfSim.mtl Configuration File

The file *./appData/settings/vrfSim/vrfSim.mtl* configures back-ends. Table 2-1 describes the parameters in *vrfSim.mtl*. The Option column lists the command-line argument equivalent for parameters that have them.

Table 2-1: *vrfSim.mtl* parameters (Sheet 1 of 7)

Parameter	Description	Option
additionalSystemScriptsDirectory	Directories other than the default script directory where VR-Forces should look for system scripts.	
aggregateSpatialModelTickPeriodUsesRealTime aggregateSpatialModelTickPeriod aggregateSpatialModelTickVariance aggregateSpatialModelTickAsFastAsPossibleWhilePaused	Configure aggregate spatial model tick rates. Default is to run the aggregate spatial model every frame. Tick period is given in seconds, with the special value of -1 indicating tick every frame.	
appNumber	Specifies the application number. Default: 3001.	`-a` | `-p`

Table 2-1: *vrfSim.mtl* parameters (Sheet 2 of 7)

Parameter	Description	Option
assertOnBlockingTerrainCalls	When set to true (1), causes blocking terrain calls to assert in debug mode if the simulation is running. Blocking terrain calls can cause long ticks in a running simulation which can have very negative effects on the models. This parameter can help developers find places in the code that are making the offending calls. Note that calling the blocking form of any terrain intersection function will cause an assertion; it is not necessary for the call to actually block and even non-paging implementations will assert. This is to make it easier to find potential problems regardless of the particular terrain or location being used. Default: 0. For more information, please see API documentation.	
batchScenarioFileName	Specifies a batch file to run.	`-B`
cgfDispatcherReceivePort	Specifies the port to be used by the *DtCgfDispatcher's* file transporter to receive order of battle and plan files from the *DtVrfRemoteController*.	
countryCodesMappingFile	The file VR-Forces uses to import country codes to map to entity type enumerations.	
daemon	Runs vrfSim as a daemon process (Linux only.) vrfSim will not attempt to read characters from a console, and will fork a background process on startup. It will exit cleanly on receipt of the SIGTERM, SIGQUIT, SIGINT signals. Default: Off.	`--daemon`
datumShiftX datumShiftY datumShiftZ	These parameters, along with the spheroidSemiMajor and spheroidSemiMinor parameters, let you change the reference ellipsoid used for geocentric to geodetic conversions. For more information, please see Choosing a Reference Ellipsoid in VR-Link Developers Guide. These parameters are used only if VRF_useCustomMapDatum is set to 1.	
defaultParameterDatabasePath	Specifies the location to search for the object parameter database if the full path is not specified in a scenario file.	
defaultTerrainDatabasePath	Specifies the location to search for the terrain database if the full path is not specified in a scenario file.	
diGuyCharacterDataFile	Specifies the DI-Guy character data file to load if useDIGuy is 1.	

Table 2-1: *vrfSim.mtl* parameters (Sheet 3 of 7)

Parameter	Description	Option
diGuyAnimationsFile	Specifies the DI-Guy animations file to load if useDIGuy is 1.	
doNotUseConsole	Disables (1) or enables (0) writing of output to the console. Default: 0.	
DtNotifyLevel	Sets the notification level (0-4) for information and warning messages. Default: 2.	`-n`
entVrfDataTimeThreshold	Specifies how often, in seconds, VR-Forces environmental and entity data is sent. If you specify -1.0, the update is sent only if some item in the vrfDataObject has changed.	
forceParameterDbReload	If set to 1 (default), forces the back-end to reload the object parameter database (OPD) each time a scenario is loaded. If set to 0, if a scenario is started that uses the same OPD as the previous one (for example, in a rewind), the OPD is not reloaded.	
loadPluginIfVersionMismatch	Specifies whether (1) or not (0) to load a plug-in if there is a mismatch between how the plug-in was built and how VR-Forces was built. Mismatches can be build type (release versus debug), operating system, or protocol (DIS, HLA 1.3, HLA 1516, HLA 1516e.) Allowing a plug-in to load if there is a mismatch can cause VR-Forces to be unstable.	
logFrameRateStatistics	Enables (1) or disables (0) logging of frame rate statistics to a file.	
maxDrainInputTime	Sets the maximum time to wait in drainInput() before returning. For the MÄK RTI, the default value drains the entire input stream before returning. For the Pitch RTI, the default value reads a single input from the input stream, so set to a value other than -1 to process more information. Use with DIS or HLA.	
msdlSIDCMappingFile	The file VR-Forces uses to map between SIDC codes and entity type enumerations when it imports MSDL files.	
objectConsoleNotifyLevel	Specifies the notification level (0-4) for messages sent to the entity object console. Default: 1.	
pluginsDirectory	Specifies the directory in which configuration (MTL) files for plug-ins are located. The directory must end with a slash, for example, *./plugins/*.	

Table 2-1: *vrfSim.mtl* parameters (Sheet 4 of 7)

Parameter	Description	Option
publishSimulationTime-ForStealth	Specifies whether or not to publish the simulation time to the network so that MÄK Stealth 6.2 or earlier can set its simulation clock to work in conjunction with the simulation time.	
scenarioFileName	Specifies the scenario file to load.	`-L`
sendBackendLogToNetwork	Enables (1) or disables (0) sending simulation engine log messages to the front-end.	
sessionId	Specifies the session ID.	`-i`
simMgmtPduProcessLevel	Specifies how simulation management PDUs are processed: 1 – Processes PDUs sent to a specific back-end. Wildcards are ignored. 2 – Processes only wildcarded PDUs. Ignores those sent to specific back-ends. 3 – Processes all PDUs.	
simulationModelSet	Specifies the default simulation model set or sets. If specifying multiple SMSs, separate them by a semi-colon.	
siteId	Specifies the site ID. 0 = use internal default.	`-s` | `-t`
spheroidSemiMajor spheroidSemiMinor	There parameters, along with the datumShift parameters, let you change the reference ellipsoid used for geocentric to geodetic conversions. For more information, please see Choosing a Reference Ellipsoid in VR-Link Developers Guide. These parameters are used only if VRF_useCustomMapDatum is set to 1.	
startInRunMode	Specifies that the simulation start in run mode (1), rather than pause mode (0). Default: 0.	
statusUpdateHeartbeat	Specifies how often, in seconds, the back-end status heartbeat is sent.	
targetFrameRate	Specifies the mean frame above which the back-end will sleep, yielding CPU time to other processes. This option applies only to variable frame mode. For more information, please see "Tuning the Target Frame Rate," on page 1-13. Default: 22.	
terrainDatabase	Specifies the terrain database to load. This parameter is overridden by the scenario file if one is specified in scenarioFileName.	`-T`

Table 2-1: *vrfSim.mtl* parameters (Sheet 5 of 7)

Parameter	Description	Option
useCustomMapDatum	Allows modification of the reference ellipsoid used for geocentric to geodetic conversion. If you enable this parameter, there are several sub-parameters to configure. For details, please see the comments in the file.	
useDIGuy	Specifies whether (1) or not (0) to use DI-Guy characters.	
HLA Parameters	For details, please see Section B.5, "Command-line Options for HLA Federations," in *VR-Forces Users Guide.*	
destroyFedExec	Specifies whether (1) or not (0) the *DtExerciseConn* destructor should try to destroy the federation execution. Default: 1.	
execName	The federation execution name.	`-x`
federateName	The federate name.	`-N`
federateType	Lets you specify the federate type for HLA Evolved.	
fedFileName	Specifies the FED file name.	`-F`
fomMapperLib	A FOM Mapper library.	`-f`
fomMapperInitData	An initialization string.	`--fomMapperInitData`
hostAddressString	Specifies the host address. This is usually the same as the device address.	
localSettingsDesignator	Specifies the local settings designator for HLA Evolved.	
mimModule	Specifies a MIM (MOM and Initialization) Module for HLA Evolved.	
minDrainInputTime	The minimum time to stay in drainInput() before returning.	
rprFomVersion	The RPR FOM version. (0.5, 0.8, 1.0, 2.0)	`--rprFomVersion`
runInTimeManagementMode	Enables (1) or disables (0) use of time management.	
sendFedTime	Enables (1) or disables (0) sending and receipt of interactions in time stamp order. Default 0.	
useAbsoluteTimeStamps	If set to 1, use absolute time stamps. If set to 0, use relative time stamps. Default: 0.	
useAdvisories	Enables (1) or disables (0) HLA advisory messages.	

Table 2-1: *vrfSim.mtl* parameters (Sheet 6 of 7)

Parameter	Description	Option
DIS Parameters	Please see Section B.6, "Command-line Options for DIS Exercises," in *VR-Forces Users Guide*.	
addMulticastAddr	The multicast address.	`-S`
appIdRange	Specifies the application ID range to use to identify entities generated by VR-Forces.	
defaultHeartbeatThreshold	Specifies the DIS heartbeat threshold, in seconds. A heartbeat is sent when the threshold is reached, even if no data has changed.	
defaultObjectTimeout	Specifies the DIS object timeout threshold, in seconds. If VR-Forces does not receive a heartbeat for an object for the time period specified, it removes the object from the exercise.	
destAddrString	Destination address for point-to-point communications mode.	`-A`
deviceAddress	Specifies the address of the network card to use for UDP traffic.	
disPort	The port number.	`-P`
exerciseId	The exercise ID.	`-x`
heartbeatVariance	When an entity is created, a random value between -heartbeatVariance and +heartbeatVariance is added to the heartbeat. This spreads heartbeats over time instead of them all being at the same time.	
hostAddressString	Specifies the host address. This is usually the same as the device address.	
maxDrainInputReads	The maximum number of reads to make in drain input before returning	
mcastTtl	Specifies the multicast time to live.	`--mcastTtl`
recvBufferSize	Specifies the receive buffer size, as a positive value. A value of -1 means use the system default.	`--recvBufferSize`
sendBufferSize	Specifies the send buffer size, as a positive value. A value of -1 means use the system default.	`--sendBufferSize`

Table 2-1: *vrfSim.mtl* parameters (Sheet 7 of 7)

Parameter	Description	Option
subnetMask	When the destination address is not specified ("0.0.0.0"), the subnet mask is used in conjunction with the network interface address to determine the destination broadcast address. If neither is specified (subnet mask is blank), the network interface's default broadcast address is used.	
suppressSelfReflect	Prevent VR-Forces from reflecting DIS PDUs.	
useAbsoluteTimeStamps	If set to 1, use absolute time stamps. If set to 0, use relative time stamps. Default: 0.	
useAsyncIO	Enables (1) or disables (0) use of asynchronous I/O, which can help reduce dropped packets under heavy network load. Default: 0.	`-I`
useIpv6	Use the IPV6 protocol.	

2.3. Configuring DI-Guy Integration

VR-Forces can specify the character, appearance, and animation values for DI-Guy models used in 3D visualization applications such as VR-Forces and VR-Vantage. A model's character determines the kinds of movement it can make. The appearance determines what it looks like. The animation specifies the movements that the character makes.

In the VR-Forces front-end, you can specify the animation with the DI-Guy Animation task. You can set the appearance with the DI-Guy Appearance set data request. For details about specifying DI-Guy characteristics in the front-end, please see *VR-Forces Scenario Management Guide*.

You can specify the default character, appearance, and animation for a lifeform entity in the Entity Editor or OPD Editor. (For details, please see "Editing a Lifeform's DI-Guy Character, Appearance, and Animation," on page 5-19.) The DI-Guy mappings are stored in the entity's *.entity* file.

The DI-Guy characters, appearances, and animations available to lifeforms are controlled by two configuration files:

- *./appData/settings/vrfSim/character_animations_table.mtl* lists the DI-Guy characters available for VR-Forces entities and the appearances available for each character. This information is used to populate the lists in the Entity Editor. You can edit this file to add additional DI-Guy characters to those already configured for VR-Forces. The syntax of entries is described in the file.

! Any characters you add to *character_animations_table.mtl* must be valid DI-Guy characters that are already in *character_digest.xml*. You cannot arbitrarily make up new types of characters. If you create new characters using a supported version of the DI-Guy SDK, VR-Forces will support these characters.

- *./appData/settings/vrfSim/character_digest.xml* contains information that VR-Forces needs to synchronize an entity's simulated location with the movements generated by DI-Guy animations. For example, if a model's animation causes the model to step to the left, VR-Forces needs to move the simulated location of the entity the same distance to the left.

2.3.1. Adding a New DI-Guy Animation

This section explains how to add a new DI-Guy animation to VR-Forces. It assumes that you have the DI-Guy software and have created the new animation.

The new animation must be made with the same version of DI-Guy supported by VR-Forces. Please see *VR-Forces Release Notes* for the currently supported version.

To add a new DI-Guy animation:

1. Create the new animation in DI-Guy. You will create an animation and add it to a character's action table. Make sure that the name of the animation file matches the name of the action you added to the action table. For example, if the name of the animation is layEgg, but you call the action lay_egg, it will not work.



There is a 1-1 relationship between characters and their action tables. You cannot use an animation based on a chicken character in a cow character's action table.

2. Add the *motion_name*.bdm file for the animation to *./data/Lifeforms/DIGuy/motions*.
3. Add the *action_table*.cfg file to *./data/Lifeforms/DIGuy/config/diguy*.
4. Add the new animation to the list of animations for this character in *./appData/settings/vrfSim/character_digest.xml*. For example, if the new animation is *char_chicken_action_table.cfg*, add an entry to the chicken character. The following example assumes a new animation called lay_egg. The chicken will sit, lay the egg, then stand up.

```
<character_type name="chicken">
  <class>animal</class>
  <quality_bias>5</quality_bias>
  <character_type_map>
    <type_map_field name="character_class" value="animal" />
    <type_map_field name="category" value="domestic" />
    <type_map_field name="subcategory" value="chicken" />
  </character_type_map>
  <default_appearance name="chicken_1" />
  <default_skinned_appearance name="" />
  <appearances>
    <appearance name="chicken_1" />
    <appearance name="chicken_2" />
    <appearance name="chicken_3" />
  </appearances>
  <actions>
    <action name="lay_egg" > <---Needs to match name in action table
 and motion file
      <duration>1.500000</duration>
```

```
      <speed>0.000000</speed>
      <direction>none</direction>
      <posture>upright</posture>
      <primary_variant>normal</primary_variant>
    </action>
    <action name="stand" >
      <duration>0.500000</duration>
      <speed>0.000000</speed>
      <direction>none</direction>
      <posture>upright</posture>
      <primary_variant>normal</primary_variant>
    </action>
...
```

5. Add the new animation to *./appData/settings/vrfSim/character_animations_table.mtl*. This table determines whether an animation can be assigned to an entity using the DI-Guy Animation task (`is-taskable-animation  True`) or whether it is used based on the entity's behavior. For example, if an entity is moving faster than a certain speed, it is given a running animation. An entry for our lay egg example would look like the following:

```
(chicken
  (display-name "Chicken")
  (animations
    (animation
      (animation-name "lay_egg")
      (name-to-be-displayed "Lay an egg")
      (is-taskable-animation  True)
      (animation-variant "normal")
    )
    (animation
      (animation-name "feeding")
      (name-to-be-displayed "Feed")
      (is-taskable-animation  True)
      (animation-variant "normal")
    )
...
```

2.4. Configuring Communication Models

Communication models are configured in *./data/simulationModelSets/<model-set>/commModelParams.mtl*. Communication models determine how radio messages travel from one entity to another. They determine which entities are connected to each other and how long it takes a message to get from one entity to another.

Communication model classes are derived from *DtCommModel* and are generated from the communication model factory based on the string types specified in the *commModelParams.mtl* file. A communication model entry contains parameters for the type of communication model descriptor and communication model class being used.

2.4.1. Simple Radio Communication Model

VR-Forces includes a default communication model called simple-radio-comm-model. This communication model models radio traffic in a very simple way. Radio messages always reach their intended destination, as long as the destination is on a reachable network, and messages are all passed instantly. The simple radio communication model has one parameter, **connection-mode**, which determines how the radio networks are set up. There are three connection-modes available:

- `aggregate` mode specifies that each aggregate has its own radio network. Messages sent from an entity can reach any entity that is in the same organization, at the same level (the entity's peers in the organization), and can also reach the entity's direct superior. All other entities are outside the network, and are unable to receive messages sent by the entity. This is the default mode.



If an entity is not in an aggregate, it is considered to be part of the force aggregate and its radio messages go to other entities that are part of the force aggregate.

- `force` mode specifies that there is a radio network for each force in VR-Forces. Messages sent from an entity can reach any other entity of the same force.
- `all` mode specifies that all entities in VR-Forces are part of one large radio network. In this case, any entity can receive messages sent by any other entity.

2.4.2. External Communication Model

VR-Forces includes an external communication model that can communicate with an external communication effects server over the network to determine how to deliver radio messages. For details, please see Chapter 8, *Using VR-Forces with an External Comms Effects Server*.

2.4.3. Custom Communication Models

You can create new communication models and install them in VR-Forces. This is useful if you want to define your own connectivity model, or write your own algorithms for determining if radio messages get delivered. For details, please see API documentation.

2.5. MÄK Technologies Lisp (MTL) Files

Many of the configuration files for MÄK products are ASCII text files that use MÄK Technologies LISP (MTL) to encode configuration information. MTL files have the extension *.mtl*. You can edit them in any text editor. Be sure that your text editor uses the proper end-of-line characters for your platform.

Most parameter entries take the format:

```
(setq parameter_name value)
```

For example:

```
(setq EnableWireFrame 1)
```

Or:

```
(setqb parameter_name value)
```

The setqb syntax indicates a bound variable.

To comment out a line, precede the text with two semi-colons (;;). You can also add a comment at the end of a line by preceding it with two semi-colons.

In most cases, the parameter names are known to the MÄK application and the MTL commands simply assign values to them. However, you can use the `setq` command to create arbitrary symbolic names or aliases that are then used in later commands. For example, in the following two commands, the symbolic name VaporTrail is assigned to an OpenFlight file. Then the symbolic name is used in the `trail-map` command. The name VaporTrail has no intrinsic meaning. It is given meaning by the `setq` command, which allows it to be used later in the `trail-map` command.

```
(setq VaporTrail (list "./../data/models/makTrails/Vapor-
  Trail" "VaporTrail.flt" 6.0 1.5 1.5 4.0 1.5 0.5))
(trail-map (list 1 2 -1 0 -1 -1 -1)(list VaporTrail 0.0 0.0
  0.0))
```

In addition to the `setq` command, a commonly used command is the `load` command. This command instructs the application to load the file specified, for example:

```
(load mtl-path "params.mtl")
```

2.5.1. Using Environment Variables in an MTL File

If you want to use an environment variable in an MTL file, use the following syntax:

```
(setqb parameter_name (getenv (quote env_var)))
```

For example:

```
(setqb disDestAddr (getenv (quote DEST_ADDR)))
```

2.5.2. Specifying Lists of Lists

The example of setting a symbolic name in a previous section uses a list. You can also specify a list of lists, for example:

```
(trail-map (list 1 2 -1 -1 -1 -1 -1)
   (list vaporTrail -8.0 -3.0 0.0)
   (list vaporTrail -8.0 3.0 0.0)
)
```

A parameter entry can also have multiple individual lists:

```
(trail-map (list 1 2 -1 0 -1 -1 -1)(list VaporTrail 0.0 0.0
   0.0))
```

2.5.3. Using Conditional Statements

MTL commands can be conditional. Conditional statements are used frequently when parameters are different for DIS and HLA. A simple conditional statement has the format:

```
(if (condition) (statement_to_evaluate))
```

If you have more than one statement to evaluate, use a sequence block:

```
;; HLA specific parameters
(if (equal HLA 1)
   (sequence
      (setqb fomMapperLib "")
      (setqb fomMapperInitData "")
      (setqb rprFomVersion 1.0)
      (setqb pathToSublistFile "sublist.mtl")
      (setqb ignoreAdvisories 0)
      (setqb fedLookahead 1.0)
   )
)
```

3

Scenario Files

This chapter describes the files that get created when you create a scenario.

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3.1. Introduction

When you create and save a scenario, VR-Forces stores information about the scenario in the following files:

- The scenario file, named *scenario_name.scn*, lists the locations of the other scenario files, the terrain database, and the simulation model set file, and sets several parameters for the scenario.
- The order of battle file, named *scenario_name.oob*, stores identification and state information for entities, control objects, and published tactical graphics.
- The object map file (*scenario_name.omp*) maps objects to the back-ends on which they were created.
- The plan file (*scenario_name.pln*) stores entity plans.
- The global plan file (*scenario_name.gpl*) stores the scenario's global plans.
- The scenario extras file (*scenario_name.xtr*) lists the forces that each force is hostile to. If you have installed the B-HAVE Module, it stores spawn pattern templates.
- The scripts file (*scenario_name.spt*) stores scenario-specific scripted tasks.
- The overlay file (*scenario_name.ovl*) lists tactical graphics that are not published. Published tactical graphics are in the order of battle file.
- The selection groups file (*scenario_name.sgr*) stores the selection groups in the scenario and their members.
- The saved views file (*scenario_name.osrx*) stores observer views, if any. It can also specify a startup view.
- The scenario-specific GUI settings file (*scenario_name.gui_settings*) contains GUI settings that only apply to this scenario.

For the most part, you will not want to edit these files by hand. In some cases, we recommend that you not edit them. However, this chapter explains how to edit them if you need to.

3.2. The Scenario File

When you create a scenario, you can set its parameters in the New Scenario dialog box (Figure 3-1). Thereafter, you cannot edit scenario parameters in the front-end except for the scenario description and the option to attach components to remote entities. However, you can edit them in a text editor.

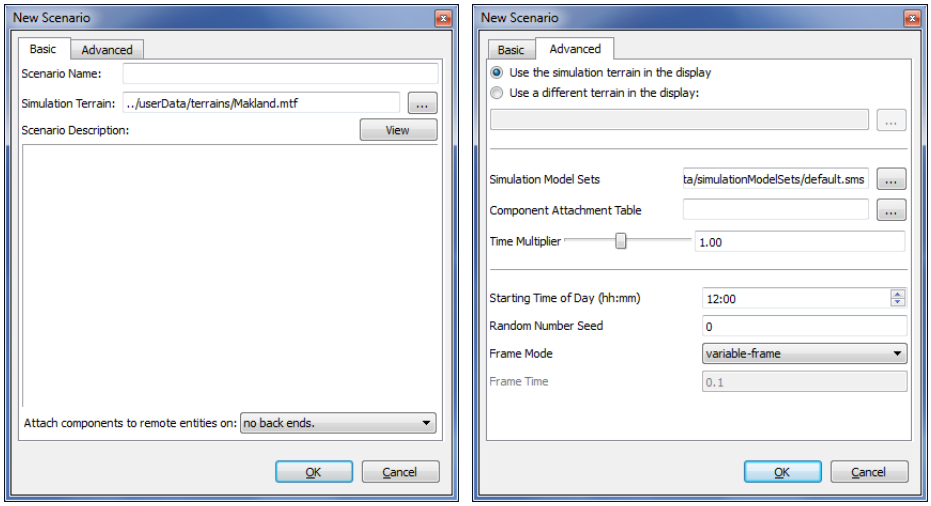


Figure 3-1. New Scenario dialog box

The default values for scenario settings in the New Scenario dialog box are drawn from the file *./appData/settings/vrfGui/default-scenario.tmpl*. If you want to change the default settings, you can edit that file.

3.2.1. Scenario Parameters

A typical scenario file looks like the following:

```
(Scenario
  (Component-Attachment  0)
  (Component-Attachment-Table  "")
  (Terrain-Database  "..\userData\terrains\Ground-db.mtf")
  (Gui-Terrain-Database  "..\userData\terrains\Ground-db.mtf")
  (Order-Of-Battle  "new.oob")
  (Scenario-Scripts  "new.spt")
  (Plan  "new.pln")
  (Global-Plan  "new.gpl")
  (Overlay  "new.ovl")
  (SelectionGroups  "new.sgr")
  (Object-Map  "new.omp")
  (Scenario-extras  "new.xtr")
  (time-multiplier  1.000000)
  (auto-reorganize False)
  (random-number-seed  0)
  (frame-mode  "variable-frame")
  (frame-time  0.100000)
  (sim-time  0.000000)
  (exercise-start-time  0.000000)
  (additional-opds )
  (Simulation-Model-Set-Files
 "../data/simulationModelSets/default.sms")
  (scenario-name  "Scenario created on ../userData/terrains/Ground
-db.mtf")
  (scenario-data
    (GuiObserverViews  "..\userData\scenarios\new.osrx")
    (GuiScenarioSettings  "..\userData\scenarios\new.gui_settings")
    (ScenarioDescription  "Some text that describes the scenario.")
    (ScenarioExtentInformation  "-2.81258e+006,-4.33259e+006,
        3.72903e+006,938.957")
  )
  (version  3.100000)
)
```



Paths in the scenario files are relative to the application directory, for example, *./bin*.

The Starting Time of Day is stored in the order of battle file, not the scenario file.

The parameters in a scenario file are as follows:

- **Component-Attachment** specifies whether or not attachment of components to remote entities is allowed in the scenario. The options are:
  - 0: no component attachment.
  - 1: the first back-end manages all remote components.
  - 2: remote component attachment is load-balanced on all back-ends.



Although you can set this value in the New Scenario and Load Scenario dialog boxes, it is not saved in the scenario file. To force a specific value, you must edit the scenario file.

- **Component-Attachment-Table** specifies the component attachment table to use if attachment of components to remote entities is allowed.
- **Terrain-Database** specifies the terrain database to be loaded by the back-end.
- **Gui-Terrain-Database** specifies the terrain database loaded in the front-end.
- **Order-Of-Battle** specifies the order of battle file.
- **Scenario-Scripts** specifies the file that has scenario-specific Lua scripts.
- **Plan** specifies the plan file.
- **Global-Plan** specifies the global plan file.
- **Overlay** specifies the overlay file.
- **SelectionGroups** specifies the selection groups file.
- **Object-Map** specifies the object mapping file.
- **Scenario-Extras** specifies the extras file, which records force hostility relationships. If the B-HAVE Module is installed, spawn pattern templates are stored in this file. It may be used for other purposes in the future.
- **time-multiplier** specifies whether a scenario runs in real time or at a rate other than real time. A value greater than 1 runs the simulation faster than real time. A value between 0 and 1 runs the simulation slower than real time. You can set this value dynamically using the Time Multiplier toolbar.

If you are running a scenario using HLA Time Managment, it is strongly recommended that you set **time-multiplier** to 1.

- **auto-reorganize** lets you specify the default behavior for aggregate reorganization. Set it to True or False. For information about reorganization, please see Section 3.6.1, "How Aggregates Are Organized," in *VR-Forces Users Guide*.
- **random-number-seed** sets the default random number seed. It provides a starting point for the generation of random numbers needed by VR-Forces. Since computer-generated random numbers are not truly random, if you run a scenario repeatedly with the same random number seed (and you run in fixed-frame-mode), you will get the same results. (For more information about repeatability, please see Section 3.13.3, "Exercise Clock Modes," in *VR-Forces Users Guide*.) Enter an integer between 0 and the largest integer permitted on your system.
- **frame-mode** sets the frame rate mode to one of the following:
  - Variable-Frame Run-To-Complete (`variable-frame`)
  - Fixed-Frame Best-Effort (`fixed-frame`)
  - Fixed-Frame Run-To-Complete (`fixed-frame-run-to-complete`).

  These frame rate modes are described in Section 3.13.3, "Exercise Clock Modes," in *VR-Forces Users Guide*.
- **frame-time** specifies the length of a frame, in seconds. If **frame-mode** is set to `fixed-frame` or `fixed-frame-run-to-complete`, you must set the frame time to a non-zero value. A value of zero for frame time will prevent simulation time from advancing in either of these modes.
- **additional-opds** specifies custom OPD files to load (for backwards compatibility).
- **Simulation-Model-Set-Files** specifies a list of SMS files to load.
- **scenario-name** is an optional parameter that assigns a name to the scenario. It is independent of the file name and is only used in some message dialog boxes.
- **scenario-data** is the name of a block of data with the following additional parameters:
  - **GuiObserverViews** specifies the saved views file for the scenario.
  - **GuiScenarioSettings** specifies the *.gui_settings* file. It records scenario-specific GUI settings.
  - **ScenarioDescription** is the text of the scenario description.
  - **ScenarioExtentInformation** lists the extents of the scenario for the zoom to extents option.
- **version** specifies versioning information for the scenario file. Do not edit this parameter.



The **sim-time** and **exercise-start-time** parameters are in the scenario file for backwards compatibility. They are not supported in scenarios created after VR-Forces 4.0.3.

3.2.2. Specifying Pathnames for Scenario Files

Pathnames in a scenario file can be absolute or relative. When VR-Forces saves a new scenario, it creates pathnames that are relative to the application directory. If you think you might need to move a scenario to another computer or a new directory structure, change the paths to be relative to the *./bin* directory. To change pathnames, edit the scenario file in a text editor. VR-Forces will preserve the new paths when it saves the scenario.

If you plan to run multiple front-ends and back-ends on multiple machines, particularly if they use different operating systems, you must change the pathnames for the terrain database and object parameter database to relative paths or simple pathnames.

Configuring How Paths are Interpreted

The following parameters in *vrfSim.mtl* determine how pathnames for the object parameter database and terrain database are resolved:

- **defaultParameterDatabasePath** specifies the path to search for the *.opd* files when an explicit path is not specified in a scenario file
- **defaultTerrainDatabasePath** specifies the path to search for terrain database files when an explicit path is not specified in a scenario file.

When the back-end loads a scenario file, it looks for the object parameter database using the following search order:

1. If the path is absolute, load the file in the specified path.
2. If the path is relative, try to load the file relative to the application path (*./bin/vrfSimprotocol*).
3. Look in the directory specified by **defaultParameterDatabasePath**.

When the back-end loads a scenario file, it looks for the terrain database using the following search order:

1. If the path is absolute, load the file in the specified path.
2. If the path is relative, try to load the file relative to the application path.
3. Look in directory specified by **defaultTerrainDatabasePath**.
4. If defined, look in the user-defined environmental variable VRF_TERRAIN_PATH.

3.2.3. Changing the Terrain Database for a Scenario

When you create a new scenario, you must choose terrain databases for the front-end and back-end. By default, the back-end uses the same database as the front end.

Once you have chosen the terrain database, you cannot change it from the graphical user interface. You can edit the pathname of a terrain database in the scenario file. However, unless the new terrain database covers exactly the same geographic area as the old one, the order of battle and overlay information associated with the scenario may be confusing or useless.

3.3. Editing the Plan Files

VR-Forces saves two plan files for each scenario, an entity plan file (*.pln*), which stores the plans for all individual entities, and the global plans file (*.gpl*), which stores global plans.

Plan files are created interactively in the VR-Forces Plan window. The Plan window ensures that the plan is written using the correct syntax. We recommend that you not try to create plan files or edit plan files by hand. However, there may be occasions when it makes sense to edit a plan file by hand or programmatically. For example, if you change the name of an entity, updating each entity's plan in the Plan window to change all plan statements that refer to that entity could be tedious. It would be much quicker to open the plan file in a text editor and replace appropriate instances of the old entity name with the new entity name.

Before you edit a plan file, make a backup copy that you can revert to if necessary.

3.3.1. The Structure of an Entity Plan File

Figure 3-2 illustrates a simple entity plan that specifies one task for each of two entities (a global plan has a similar syntax):

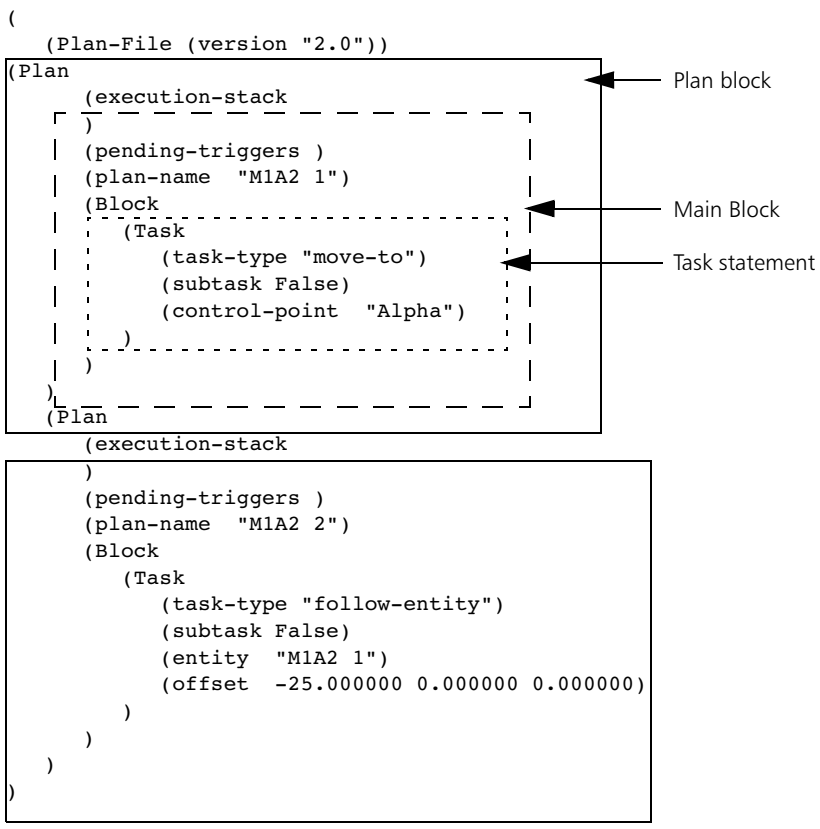


Figure 3-2. Simple plan

Plans are specified for entities by entity name. The plan is specified within a Plan block. The content of the plan is specified in the Main block. Tasks and set statements are specified in the Main block and in conditional statements. Conditional statements can be specified in the main block and can be nested in other conditional statements.

The basic syntax for a set statement in a plan is:

```
(Block
  (Set
    (set-data-request-type "set-heading")
    (heading  0.872665)
  )
)
```

Figure 3-3 illustrates the basic syntax for a conditional expression. It includes a task statement in the main block to show relative indentation.

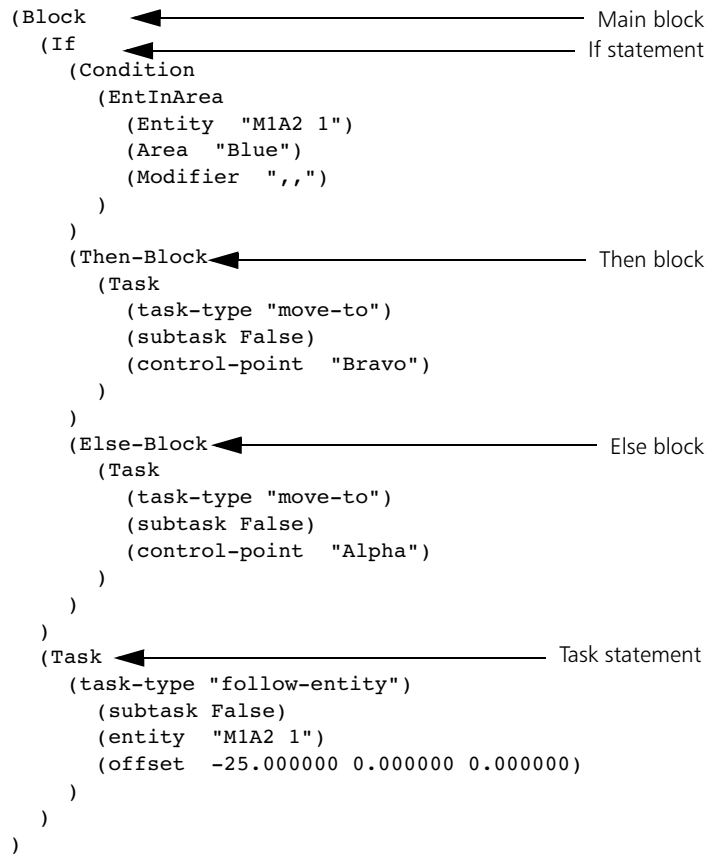


Figure 3-3. Conditional expression with subblocks

To edit a plan file by hand, add Task, Set, If, While, and When sections as needed to the Block section for each entity. For tasks or set statements, you will always have a **task-type** or **set-data-request-type** parameter that needs to contain the type of task or set data request. The presence of additional parameters depends on the task or set data request that you created. You will need to know the names of the parameters and what type of value to specify.

Make sure that you match parentheses properly.

3.4. The Object Map File

When you start VR-Forces with multiple back-ends, you can specify which back-ends simulate the various objects you create. The object map file records the back-ends on which objects are simulated. The next time you open the scenario, VR-Forces looks for the back-ends specified in the object map file. If any of the specified back-ends is not available, the front-end asks you if you want to remap objects to the back-ends that are present. You can run the simulation without remapping. However, the behavior of a simulation that is missing entities or objects is unpredictable.

Mappings between objects and back-ends are saved to the object map file. If you have a scenario that uses multiple back-ends and you are uncertain about the site:application values you need to use to run the scenario, you can view the object map file to refresh your memory. The following example shows two entities and a route mapped to two different back-ends:

```
(map-entry
  (address  1 3201)
  (name  "M1A2 1")
)
(map-entry
  (address  2 3400)
  (name  "T80 2")
)
(map-entry
  (address  1 3201)
  (name  "route_1")
)
```

The **address** parameter lists the site and application number used for the back-end on which the object was simulated.

If you want to run an existing scenario using back-ends with different site and application values, you could edit the object map file and change the address field to match the new site and application values. However, if you make any mistakes in this process, your scenario might not run correctly. As an alternative to editing the object map file by hand, you could use the load balancing option to remap objects to back ends. For details about load balancing, please see Section 1.2.3, "Load Balancing a Scenario," in *VR-Forces Scenario Management Guide*.

3.5. Editing the Order of Battle File

The order of battle is a description of the local objects in a simulation. When you create a scenario, you populate it with entities. When you save or checkpoint a scenario, VR-Forces saves a record of each entity, including its state information and geographic location, to the order of battle file. The next time you load this scenario, VR-Forces creates the entities using the settings in the object parameter database, but then overrides those settings with the information in the order of battle file. Therefore, changes you make to the object parameter database might not get picked up by existing scenarios. If you want to change a basic entity value, you might need to edit the order of battle file.

The order of battle file also describes the tactical graphics that have been defined for the scenario. For more information, please see Section 3.7, "Tactical Graphics," in *VR-Forces Users Guide* and Chapter 5, *Overlays and Tactical Graphics*, in *VR-Forces Scenario Management Guide*.

3.5.1. Saving Default Entity Parameters to the Order of Battle File

When an entity in a scenario is saved to the order of battle (OOB) file, parameters that are unchanged from the initial values in the object parameter database entry are written out in the form:

```
(parameter-name USE-DEFAULT)
```

The USE-DEFAULT keyword indicates that the next time this file is loaded (as part of a scenario) it should be initialized from data in the entity's object parameter database entry. The practical effect of the USE-DEFAULT keyword in OOB files is that if you modify the object parameter database, the next time you load a scenario those changes can affect the entities and objects in the scenario.

This lets you experiment with changes to entity parameters and view the effects of the changes to existing scenarios, without modifying the order of battle files.

3.6. The Scenario Extras File

VR-Forces lets you configure hostility relationships. That is, for any force you can specify which forces it is hostile to. By default Friendly and Opposing forces are hostile to each other. If you change the hostility relationships, they are saved in the scenario extras file (*.xtr*).

If you have the B-HAVE Module installed, it stores spawn patterns in the scenario extras file.

3.7. Temporary Scenario Directories

When you load a scenario, VR-Forces creates temporary directories in which it stores files that it needs to maintain and update the scenario. To prevent conflicts in the temporary directories when running multiple copies of VR-Forces from the same directory, VR-Forces creates unique temporary directories. The directories are created in the path specified by the TMP environment variable. If this variable is not specified on Linux, the */tmp* directory is used. The TMP variable must be specified on Windows. If VR-Forces cannot create a temporary directory, an error message is printed and the application exits. In the front-end, the temporary directory is created by *DtVrfRemoteController* and starts with the prefix *vrffe*. In the back-end, the temporary directory is created by *DtCgfDispatcher* and has the prefix *vrfbe*. In both cases, the temporary directory is removed when VR-Forces shuts down.

4

The Object Parameter Database

This chapter provides a detailed description of the object parameter database. It will be most useful to VR-Forces users who need to develop and configure new components.

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4.1. The Object Parameter Database

VR-Forces entities and objects have many parameters. Parameter values are stored in a set of files organized in simulation model sets (SMS) that VR-Forces reads when you load a scenario or create new objects. We refer to these files collectively as the object parameter database (OPD). The object parameter database specifies both the characteristics of an entity and starting entity state values. You can modify the behavior of an entity by changing the parameters for that type of entity. You can add new types of entities and new behaviors to VR-Forces by adding new files to the object parameter database.

Before you make any changes to the object parameter database, make a backup copy of the file you are changing.

Figure 4-1 illustrates the organization of the OPD. The primary definition of a simulated object, such as an entity, a tactical graphic, or a cultural feature, is stored in a file with the extension *.entity*. The entity file specifies the entity type enumeration, marking text, organizational information, and other parameters. It references a platform file (extension *.ope*), that provides a set of generic components for the object type, such as ground platform, surface platform, or line object. Each entity file also specifies the systems that allow it to interact with the simulated environment, such as sensors, weapons, and movement systems.

Systems are configured in system definition files. System definition files group related component and connection specifications into convenient packages. The components reference additional configuration files. The system definition files also make it possible to add systems to entities in the Entity Editor.

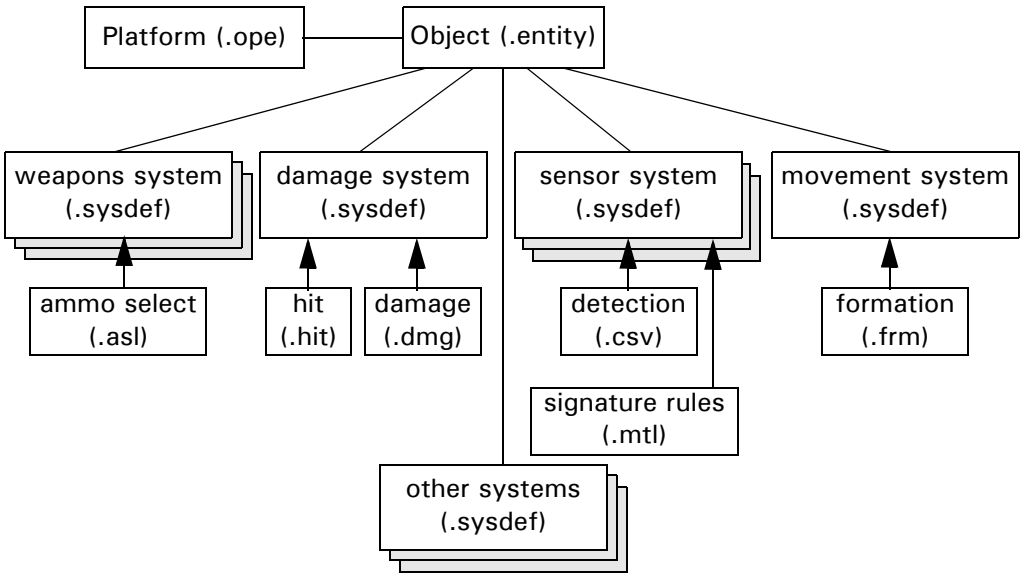


Figure 4-1. Object parameters database

4.1.1. VR-Forces Classes and Object Parameters

When you create any simulated object in VR-Forces, an instance of *DtVrfObject* is created in the simulation engine. Different types of simulated objects require different parameters for simulation and publishing, which are initialized by a subclass of *DtVrfObjectParameters*, and stored in a subclass of *DtVrfObjectBaseStateRepository*. Each *DtVrfObject* "has a" *DtVrfObjectParameters* and a *DtVrfObjectBaseStateRepository*. The type of parameters object to use for entity creation is specified in the entity's platform file by the **parameter-type** parameter. The state repository is specified in **state-repository** parameter in the local-objects block. the For example, when an entity that references the platform *Ground_Vehicle.ope*, which has a parameter type **ground-vehicle-param**, is created, a *DtVrfGroundVehicleParameters* object is created to read in the initial values from, and a *DtGroundVehicleStateRepository* is used to store runtime values.

4.1.2. Object Types

VR-Forces uses an eight-digit enumeration scheme for specifying objects. The enumerations are based on the seven-digit enumerations used by DIS and the RPR FOM. The additional field distinguishes between individual and aggregate objects.

This enumeration scheme describes a tree that goes from a more general specification to a more detailed one. Figure 4-2 illustrates a partial entity type tree. To build an entity type enumeration, start at the Kind and work your way down the tree, adding the number for each element. So, for example, if you follow the tree down to M1A2 you build the enumeration: 1 1 225 1 1 3 0. Since M1A2 is a leaf in the tree, the last field is 0. For more information about the entity enumeration scheme, please see the DIS Enumerations Document (*Enumeration and Bit Encoded Values for Use with Protocols for DIS Applications*).

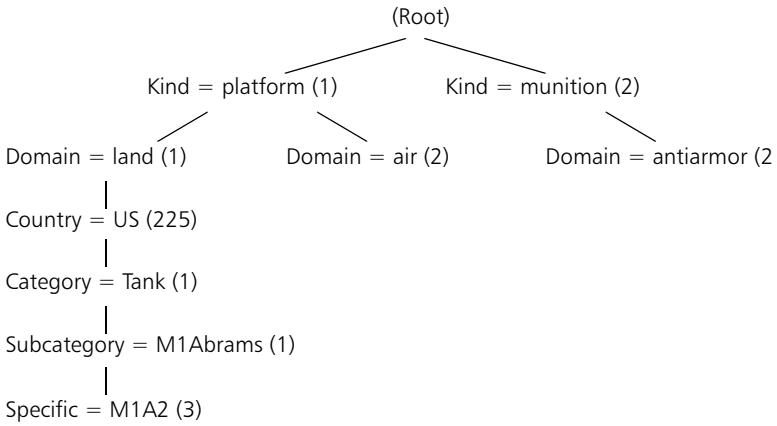


Figure 4-2. Entity type enumeration tree

The Object Super-Type

VR-Forces adds a field to the standard 7-digit entity enumeration so that we can manage objects that are not part of the DIS/RPR FOM enumeration scheme, such as aggregate entities and tactical graphics. We enclose the seven-digit enumeration in parentheses and preface it with the object super-type (Figure 4-3). For example, the entity enumeration for an M1A2, described in the previous paragraph, becomes the object type: 1 (1 1 225 1 1 3 0).

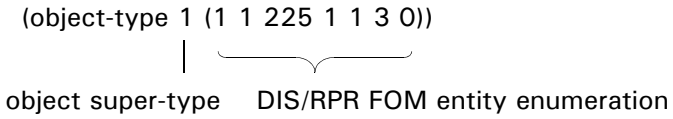


Figure 4-3. VR-Forces object-type parameter

Table 4-1 lists the values VR-Forces can use for the object super-type. For more information, please see *objTypeEnums.h* or "Object Type Enumerations," on page A-9.

Table 4-1: Object super-type field values

Object super-type	Meaning
0	Other
1	Individual (platform entities, individual tactical graphics)
2	Aggregate
3	Pseudo-aggregate
4	True Aggregate

Published Object Types and Matching Object Types

Each entity in the OPD has two object types – the published object type and the matching object type.

The published object type is used as follows:

- When the front-end sends a create entity message to the back-end, the back-end uses the object type to determine which entity model to create.
- When the back-end publishes an entity on the network it uses the published object type as the entity enumeration.

Each field of a published object type must have a specific value.

The matching object type is used as follows:

- When the back-end receives a request to create an entity and it cannot find an exact match for the object type that it is sent, it finds the best match among matching object types to determine which entity model to create. (For details about the best match method, please see "The Best Match Method," on page 4-7.)
- When the back-end discovers an entity on the network, it finds the best match among matching object types so that it can create local representative *DtVrfObjects*.

The matching type can be the same as the published object type or it can have wild-cards (-1).

For example, in VR-Forces, the published object type for an A-10 Thunderbolt is 1:2:225:2:4:1:0. If the matching type for the A-10 Thunderbolt is also 1:2:225:2:4:1:0 and VR-Forces discovers a remote entity with that same object type, it can match it to the A-10 Thunderbolt simulation model and can represent it properly in the simulation. However, if VR-Forces discovers a remote entity with the object type 1:2:225:2:4:1:1 (which is just a variation of an A-10), it will not be able to match the remote entity to an A-10 model because there is no A-10 match for that object type. (VR-Forces would end up matching the remote entity to a more generic fighter model, as explained in "The Best Match Method," on page 4-7.) But if the A-10's matching object type is 1:2:225:2:4:1:-1, then VR-Forces will be able to match the remote entity to the A-10 model using the best match method.

Object types are specified in the *.entity* file as follows:

```
<simObject objectType="1:1:2:225:2:4:1:0" matchType="1:1:2:225:2:4:1:-1"
  platform="@(platforms-dir)/Fixed_Wing_Aircraft.ope">
```

The **objectType** attribute specifies the published object type; **matchType** specifies the matching object type.

The Best Match Method

As explained in "Object Types," on page 4-4, object types describe an entity in increasing specificity as the object type fields move from left to right. Objects in the object parameter database are specified in a hierarchy in which entries at higher levels of the hierarchy have wildcard values (-1s) in object type fields that do not need to be specified at that level of the hierarchy. When VR-Forces looks up an object type, it begins at the root of the tree, working its way down until no better matches are found (the best-match method.)

Suppose the object type hierarchy for figher jets looks like this:

- -1:-1:-1:-1:-1:-1:-1:-1 – match any object.
- 1:1:2:-1:-1:-1:-1:-1 – match any fixed-wing entity.
- 1:1:2:225:2:-1:-1:-1 – match any U.S. attack fixed-wing.
- 1:1:1:2:225:2:4:1:-1 – match any A-10 Thunderbolt. (In VR-Forces, this is the A10 Thunderbolt matching object type.)
- 1:1:1:2:225:2:4:1:0 – match a specific A-10 Thunderbolt. (In VR-Forces, this is the A10 Thunderbolt published object type.)

As you replace each wildcard value (-1) with a specific enumeration, the scope of the object type narrows. Given this hierarchy, if VR-Forces discovers an entity with the object type 1:1:2:225:2:11:0:0, it starts trying to find the best match as follows:

1. The discovered object type matches the top level - any object, because all fields are wild cards.
2. The discovered object type matches the fixed-wing object type, because the first three fields match and the rest are wild cards.
3. The discovered object type matches the U.S. attack fixed-wing object type.
4. The discovered object type does not match the A-10 Thunderbolt matching object type. Although the first five fields match, the sixth is different and is not wild carded.

The best match is the U.S. attack fixed-wing object type, so VR-Forces will use the generic U.S. attack fixed-wing model to represent the discovered entity.

4.1.3. Parameter Types

In addition to specifying an **object-type** for each object, you must specify a **parameter-type** for each object. The **parameter-type** determines the parameters and components that can be specified for an object. For example, a rotary-wing or fixed-wing entity can have a **nose-support** parameter, but a ground vehicle cannot. Figure 4-4 illustrates the object parameter type hierarchy.

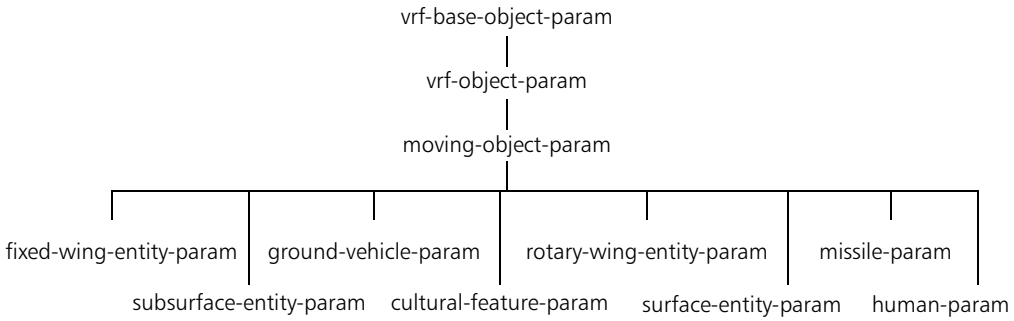


Figure 4-4. Object parameter hierarchy

The **parameter-type** specifies the set of parameters appropriate to an entity, and the entity state repository maintains state information for an entity, so the **parameter-type** and state repository must match. For more information, please see "The State Repository Hierarchy," on page 4-12.



The **object-type** is specified in an object's *.entity* file. The parameter-type is specified in the platform (*.ope*) file.

4.1.4. Local and Remote Subcomponents

As explained in Section 3.4.2, "Local Objects and Remote Objects," in *VR-Forces Users Guide*, each VR-Forces back-end simulates objects itself (local objects), and maintains state information about remote objects. All of these objects are instantiated as *DtVrfObjects*. The *DtVrfObject* class has a "has a" relationship with the following classes:

- *DtSimObjectStateRepository*
- *DtSimObjectNetInterface*
- *DtSimTaskManager*
- *DtSimComponentManager*
- *DtVrfObjectPlanManager*.

These classes are referred to as subcomponents of the object. Table 4-2 maps the subcomponent classes to the parameters that specify them.

Table 4-2: Subcomponent classes and parameters

Class	Parameter
DtSimObjectStateRepository	state-repository
DtSimObjectNetInterface	net-interface
DtOrganizationManager	organization-manager
DtSimTaskManager	task-manager
DtSimComponentManager	component-manager
DtVrfObjectPlanManager	plan-manager

VR-Forces creates different subcomponents for an object depending on whether it is a local object or a remote object. The subcomponents are specified in the **local-objects** and **remote-objects** parameter blocks for that object. Table 4-3 lists the permissible entries for each parameter listed in Table 4-2.

Table 4-3: Permissible subcomponent parameters

Parameter	Permissible values
state-repository	◆ vrf-object-base-state-repository ◆ vrf-overlay-object-state-repository ◆ vrf-object-state-repository ◆ vrf-moving-object-state-repository ◆ vrf-aggregate-state-repository ◆ fixed-wing-entity-state-repository ◆ ground-entity-state-repository ◆ human-state-repository ◆ cultural-feature-state-repository ◆ missile-entity-state-repository ◆ rotary-wing-entity-state-repository ◆ surface-entity-state-repository ◆ subsurface-entity-state-repository
net-interface	◆ aggregate-local-entity-net-interface ◆ individual-local-entity-net-interface ◆ local-environmental-net-interface ◆ pseudo-aggregate-local-entity-net-interface ◆ vrf-aggregate-remote-entity-net-interface ◆ vrf-individual-remote-entity-net-interface ◆ vrf-remote-environmental-net-interface ◆ aggregate-remote-entity-net-interface ◆ individual-remote-entity-net-interface ◆ remote-environmental-net-interface
task-manager	◆ local-task-manager
component-manager	◆ component-manager
plan-manager	◆ vrfobject-plan-manager

Every object must have a state repository specified. Objects that should be published need a net interface. Other subcomponents are optional. However, for most entities, you will want to specify a task manager, plan manager, and component manager so that you can control the entity and give it tasks.

The local and remote objects parameters are specified in the platform (*.ope*) files. Therefore they apply to all entities that reference a particular platform. Use the existing entries in the object parameter database as guidance if you create a new platform or change an existing platform. A typical entry for local and remote objects is:

```
(local-objects
  (state-repository  "ground-entity-state-repository")
  (state-repository-min-tick-period  -1.000000)
  (state-repository-min-tick-period-variance  -1.000000)
  (net-interface  "individual-local-entity-net-interface")
  (net-interface-min-tick-period  -1.000000)
  (net-interface-min-tick-period-variance  -1.000000)
  (task-manager  "local-task-manager")
  (component-manager  "component-manager")
  (plan-manager  "vrfobject-plan-manager")
)
(remote-objects
  (state-repository  "vrf-moving-object-state-repository")
  (state-repository-min-tick-period  -1.000000)
  (state-repository-min-tick-period-variance  -1.000000)
  (net-interface  "vrf-individual-remote-entity-net-interface")
  (net-interface-min-tick-period  -1.000000)
  (net-interface-min-tick-period-variance  -1.000000)
  (task-manager  "")
  (component-manager  "")
  (plan-manager  "")
)
```

The State Repository Hierarchy

Each VR-Forces object must have a state repository to maintain essential state information about the object, such as its current location, orientation, appearance, and so on. Therefore, each object must specify a state repository and the state repository must match the **parameter-type** for the object. (The state repository and **parameter-type** are specified in the platform file.)

Table 4-4 lists parameter types and the state repository type required.

Table 4-4: State repository and parameter types

State Repository Type	Parameter Type
ground-entity-state-repository	ground-vehicle-param
fixed-wing-entity-state-repository	fixed-wing-entity-param
individual-lifeform-state-repository	individual-lifeform-param
rotary-wing-entity-state-repository	rotary-wing-entity-param
human-state-repository	human-param
cultural-feature-state-repository	cultural-feature-param
missile-entity-state-repository	missile-param
surface-entity-state-repository	surface-entity-param
subsurface-entity-state-repository	subsurface-entity-param
vrf-moving-object-state-repository	moving-object-param
vrf-overlay-object-state-repository	vrf-object-param
vrf-object-state-repository	

The Net Interface Hierarchy

VR-Forces manages network relationships of local and remote entities through the network interface classes. Choose the set of local and remote network interface types that most closely represent the type of object being simulated. For example, for an individual vehicle such as a tank, choose individual-local-entity-net-interface for the local network interface and vrf-individual-remote-entity for the remote network interface. Please see Appendix A, *Object Parameters* for tables that list the network interfaces used for the entities provided with VR-Forces.

4.2. Component Descriptors and Parameters

The parameters for an entity include a list of all the sensor, controller, and actuator components it uses. (For details, please see Section 3.5.4, "VR-Forces Uses a Component Architecture," in *VR-Forces Users Guide*.) These components might be in the OPE file or in a system definition file. If there are no components of a certain type (for example, no sensors), you can omit the list. (In other words, you do not need a placeholder list for unused components.)

A component descriptor is a text block in a platform or system definition file that describes a component (see Example 4.1). A component descriptor must include the type of the descriptor and the type of the component that it is describing. A component descriptor can also contain parameters for the component. "Common Elements of Component Descriptors," on page 4-13 describes the construction of a component descriptor.

Components can receive data from, and convey data to, other components through ports. These ports are specified in platform files and system definition files.

A component can create a port group, which groups a set of related ports together. For example, the automotive-control port group groups the throttle, steering, and brake ports. Use of port groups simplifies specification of connections because you just have to specify a port group instead of many individual ports. For component descriptions and a list of port groups, please see the online help for the OPD Editor. For a detailed discussion of ports and port groups, please see API documentation.

The port group also provides a mechanism for ensuring that only one data provider attempts to put values on those ports each simulation frame. For more information, please see "Configuring the Priority of Components," on page 4-16.

4.2.1. Common Elements of Component Descriptors

The common elements of component descriptors are:

- Name – The first element in a component descriptor specifies the component's name. This name can be whatever you want, but it must be unique within the entity or the system the component is defined in. It gets used in the connections section of the entity's parameters. Other components may use this name to find the specified component. In Example 4.1, the name of the first component is move-along (line 2).
- **component-descriptor-type** – The component descriptor factory creates the type of component descriptor specified by this type. This lets the system know what types of additional data may be present. In Example 4.1, the component descriptor type for the move-along component is ground-move-to-descriptor (line 3).
- **component-type** – The component factory creates the type of component specified in this entry. In Example 4.1, the component type is ground-auto-move-along-controller (line 4).



The component-descriptor-type and component-type values are specified in code. You cannot make them up. Please see *compTypes.h* and *compDescTypes.h*.

- connections (optional) – The connections (Example 4.1, line 46) entry specifies how the components connect to one another (through ports, port groups, or both). Components attach to each other by connecting output and input ports to one another, or output port groups to input port groups. Since a component can have more than one port, port group, or both, the name of the port or port group to use is also specified. If an entity does not have any components that need to connect to one another, then you can omit this entry. Items in the connections entry can be in one of the following forms:
  - Specify a port-to-port connection:

    ```
    connect component_name:output_port component_name:input_port
    ```

  - Specify a port group-to-port group connection:

    ```
    connect component_name:output_port_group
      component_name:input_port_group
    ```

    The connections in Example 4.1 use this format.

  - Specify a port-to-port connection, in which one or both of the ports exists inside of a group, as follows:

    The input port belongs to an input port group:

    ```
    connect component_name:output_port
      component_name:input_port_group:input_port
    ```

    The output port belongs to an output port group:

    ```
    connect component_name:output_port_group:output_port
      component_name:input_port
    ```

    Both input and output ports belong to groups:

    ```
    connect component_name:output_port_group:output_port
      component_name:input_port_group:input_port
    ```



The port and port group names are defined in code for each component. Please see class documentation or the online help for the OPD Editor for the names of port and port groups used by a given component.

All of the entity components that you can use are described in the online help for the OPD Editor.

Example 4.1 shows component descriptors for the Move Along and Patrol Between Points controllers and the Powertrain actuator for a ground vehicle (from the *ground-tracked-default.sysdef* file.) The Powertrain actuator simulates movement of a ground vehicle based on the throttle, brake, and steering inputs it receives from the automotive controllers. The example also shows how the output port groups for the controllers are connected to the input port group of the powertrain.

Example 4.1

```
(controllers
  (move-along
    (component-descriptor-type "ground-move-to-descriptor")
    (component-type  "ground-auto-move-along-controller")
    (min-tick-period  -1.000000)
    (min-tick-period-variance  -1.000000)
    (tick-period-uses-real-time False)
    (process-state-repository-name  "")
    (process-state-repository-type  "")
    (is-enabled True)
    (near-distance  25.000000)
    (at-distance  1.000000)
    (approach-speed  2.000000)
    (road-center-offset  2.000000)
  )
  (patrol-between-points
    (component-descriptor-type "ground-move-to-descriptor")
    (component-type  "ground-auto-patrol-between-controller")
    (min-tick-period  -1.000000)
    (min-tick-period-variance  -1.000000)
    (tick-period-uses-real-time False)
    (process-state-repository-name  "")
    (process-state-repository-type  "")
    (is-enabled True)
    (near-distance  25.000000)
    (at-distance  1.000000)
    (approach-speed  2.000000)
    (road-center-offset  2.000000)
  )
) ;; end controllers
(actuators
  (powertrain
    (component-descriptor-type "automotive-component-descriptor")
    (component-type  "automotive-actuator")
    (min-tick-period  -1.000000)
    (min-tick-period-variance  -1.000000)
    (tick-period-uses-real-time False)
    (process-state-repository-name  "")
    (process-state-repository-type  "")
    (is-enabled True)
    (art-part-list )
    (check-terrain-collisions False)
    (use-high-fidelity-ground-clamping True)
  )
) ;; end actuators
(connections
  (connect move-along:automotive-control powertrain:automotive-
    control)
```

```
48      (connect patrol-between-points:automotive-control
          powertrain:automotive-control)
49    ) ;; end connections
```

The connection in line 46 would read: the move-along component sends output to its automotive-control output port group. The powertrain receives the move-along controllers output through its automotive-control input port group.

4.2.2. Configuring the Priority of Components

Each simulation frame, VR-Forces ticks each entity's components in the order in which they are listed in the platform and system definition files. If a component believes it should be providing data, it takes control of the receiving component's ports or port group. Once a component acquires the ports, no other component can send data to that component during that frame. Therefore the order in which components are listed provides a natural priority scheme.

For example, among the ground movement controllers, the collision avoidance controller is placed on the controller list before any of the other movement controllers. If this controller needs to provide input to the ground automotive actuator to avoid a collision, it takes control of the automotive-control port group on the next tick and overrides the controller that previously owned the port group (such as Move To or Move Along).

4.3. System Definition Files

The Entity Editor allows VR-Forces users to easily add component systems, such as weapons, sensors, and movement, to entities without needing to understand the components, configuration files, and connections required to make these systems work. These systems are defined in system definition files (*.sysdef*). System definition files are referenced in an entity's *.entity* file. They are read by the OPD Editor and can be edited in it.

System definition files have two major sections – data and metadata. The data is a list of the components and connections required to implement the system for an entity.

The metadata explains to the Entity Editor how to present the system to the user and how to integrate it into the entity model.

4.3.1. Creating a System Definition File

If you want to create a new system definition file, MÄK recommends that you copy an existing file and use it as a template for adding the components that you want to configure into a system. You can use the OPD Editor to do this or a text editor.

The format of a system definition file is as follows:

```
(system-name
  (controllers
  )
  (actuators
  )
  (connections
  )
  (resources
  )
  (meta-data
    (system-name "Spot Report Generator")
    (system-description "Allows the entity to send spot reports though
 its radio when its sensors detect other entities in the scenario.")
    (allowed-state-repository-types "all")
    (system-categories "other")
    (meta-data-entry-list
    )
    (parameter-data-list
    )
  )
)
```

As you can see, system definition files use MTL syntax. The system-name is an arbitrary name that uniquely identifies the system. The component sections list the various controllers, actuators, sensors, and resources that are needed to build the system. The connections list the connection among the components.

4.3.2. Configuring System Connections

Within each system definition file, you list the connections among the components in the file. (For general information about connections, please see "Common Elements of Component Descriptors," on page 4-13.) For systems that are self-contained, for example movement systems, there is no need to connect to components in other systems. However, some systems need to connect to components outside their system. For example, a visual sensor needs a list of object types to detect. This section explains how to make these out-of-system connections.

To understand how system definition files and *.entity* files are integrated, we will look at:

- A componentSystem element in a *.entity* file.
- The related system definition file.
- The connection section in the system definition file.

The M1A2, which uses the Ground_Vehicle platform, is configured with a visual sensor (in *M1A2_Abrams_MBT.entity*) as follows:

```
1    <simObject objectType="1:1:1:225:1:1:3:0"
     platform="platforms\Ground_Vehicle.ope">
2    ...
3    <componentSystem systemName="sensor"
       platform="@(system-dir)/sensors/visual-sensor.sysdef">
4      <bodyPosition paramName="sensor-position" right="0.57"
         forward="-1.14" up="2.1"/>
5      <real paramName="max-range">4000</real>
6    </componentSystem>
```

The sensor component references the system definition file *visual-sensor.sysdef*. The parameters specified provide values for the variables in the system definition file. (For more information, please see "Adding Variable Bindings to Platform and System Files," on page 4-21.)

The system definition file has the following connections:

```
1    (visual-sensor-system
2        ...
3      (connections
4        (connect system:object-types-to-detect
           visual-sensor:object-types-to-detect)
5        (connect visual-sensor:detected-objects system:detected-objects)
6        (connect system:sensor-offset visual-sensor:sensor-offset)
7      )
8      (resources )
9      (meta-data
10       (system-name  "Visual Sensor")
11       (system-description  "Allows an entity to detect other objects
       through visible light.")
12       (allowed-state-repository-types "all")
13       (system-categories "sensor")
14   ...
15   )
```

The system definition file defines connections for its components. The first connection in the list (line 4) means that some external component (`system`) is providing input from its `object-types-to-detect` port to the visual sensor's `object-types-to-detect` port. The second connection specifies that the visual sensor's `detected-objects` port sends data to the some external component's `detected-objects` port. When VR-Forces creates an entity, it needs to substitute an actual component for the generic "system" component specified in the system definition file. It does this by referring to an auto-connection block in the OPE file

The platform file has a set of auto-connection blocks like the following (from *Ground_Vehicle.ope*:

```
(auto-connection
  (source-controller "target-selection")
  (source-port-name "object-types-to-detect")
  (destination-category "sensor")
  (destination-port-name "object-types-to-detect")
)
```

The auto-connection block in the OPE file is a template that VR-Forces uses to match systems of a specified category to the appropriate controllers. In this example the `target-selection` controller sends data through its `object-types-to-detect` port to the `object-types-to-detect` port of any system that is in the sensor category. Since the visual sensor is in the sensor category, it substitutes the `target-selection` controller for the generic system in building its connections.

Figure 4-5 illustrates the relationships of the OPE file, *.entity* file, and system definition files referenced in this section and how connections are made.

The M1A2 entity, which uses the Ground_Vehicle platform, has a visual sensor (callout 1). The visual sensor has several connections. The one illustrated in the figure (2) takes input from an external source's `object-types-to-detect` port and sends it to the visual sensor's `object-types-to-detect` port (3). In this connection, the external source is represented by `system`. Before the sensor can actually work, this unspecified system must be determined.

When the entity is created, VR-Forces checks all the auto-connections in the OPE file (4). In this case, there is an auto-connection from the target-select controller's `object-types-to-detect` port to the `object-types-to-detect` port of a component whose destination category is `sensor` (5). To make this connection, the unspecified sensor must be determined.

VR-Forces matches the `destination-category` value "sensor" in the OPE file to the `system-categories` value "sensor" in the system definition file and the connections can now be completed (6).

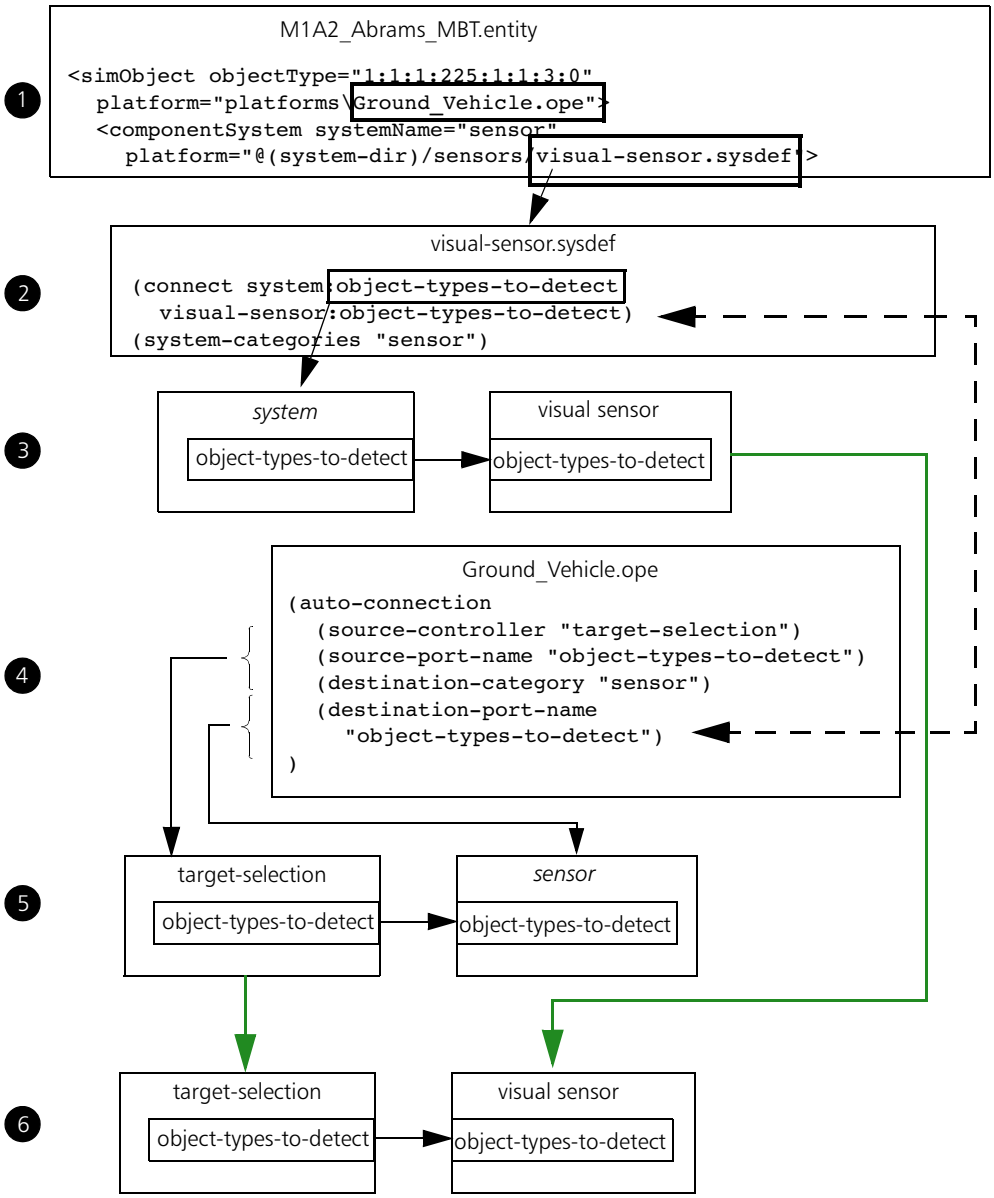


Figure 4-5. External component connection

Most VR-Forces users add new systems by copying existing ones and changing their parameters. If you add new systems in this way, you will not need to worry about adding connections, since the existing auto-connection system will handle them automatically. If developers add new types of components that require intersystem connections, they will need to add new auto-connection blocks to the appropriate OPE files for them to connect.

4.4. Adding Variable Bindings to Platform and System Files

Platform files ande most system definition files (SDF) are used by multiple entities. However, the values of some parameters in may need to vary for the different entities that use them. This is handled by using variables in the platform and system definition files and specifying the values for these variables in the *.entity* files. VR-Forces uses variable bindings for the parameters that you are most likely to want to change from entity to entity. If there are other parameters that you want to vary, you can add your own variable bindings.

When you add a variable binding, you must:

1. Change the hard-coded value to a variable in the platform or SDF file.
2. Add the variable to the *.entity* file.
3. Update the Entity Editor so that you can edit the value for the new variable.

The following example shows a variable binding for fuel in a movement system. The varible is specified in the SDF as follows:

```
(resources
  (fuel
    (resource-type "real-resource")
    (amount  $fuel-amount)
    (full-amount  $fuel-amount)
  )
)
```

The *.entity* file for an entity that uses this movement system specifies a value for the variable:

```
<componentSystem systemName="movement"
  platform="@(system-dir)/movement/ground-tracked.sysdef">
  <real paramName="fuel-amount">465</real>
</componentSystem>
```

As you can see, the parameter defined as **fuel-amount** in the *.entity* file is referenced as `$fuel-amount` in the SDF.

4.4.1. Adding a Variable Binding

The procedure for adding a variable binding is the same for platform files and SDF files.

To add a variable binding to a platform file or SDF:

1. In the system definition file, substitute a variable name, in the format $*variable-name* for the hard-coded value that you want to replace. For example, the *Ground_Vehicle.ope* file has a value **is-organized**:

```
(groundParams
  …
  (is-organized True)
  …
)
```

To make this a variable, replace the value with a variable name, as follows:

```
(groundParams
  …
  (is-organized $entity-is-organized)
  …
)
```

You can do this by hand in the OPE file or in the OPD Editor.

2. In each *.entity* file that uses this platform file or SDF, add an element to specify a value for the variable. The attribute must specify the type of the value, the name of the variable, and the value for the variable, for example.

```
<simObject objectType="1:1:1:225:1:1:3:0"
  platform="platforms\Ground_Vehicle.ope">
  <bool paramName="entity-is-organized">True</bool>
...
</simObject>
```

Although you can add these entries by hand, it is highly recommended that you do so in the Entity Editor by applying platform updates. When you apply platform updates, all changes to platform and SDFs get applied to all entities that use them. For details, please see "Applying Platform Updates," on page 5-62.

! If you do not add an attribute to an *.entity* file that references the modified platform or SDF, a default value will be used, which may result in unexpected behavior.

4.4.2. Making Variables Editable in the Entity Editor

When you add new variable bindings, you can make them editable in the Entity Editor. Variables in platform files are edited in the Attributes panel (the right-most panel) of the Entity Editor. They include variable such as speed, mass, and bounding volume. Variables in SDFs are edited in the Properties dialog boxes for the individual systems. The procedures for adding these two types of variables to the Entity Editor are different.

4.4.3. Adding Platform Variable Bindings to the Entity Editor

Variable bindings for platform files are edited in the Attributes Panel. The layout of this panel is controlled by *.ui* files. The Entity Editor has a *.ui* file for each platform. The files are in *./data/simulationModelSets/<sms>/gui/ui*. You can edit *.ui* files in a text editor or in Qt Designer.



You do not need a developers license to use Qt Designer. You will need to download the version of Qt used by your version of VR-Forces. Please see *VR-Forces 4.2 Release Notes* for details.

In "Adding Variable Bindings to Platform and System Files," on page 4-21, we added a new variable binding to the *Ground_Platform.ope* file. The corresponding entry in *ground-vehicle-param.ui* file would be:

```
<item>
  <widget class="QCheckBox" name="entity_is_organized">
    <property name="text">
    <string>Is Organized</string>
    </property>
    </widget>
</item>
```

Notice that the variable name entity-is-organized in the OPE file is expressed as entity_is_organized in the *.ui* file. You must use underscores in the *.ui* file for the variable name.

UI File Details

Whether you edit a *.ui* file by hand or using Qt Designer, you need to understand how data entry elements are defined. This varies depending on the type of widget used, such as text box, check box, option button, or list.

It is beyond the scope of this manual to explain Qt Designer and GUI layout. However, at the most basic level, the controls in the GUI are specified in item elements. Each item has a widget that has a **class** and an **objectName**. (The XML attribute is **name**. In Qt DEsigner it is objectName.)

- The **objectName** for an item is the platform variable name with dashes changed to underscores. For example the **objectName** for the short-name variable is short_name.
- If an item has a label, the **objectName** must be <variable_name>_label. For example, the **objectName** for the Short Name label is short_name_label.

Each data entry widget creates a data entry field that is appropriate for the variable type (integer, real, string). Other elements (systems, vector entry) create more complex controls.

Depending on the type of information displayed, you can assign additional properties to each data entry field. These properties can be:

- element_type. String property that can be assigned a particular reader/writer (variable) type (for example, DtRwReal) or any other internal type that has been registered for element creations. These types are:
  - single_system_selector
  - multi_system_selector
  - sensor_signatures
  - aggregate_composition
  - aggregate_formation_editor
  - push_button
  - scripted-movement-system-selector.
- enable_if_checked. String property that defines a check box element. If the check box is selected, the variable is enabled. If clear, it is disabled.
- disable_if_checked. String property that will define a check box element. If the check box is selected, the variable is disabled. If clear, it is enabled.
- disable_if_multiple_selection. Boolean property. If selected, when the user selects multiple entities, this item cannot be edited.
- hide_by_default. Boolean element. If selected, this item is hidden by default and is visible only if the Advanced button is clicked.
- signal_slot. String element. If defined for a push button, a particular slot is called when that signal is sent. The format is:

```
<signal>;<referencedControl>;<slot>released();bounding_volume;onCalculat
  eSupportPointsChanged()
```

The referenced control is the name of an existing control in the *.ui* file

4.4.4. Adding System Definition File Variables to the Entity Editor

When you add a system to an entity in the Entity Editor, you can edit its properties. The Properties dialog box is not configured in a *.ui* file. It is generated based on the meta data section of the SDF. Suppose that you want to change the rounds per minute parameter in *120mm-gun.sysdef* to a variable binding. You would create the variable binding as described in "Adding Variable Bindings to Platform and System Files," on page 4-21 and you would add details to the meta data as shown in the following example:

```
(weapon-120mm-gun
  ...
  (rounds-per-minute $rounds-fired-per-minute)
  ...
  (meta-data
    (parameter-data-list
      (bool-parameter-data
        (parameter-name  "rounds-fired-per-minute")
        (variable-type  "DtRwBoolean")
        (display-label  "Rounds Fired Per Minute")
        (display-units  "")
        (source-units  "")
        (default-value  True)
      )
...
```

4.5. Configuring Aggregate Entities

All aggregate entities have the **parameter-type** "moving-object-param". Aggregate entities have relatively few individual parameters. The principle function of the various elements is to specify controllers and formations, and to specify the **echelon-level** for the different levels of aggregates.

4.6. Configuring Tactical Graphics

The object parameter database includes parameters for tactical graphics. Tactical graphics provided with VR-Forces have the **parameter-type** vrf-base-object-param. You should not change the parameters for the objects provided with VR-Forces. However, if you are using the VR-Forces toolkit, you could create other types of tactical graphics. You would have to include parameters for them in the object parameter database.

4.7. Pathname Interpretation in Simulation Model Set Files

The files that make up a simulation model set, such as *.entity* files and system definition files, usually contain references to other files in the SMS. These supporting files may also have references to other configuration files. VR-Forces supports the file relationships by specifying files using relative paths and by defining directory variables. This allows you to maintain custom simulation model sets outside of the VR-Forces file hierarchy and not have to move them every time you install a new version of VR-Forces.

Examples of directory variables are in the SMS file and OPD file. The following lines from the *default.sms* file show a binding (model-set-directory) and its use:

```
(simulation-model-set
  (variable-bindings
    (DtRwString
      (model-set-directory  "default")
    )
    (DtRwString
      (opd-dir  "$(model-set-directory)")
    )
  ...
  )
  (opd-file  "$(model-set-directory)\vrfSim.opd")
  (physical-world  "$(model-set-directory)\physicalWorldParams.mtl")
  ...
)
```

Similarly, the *vrfSim.opd* file has bindings, which are then used in *.entity* files, as shown.

From *vrfSim.opd*:

```
(variable-bindings
  (DtRwString
  ...
    (system-dir "$(opd-dir)/vrfSim/systems"
    )
    (DtRwString
      (ammoselect-dir "$(opd-dir)/vrfSim/ammoselect"
    )
    ...
)
```

From *M1A2_Tank.entity* (**system-dir** variable):

```
<componentSystem systemName="damage"
  platform="@(system-dir)/damage/ground-heavy-armor.sysdef"/>
```

4.8. Updating Object Parameter Database Files for New Releases

New releases of VR-Forces frequently include new components and new parameters for existing components. If you are using a customized object parameter database you will probably want to update it to take advantage of the new components and parameters. Unfortunately, there is no automatic way to migrate an object parameter database. Here are some guidelines and options for migrating your OPD:

- If you have created new entities using the VR-Forces-installed system definition files, copy their *.entity* files into the *./data/simulationModelSets/default/vrfSim* directory. They will pick up all changes to systems, platforms, and other configuration files.



Copying *.entity* files does not copy changes made to element definitions and entity type mappings. You will have to update element definitions and entity type mappings using the Entity Editor or the Visual Models Editor and Entity Type Mappings dialog box.

- If you have added new systems using the VR-Forces-installed components, copy the system definition files and any other configuration files, such as damage files or detection files, to the appropriate directories in the simulation model set.
- If you have added new entities or systems that rely on new components created with the VR-Forces API, you will have to rebuild the components using the new version of VR-Forces and copy all required files as described in the previous paragraphs.
- Use multiple simulation model sets. VR-Forces can load multiple simulation model sets (for details, please see Section 1.1.1, "Specifying Multiple Simulation Model Sets," in *VR-Forces Scenario Management Guide*). If your customizations do not overlap the default SMS or are relatively easy to separate from the default SMS, you can create a separate SMS and load it along with the SMS supplied with VR-Forces.

5

Using the Entity Editor

The Entity Editor is a stand-alone tool that lets you configure entities, edit the Create menu, and create new simulation model sets.

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5.1. Introduction to the Entity Editor

Many VR-Forces users want to edit some or all of the following entity simulation characteristics:

- Weapons systems
- Basic parameters
- Sensors
- 2D icons and 3D models
- Formations.

Users also want to add new entities or tactical graphics types. The Entity Editor allows you to edit most of the aspects of an entity or tactical graphic that a typical VR-Forces user will want to change. You can easily add and remove sensors, weapons systems, and other major component systems, change the 2D and 3D models used to represent them, and edit their properties.



The Entity Editor primarily lets you edit entity properties that affect simulation. Entities also have visualization models, which are configured in the front-end in the Visual Model Editors and Entity Type Mappings dialog boxes. However, the Entity Editor also lets you configure the 3D models and 2D icons used to display entities. For more information, please see Chapter 11, *Mapping Models and Effects* and Chapter 12, *Model and Element Definitions*.

The Entity Editor does not let you add or remove individual components or edit most of the more detailed entity parameters. For these advanced editing tasks, you can use the OPD Editor, which is described in Chapter 6, *Using the OPD Editor*, or edit specific configuration files, which are described throughout this manual.

If you want to add new entities or customize the entities supplied with VR-Forces, start with the Entity Editor. Use the OPD Editor or a text editor only if the Entity Editor does not let you make the changes you need to make.

5.1.1. Simulation Model Sets

A simulation model set (SMS) defines all of the entity and object models that you can create in a VR-Forces simulation. The simulation model set file tells VR-Forces where to find all of the configuration files it needs to create, simulate, and display entities and other simulation objects. Every scenario must reference one or more simulation model sets.

If you use the Entity Editor to edit entity models, the only configuration file that you need to be aware of is the simulation model set file that you are using. All of the other files are handled by the Entity Editor.

When you use the Entity Editor, you are editing a simulation model set. The default SMS provided with VR-Forces is *default.sms*. We recommend that you keep the default SMS as a reference model set and not edit it. If you want to edit entity models, create a new SMS based on *default.sms* and use it as the default SMS for your scenarios. For details about creating a new SMS and changing the default SMS, please see "Creating a New Simulation Model Set," on page 5-8.

5.1.2. Migrating a Simulation Model Set to a New Release

When you edit an SMS in the Entity Editor, it:

- Creates or edits *.entity* files for the entities that you edit.
- Modifies visual definition files and entity type mappings.

The Entity Editor does not create or change any other files. It is possible that you may add or edit some of the files that entity systems reference, such as damage files. You might also create or modify scripts that are stored in an SMS.

If you upgrade to a new version of VR-Forces, you can quickly add any of the new entities you created by copying their *.entity* files into an SMS in the new release. This will make the entities available to the simulation engine, but will not include their visual definitions. For each entity that you add this way, you will have to edit the 2D and 3D models in the Entity Editor.

If you made any changes to other files, you will have to copy those changed files to the new SMS.

If you have written scripts, use the script export process to export them from the previous release of VR-Forces and then import them into the new release.

5.2. Starting the Entity Editor

➤ To start the Entity Editor in Windows, choose **Start** → **Programs** → **MÄK Technologies** → **VR-Forces 4.2** → **Tools** → **Entity Editor**. The Entity Editor opens (Figure 5-1).

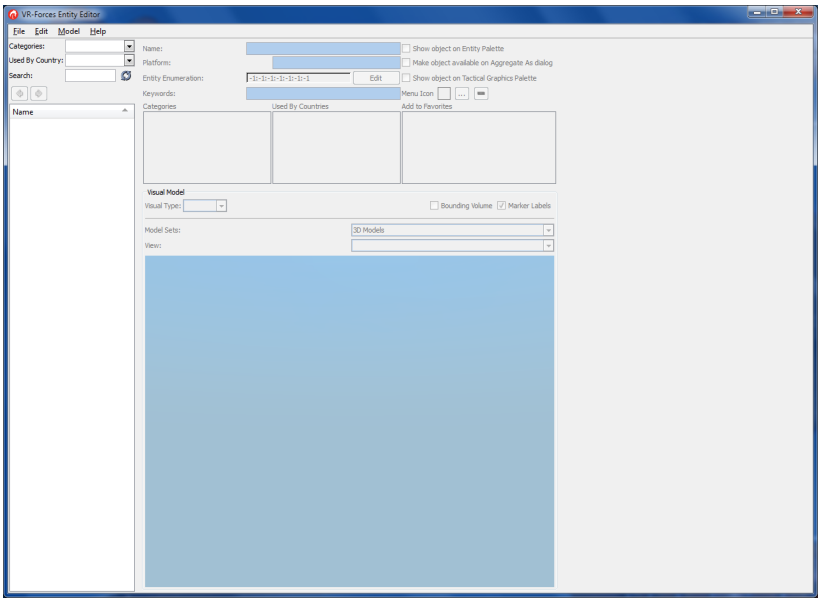


Figure 5-1. Entity Editor

To start the Entity Editor from the command-line in Windows or Linux:

1. Change directory to *./bin*.
2. Run:

```
entityEditor options
```

Table 5-1 describes the command-line arguments for the Entity Editor.

Table 5-1: Entity Editor command-line arguments

Argument	Description
`(--` | `--ignore_rest)`	Ignores the rest of the labeled arguments following this flag.
`--doNotCheckPluginVersions`	Do not check versions in the plug-ins to make sure they can load against this version of the application.
`--doNotLoadVrfPlugins`	Do not load the plug-ins contained in XML files in the *./plug-ins* directory.
`(-G` | `--locale)` *`language`*	The name of the language to load into the GUI.
`(-h` | `--help)`	Displays usage information and exits.

Table 5-1: Entity Editor command-line arguments

Argument	Description
`--loadPlugin` *`filename`*	Load the specified Entity Editor plugin. Can be a specific plug-in or plug-in XML file.
`--opdEditorLocation` *`string`*	Location of the OPD Editor application.
`--settingsDirectory` *`string`*	Sets the directory to load all ui and settings files from.
`--showConsole`	Show the console.
`--smsFile` *`string`*	Loads the specified SMS file.
`(-v | --version)`	Displays version information and exits.
`--visualTerrain` *`string`*	Terrain used when displaying entities.

5.3. Creating a New Simulation Model Set

You can create new SMSs by copying and editing an existing SMS or you can create a completely new SMS and create the entities that you want to include in it.

To create a new simulation model set from an existing SMS:

1. Choose **File** → **New Simulation Model Set**. The New Simulation Model Set dialog box opens (Figure 5-2).

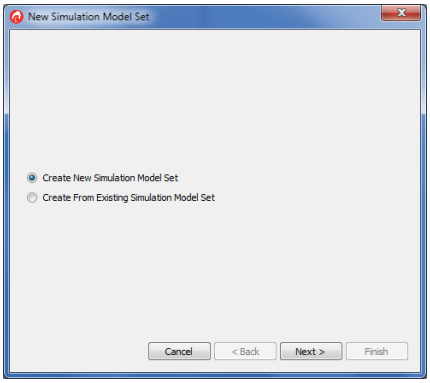


Figure 5-2. New Simulation Model Set dialog box

2. Select Create From Existing Simulation Model Set.
3. Click Next. The Select Model Set to Copy dialog box opens.
4. Select a model set and click Next. The New Model Set Name dialog box opens.
5. In the File name box, type a name for the new model set.
6. Click Finish. The Entity Editor loads information from the source model set.
7. Make any changes you want to the model set.
8. Choose **File** → **Save Simulation Model Set**.

5.3.1. Creating a Completely New Simulation Model Set

To create a completely new simulation model set:

1. Choose **File** → **New Simulation Model Set**. The New Simulation Model Set dialog box opens (Figure 5-2).
2. Select Create New Simulation Model Set.
3. Click Next. The New Model Set Name dialog box opens.
4. In the File name box, type a name for the new model set.
5. Click Finish. The Entity Editor loads systems information from the default model set.
6. Create the entities that you want to have in the model set, as described in "Creating a New Entity," on page 5-44.
7. Choose **File** → **Save Simulation Model Set**.

5.3.2. Specifying the Default Simulation Model Set for Scenarios

When you create a new scenario, the New Scenario dialog box lists *default.sms* as the SMS to use. You can change the default SMS by editing the **simulationModelSet** parameter in *./appData/settings/vrfSim/vrfSim.mtl*.

5.4. Opening a Simulation Model Set

To edit entity models in the Entity Editor, you must open a simulation model set.

To open a simulation model set:

1. Choose **File** → **Open Simulation Model Set**. The Open Model Set dialog box opens.
2. Select the SMS you want to open.
3. Click Open. The SMS is loaded and a list of entities is displayed in the Entity Editor.

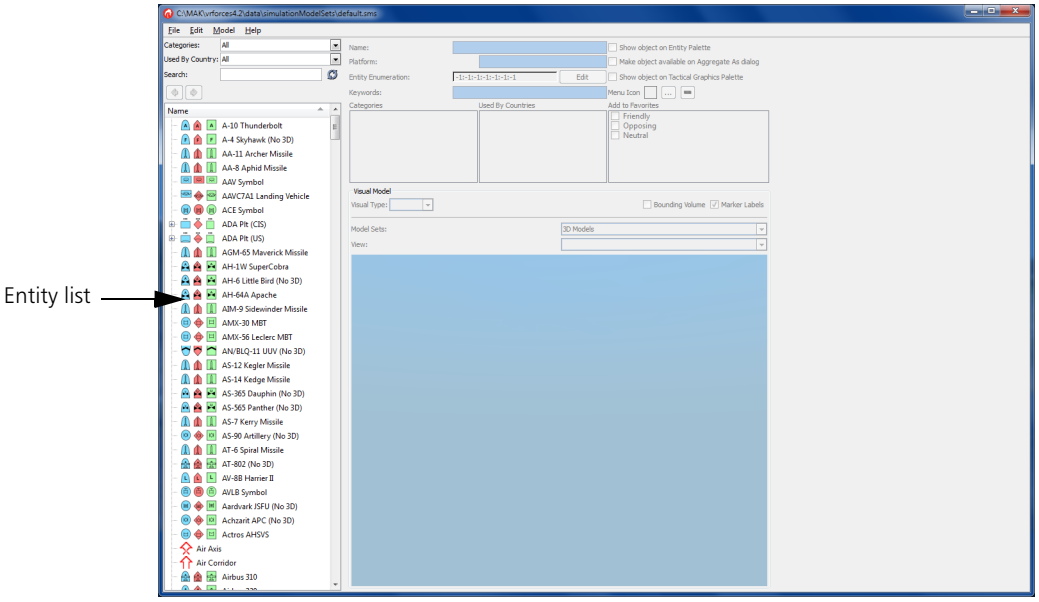


Figure 5-3. Entity Editor with simulation model set loaded

5.5. Editing an Entity Simulation Model

This section explains how to edit some of the basic parameters of an entity model.

5.5.1. Selecting an Entity to Edit

Most of the Entity Editor procedures assume that you have selected an entity in the entity list to edit.

To select an entity to edit:

1. In the entity list, select the category for the type of entity you want to edit.
2. Select the entity in the list.

5.5.2. Editing an Entity's Categories

Entities are organized by categories on the Create menu and the Entity Palette. You can change the categories that an entity is part of. For details about adding new categories to the list, please see "Adding a New Category," on page 5-58.

➤ To assign an entity to a category, in the Categories list, select the check boxes for the categories you want it to be part of and clear the check boxes for the categories that you do not want (Figure 5-4).

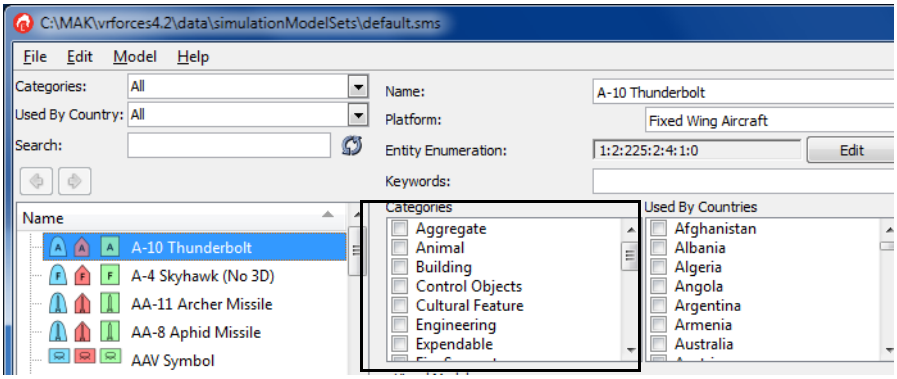


Figure 5-4. Categories list

5.5.3. Editing an Entity's Used By Countries List

The country code in a vehicle's entity enumeration specifies the country in which the vehicle is manufactured. It does not indicate where the vehicle is used, and many vehicle types are used in multiple countries. When creating a scenario, it can be convenient if the Entity Palette only lists the vehicles used by the country for which you are laying down forces. The Used By Countries list in the Entity Editor lets you specify the countries that use a vehicle. Users can then filter the Entity Palette by country.

The Used By Countries list works exactly like the Categories list. For details about how to configure the list of countries, please see "Editing the Category List," on page 5-58.

➤ To assign an entity to a country of use, in the Used by Countries list, select the check boxes for the countries that use it.

5.5.4. Changing an Entity's Entity Enumeration

The Entity Editor lets you change an entity's Object Type (Entity Enumeration) and Matching Type. You might want to, or have to do this for any of the following reasons:

- If you create a new model, you must specify an entity enumeration (Object Type). (The Entity Editor automatically constructs a Matching Type whose Domain and Kind field match the Object Type and whose other fields are wild cards.)
- If you create a new model from an existing model, the Entity Editor automatically increments the existing model's enumeration for use with the new model. However, you might want to use a different enumeration than the one the Entity Editor generates. (The Entity Editor automatically creates a Matching Type that is the same as the Object Type.)
- You might want to change an existing entity's enumeration.
- You might want to change an entity's matching object type.



The Entity Enumeration value displayed in the Entity Editor is the 7-digit DIS or RPR FOM enumeration that VR-Forces uses to build the published object type. The matching object type is not displayed in the Entity Editor, but you can specify it in the Change Enumeration dialog box as described in this procedure. For details about published and matching object types, please see "Published Object Types and Matching Object Types," on page 4-6.

To change an entity's entity enumeration:

1. Select the entity in the entity list.
2. Click Edit next to the Entity Enumeration text box (Figure 5-5). The Change Enumeration dialog box opens (Figure 5-6).

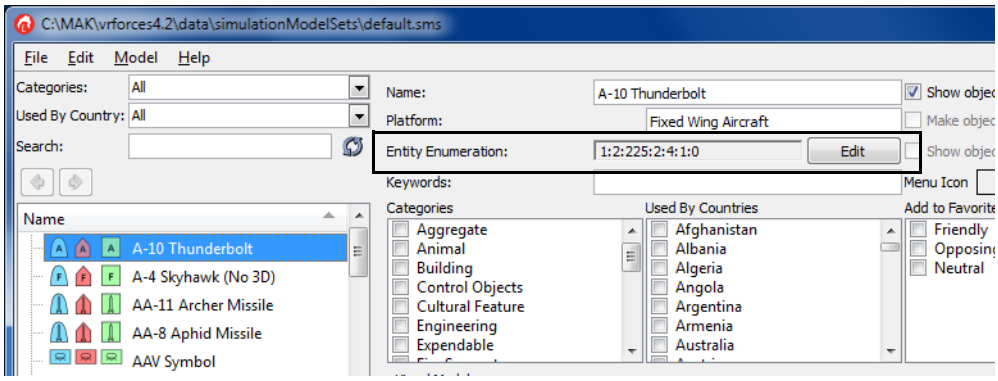


Figure 5-5. Entity enumeration

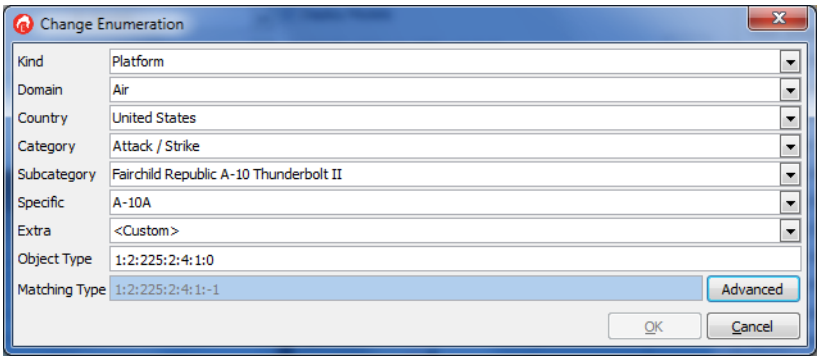


Figure 5-6. Change Enumeration dialog box

3. Edit the enumeration by selecting options from the lists for enumeration elements or typing a new enumeration in the Object Type text box.
4. Optionally, specify the Matching Type as follows:
   a. Click Advanced. The dialog box expands (Figure 5-7).

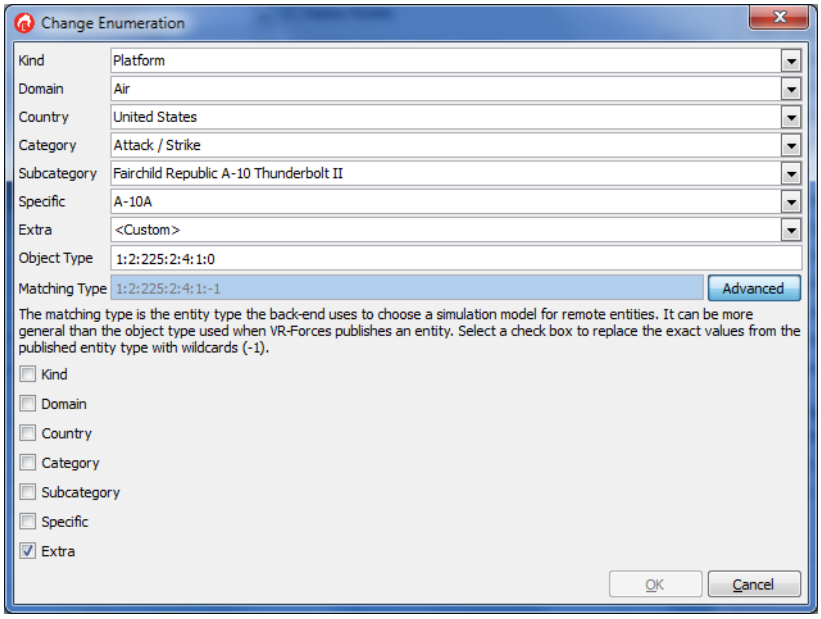


Figure 5-7. Change Enumeration dialog box, Advanced

b. For each field in the matching type enumeration that you want to be a wild card (-1), select the appropriate check box.

5. Click OK. The enumeration changes.

5.5.5. Changing an Entity's Name

The entity name is the name listed on the Entity Palette and Create menu. The text placed on the screen next to a 2D entity icon, is the marking text. The marking text is based on the Short Name, which is configured in the Attributes section of the Entity Editor (Figure 5-11).

To change an entity's name:

1. Select the entity in the entity list.
2. Type a new name in the Name text box (Figure 5-5).

5.5.6. Specifying Whether an Entity Can Be Created

You can control whether or not an entity is listed on the Entity Palette. It may not make sense to be able to create some types of entities, such as missiles, which are normally added to a scenario and removed dynamically.

➤ To enable or disable creation of an entity from the Entity Palette, select or clear the Show Object on Entity Palette check box (Figure 5-8).

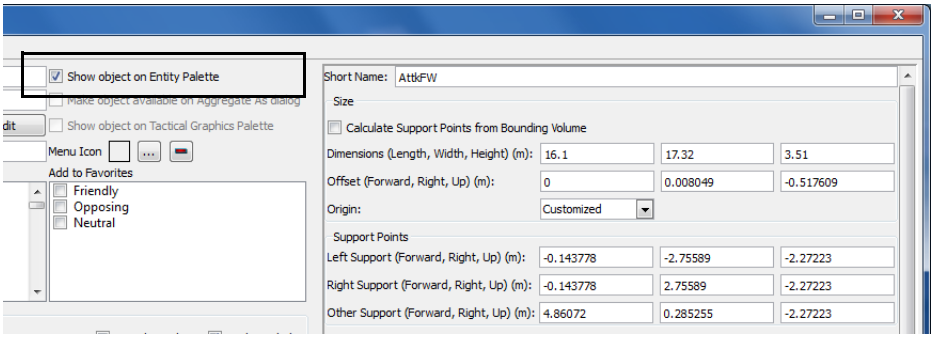


Figure 5-8. Show Object on Entity Palette check box

5.5.7. Editing an Entity's Bounding Volume (Size)

VR-Forces uses an entity's bounding volume to do intersection tests. The bounding volume is specified by the values in the Size group box. You can display an entity's bounding volume in the Visual Model group box. If you change size values, the bounding volume changes accordingly.



The bounding volume is not the same thing as the selection box that is displayed around an entity when you select it. The selection box is just part of the front-end display. The bounding volume is used by the simulation engine.

To change an entity's bounding volume:

1. Select the entity you want to edit in the entity list.
2. Change any of the values in the Size group box (Figure 5-9).

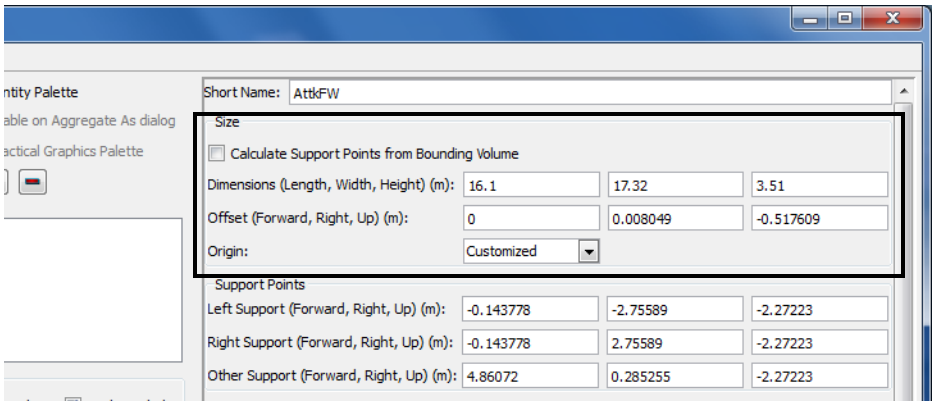


Figure 5-9. Size group box

Displaying an Entity's Bounding Volume



You must run VR-Forces at least once before you can display bounding volumes in the Entity Editor.

To display an entity's bounding volume:

1. Select the entity in the entity list.
2. In the Visual Model group box, on the Model Sets list, select 3D Models.
3. Select the Bounding Volume check box. The bounding volume is displayed (Figure 5-10).

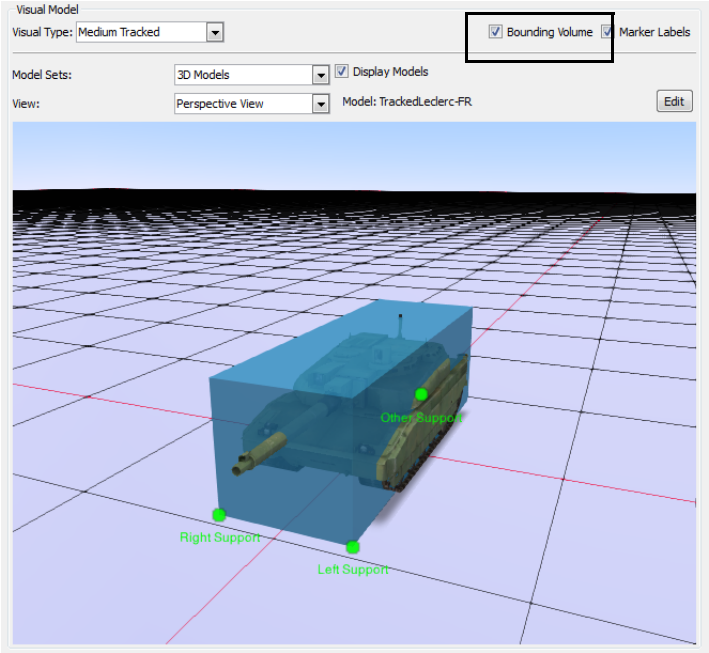


Figure 5-10. Bounding volume

5.5.8. Editing Behavioral Parameters

The Entity Editor lets you edit some of the entity parameters that affect behavior. For detailed information about entity parameters, please see the parameter descriptions in the OPD Editor online help.



The Sensor Signature parameters specify the distance at which other entities can sense the entity you are editing. By contrast, the sensor systems on the entity control its ability to sense other entities. For more information, please see "Editing an Entity's Systems," on page 5-35.

➤ To edit entity parameters, edit any of the parameters in the Attributes panel (Figure 5-11). (The panel reconfigures itself as you select different types of entities.)

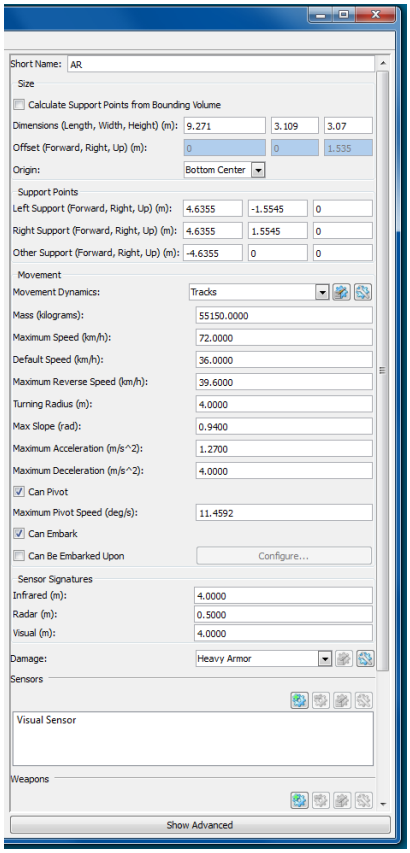


Figure 5-11. Attributes panel

5.5.9. Editing a Lifeform's DI-Guy Character, Appearance, and Animation

VR-Forces can specify the character, appearance, and animation values for DI-Guy models used in the 3D view and visualization applications such as VR-Vantage. A model's character determines the kinds of movement it can make. The appearance determines what it looks like. The animation specifies the movements that the character makes. In the VR-Forces front-end, you can specify the animation with the DI-Guy Animation task. You can set the appearance with the DI-Guy Appearance set data request. This feature is valid only for lifeforms (the Human and Animal categories).

To specify the default DI-Guy characteristics for a lifeform:

1. In the Categories list, select the Human or Animal category.
2. Select an entity in the entity list.
3. In the Visual Model group box, on the Model Sets list, if 3D Models is not selected, select it.
4. In the Visual Model group box, click Edit. The Modify Visuals dialog box opens (Figure 5-12). The Use DIGuy option should be selected. If it is not selected, select it.

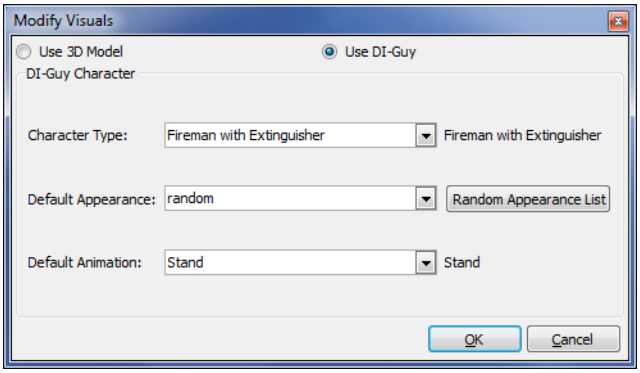


Figure 5-12. DI-Guy Character group box

5. Select the DI-Guy character you want to use from the Character Type list.
6. Select the default appearance from the Default Appearance list. One of the default options is to use a random appearance.
7. If you selected random appearance, optionally, specify the list of appearances to choose from. For details, please see "Configuring the Random Appearance List," on page 5-20.
8. Select the default animation from the Default Animation list. The default animation is the animation the entity uses if it is not tasked and if it has a posture and speed that is appropriate to the animation.

Configuring the Random Appearance List

If you specify that a lifeform use a random appearance for DI-Guy models, then VR-Forces chooses from a list of appearances when it specifies the appearance to use. By default, the list is all appearances available for the chosen character. However some appearances might not be appropriate for a scenario, so you can specify a subset of appearances to use.

To configure the random appearance list:

1. In the Categories list, select the Human category (or Animal category).
2. Select an entity in the entity list.
3. In the Visual Model group box, on the Model Sets list, if 3D Models is not selected, select it.
4. In the Visual Model group box, click Edit. The Modify Visuals dialog box opens (Figure 5-12). The Use DI-Guy option should be selected. If it is not selected, select it.
5. Click Random Appearance List. The Random Appearances List dialog box opens (Figure 5-13). The appearances available for the character type are listed.

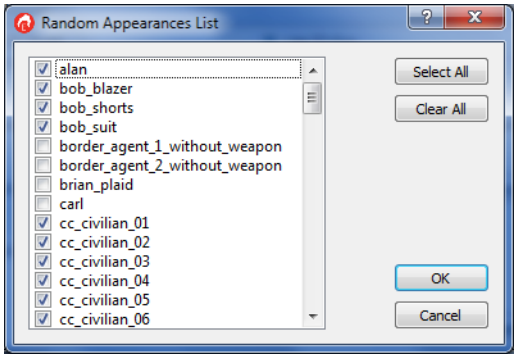


Figure 5-13. Random Appearances List dialog box

6. Select the appearances that you want to include in the random appearance list.
7. Clear any appearances that you do not want to include in the random appearance list.
8. Click OK.
9. Click OK to close the Modify Visuals dialog box.

5.5.10. Undoing (Reverting) Changes to an Entity

If you have made changes to an entity and have not yet saved the simulation model set, you can revert to the original entity configuration. You can revert an entity at any time prior to saving the SMS, regardless of how many other entities you may have changed since you edited the entity you want to revert.

To undo changes to an entity:

1. Select the entity in the entity list.
2. Choose **Model** → **Revert Model**.

5.6. Editing an Entity's Visual Model

The Visual Model Editors dialog box allows you to configure all aspects of entity visualization, including the 2D icon and 3D model used. (For details, please see Chapter 12, *Model and Element Definitions*.) However, the Entity Editor lets you quickly and easily change the 3D model or 2D icon used to represent an entity. When you change a model in the Entity Editor, the entity's model definition also gets changed.

To change the visual model for an entity:

1. In the entities list, select the entity whose model you want to change. The model for the currently selected model set is displayed in the Visual Model group box.



The panels are live windows. If you move the cursor over a panel, you can manipulate the view using the same keyboard controls that are available in the front-end.

2. In the Model Set list in the Visual Model group box, select the model set that you want to edit for this entity.
3. Optionally, select a visual type in the Visual Type list. This choice changes the 3D model for any entity that is using a generic model. If an entity has a specific model, changing the visual type does not affect it.
4. To change a 3D model or 3D colorized model:
   a. Click Edit. The Modify Visuals dialog box opens.
   b. If the dialog box has options for 3D Models or DI-Guy, select Use 3D Model. The Modify Visuals dialog box lists available models (Figure 5-14). (You can add new models. For details, please see "Adding a New Visual Model or Image," on page 5-24.)

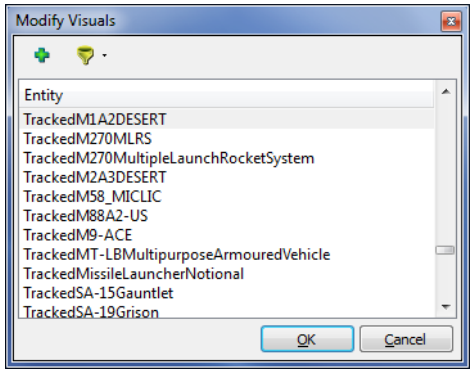


Figure 5-14. Modify Visuals dialog box (3D)

c. Select the entity model that you want to use. The new model is displayed in the panel.

d. Click OK to close the Modify Visuals dialog box.

5. To change a 2D icon using the MIL-STD font:

a. Click Edit. The Modify Visuals dialog box opens (Figure 5-15).

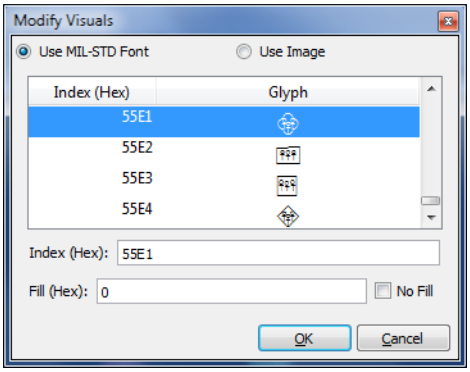


Figure 5-15. Modify Visuals dialog box (2D)

b. Select the Use MIL-STD Font option. The dialog box lists index values and associated glyphs.

c. Select the icon glyph that you want to use. The new icon is displayed in the panel

d. Click OK to close the Modify Visuals dialog box.

6. To change a 2D icon using an image:

a. Click Edit. The Modify Visuals dialog box opens (Figure 5-15).

b. Select the Use Image option. The dialog box lists the forces that are configured for this simulation model set (Figure 5-16).

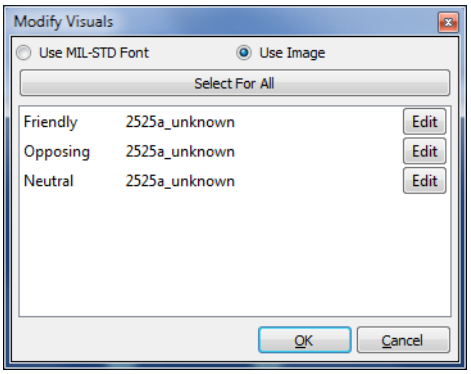


Figure 5-16. Modify Visuals dialog box (2D image)

c. Click the Edit button for the force whose icon you want to change, or to choose the same image for all forces, click Select for All. The Select Model Definition dialog box opens (Figure 5-17). It lists the available images. By default the list is for MIL-STD 2525a icons. (You can add new images. For details, please see "Adding a New Visual Model or Image," on page 5-24.)

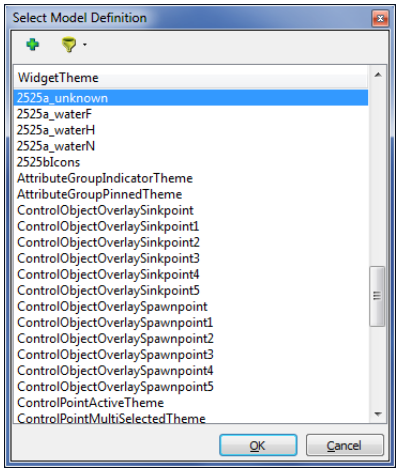


Figure 5-17. Select Model Definition dialog box

d. Select the image that you want to use. The new image is displayed in the panel.

e. Click OK.

f. Click OK to close the Modify Visuals dialog box.

5.6.1. Adding a New Visual Model or Image

When you change a model or image in the Entity Editor, you are presented with a list of the currently configured model definitions or images. You can add additional models and images to the list. The procedure is essentially the same for both cases.

To add a new model or image to the visual models list:

1. In the Model Set list, select the model set that you want to edit.
2. For 3D models or 3D colorized models, click Edit. The Modify Visuals dialog box opens (Figure 5-14). Go to step 3.

   For 2D icons, do the following:

   a. Click Edit. The Modify Visuals dialog box opens (Figure 5-15).

   b. Select the Use Image option. The dialog box lists the forces that are configured for this simulation model set.

   c. Click the Edit button for the force to which you want to add an image. The Select Model Definition dialog box opens (Figure 5-16).
3. Click the Add button (+). The Model Definition dialog box opens. This is a standard file chooser dialog box.
4. Select the file for the model that you want to add to the list. It must be a model or image type that VR-Forces supports.
5. Click OK.
6. Click OK to close the Modify Visuals dialog box.

5.7. Editing Aggregate Composition and Formations

The procedures for creating aggregate entities and editing their generic parameters are the same as for individual entities (described elsewhere in this chapter). This section describes how to edit aggregate composition and formations.



The Convoy aggregate provided with VR-Forces is an exception to the discussion of aggregates in this section. It does not have any formations because there is no preconceived membership in a convoy. It does not have an Auto Aggregation Controller, which allows an aggregate to aggregate and disaggregate. Although you can assign this controller, it is not recommended, because the resulting behavior would be undefined.

Each aggregate entity provided with VR-Forces has a pre-defined set of subordinates and the following defined formations:

- Column
- Line
- Vee
- Wedge.

You can easily edit subordinate lists and formations in the Entity Editor. You can add, remove, and replace subordinates and you can change their order in the subordinate list. (The order in the subordinate list determines which aggregate is considered the leader. It also affects aggregate reorganization.)

You can add, remove, and rename formations. You can also:

- Change the layout of subordinates in a formation.
- Create new formations.
- Specify the default formation.

The Formation Editor allows you to change the display of formations as follows:

- Expand and collapse the display of subordinate aggregates.
- Zoom in and out on the display.
- Display subordinate bounding boxes.

Figure 5-18 illustrates the Entity Editor with an aggregate selected. The Aggregate Composition group box is highlighted.

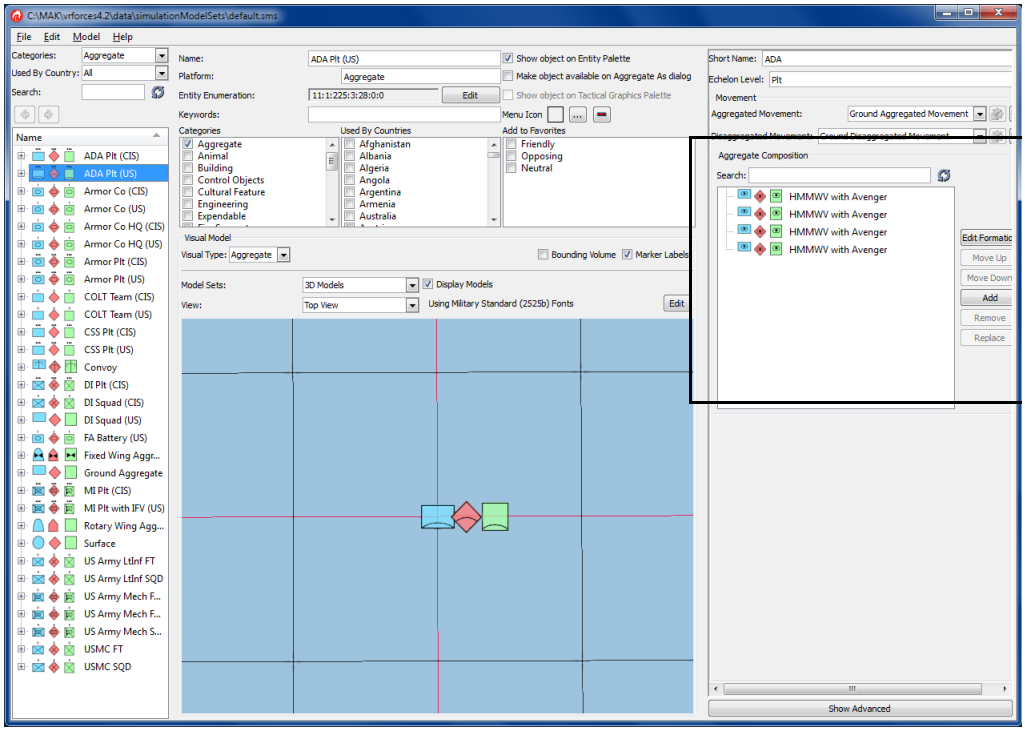


Figure 5-18. Aggregate Attributes

5.7.1. Adding Subordinates

When you create a new aggregate without copying an existing entity, you must specify its subordinates. You can also add subordinates to existing aggregates.

To add a subordinate to an aggregate:

1. In the Aggregate Composition group box, click Add. The Add to Hierarchy dialog box opens (Figure 5-19).

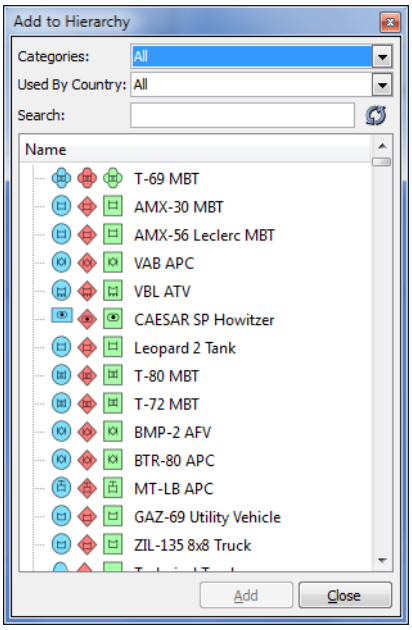


Figure 5-19. Add to Hierarchy dialog box

2. In the list of entities, select the entity that you want to add.
3. Click Add. The entity is added to the list in the Aggregate Composition window. It is also added to each formation using a default layout algorithm.
4. Continue to add as many subordinates as desired.
5. Click Close.

5.7.2. Removing Subordinates

To remove a subordinate from an aggregate:

1. In the Aggregate Composition window, select the subordinate that you want to remove.
2. In the Aggregate Composition group box, click Remove. The subordinate is removed from the aggregate.

5.7.3. Replacing Subordinates

Replacing a subordinate is a convenient way to remove a subordinate and insert a different subordinate in the same location in one step.

To replace a subordinate:

1. In the Aggregate Composition window, select the subordinate that you want to replace.
2. In the Aggregate Composition group box, click Replace. The Add to Hierarchy dialog box opens (similar to Figure 5-19).
3. In the list of entities, select the entity that you want to add as a replacement.
4. Click OK. The entity replaces the selected entity in the Aggregate Composition window. It is also added to each formation in the location of the replaced entity.

5.7.4. Changing the Order of Subordinates

The order of subordinates in the Aggregate Composition window determines which entity is the leader, the order in which aggregates are placed into formation, and the succession when aggregates are reorganized.

To change a subordinate's position in the aggregate composition:

1. In the Aggregate Composition window, select the subordinate that you want to move.
2. In the Aggregate Composition group box, click Move Up or Move Down.

5.7.5. Editing a Subordinate Aggregate

Aggregates can contain individual entities and other aggregates as subordinates. When you are editing an aggregate, you might decide that you want to edit one of its subordinates. You can jump to the subordinate quickly without selecting it in the main list of entities.

If you edit a subordinate aggregate, the changes affect all uses of that subordinate, not just the one in this particular aggregate.

To edit a subordinate:

1. In the Aggregate Composition window or in the Formation Editor, right-click the subordinate that you want to edit. A menu is displayed.
2. In the menu, choose **Edit**. The Entity Editor redisplays to show the selected entity. (If the Formation Editor is open, you must close it before you can edit the subordinate.)

Navigating the Subordinate Hierarchy

If you jump to a subordinate in the Entity Editor, you can quickly back up to its superior aggregate by clicking the back arrow above the entity list (Figure 5-20).

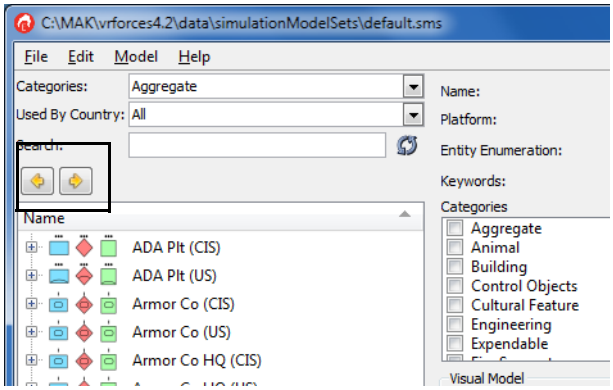


Figure 5-20. Forward and Back arrows

5.7.6. Adding Formations

To add a formation:

1. In the Aggregate Composition group box, click Edit Formation. The Formation Editor opens (Figure 5-21).

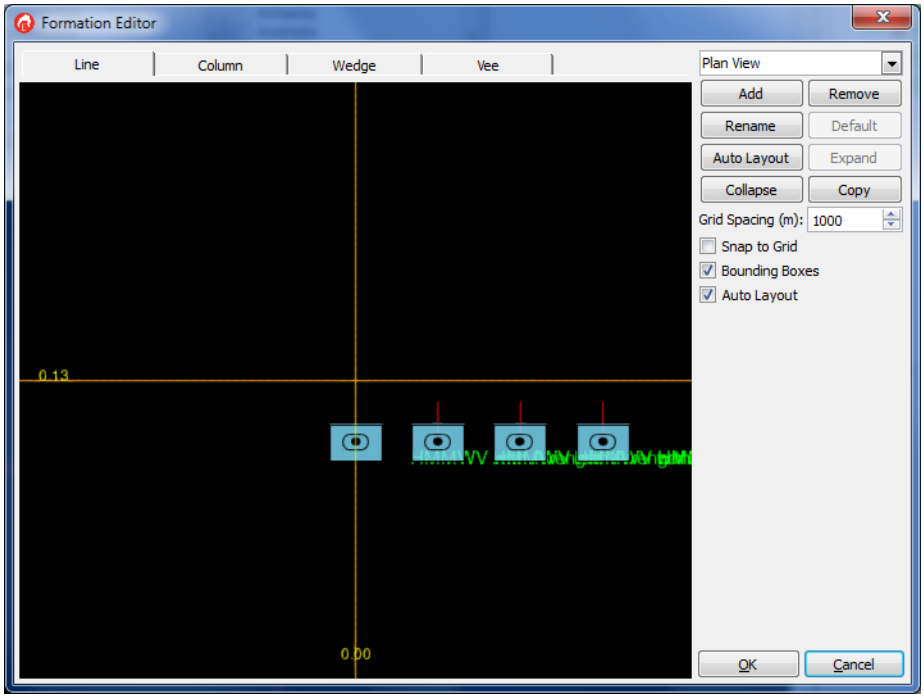


Figure 5-21. Formation Editor

2. In the Formation Editor, click Add. The Add Formation dialog box opens (Figure 5-22).

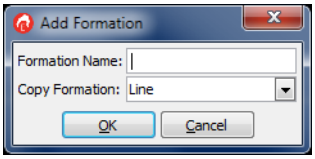


Figure 5-22. Add Formation dialog box

3. In the Formation Name box, type a name for the formation.
4. In the Copy Formation list, select an existing formation to copy to the new formation.
5. Click OK.
6. Edit the layout of the formation as described in "Changing a Formation's Layout by Hand," on page 5-34.

5.7.7. Removing Formations

To remove a formation:

1. In the Aggregate Composition group box, click Edit Formation. The Formation Editor opens (Figure 5-21).
2. In the Formation Editor, select the tab for the formation that you want to remove.
3. Click Remove. The tab is removed.

5.7.8. Renaming Formations

To rename a formation:

1. In the Aggregate Composition group box, click Edit Formation. The Formation Editor opens (Figure 5-21).
2. In the Formation Editor, select the tab for the formation that you want to rename.
3. Click Rename. The New Name dialog box opens.
4. Type a name for the formation.
5. Click OK.

5.7.9. Specifying the Default Formation

The default formation is the formation assigned to an aggregate when you create it in VR-Forces. The default formation is the leftmost tab in the Formation Editor.

To specify the default formation:

1. In the Aggregate Composition group box, click Edit Formation. The Formation Editor opens (Figure 5-21).
2. In the Formation Editor, select the tab of the formation that you want to specify as the default formation.
3. Click Default. The selected tab gets moved to the leftmost position.

5.7.10. Expanding and Collapsing the Display of Formations

You can expand and collapse the display of formations in the Formation Editor window. This lets you see how entities are dispersed over the terrain. It can help you quickly identify any unintended variations in subordinate formations.

➤ To expand or collapse the display of formations in the Formation Editor, click the Expand or Collapse buttons.

5.7.11. Displaying Bounding Boxes

You can display bounding boxes for the subordinate aggregates in an aggregate. This may be useful when you collapse the views of individual aggregates, but you still want to have a sense for the area that they occupy. Figure 5-23 illustrates an aggregate with the display of bounding boxes off and on.

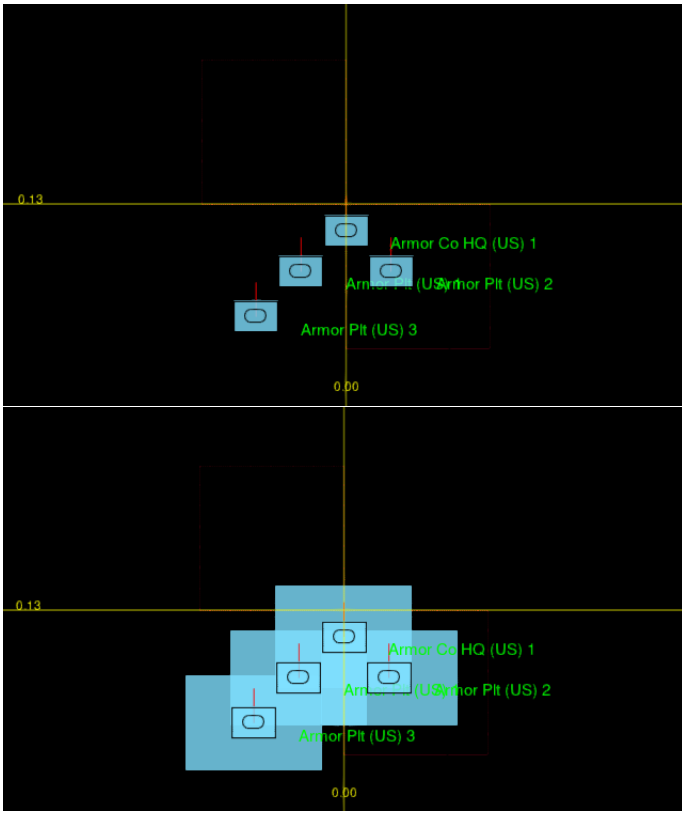


Figure 5-23. Aggregate bounding boxes in Formation Editor

➤ To display or hide bounding boxes, in the Formation Editor, select or clear the Bounding Boxes check box.

5.7.12. Copying Formations

You can copy formations from one aggregate to another. When you copy formations, the subordinates in the aggregate are laid out in each formation according to their order in the Aggregate Composition window.

To copy a formation:

1. In the entity list, select the aggregate that you want to copy formations to.
2. In the Aggregate Composition group box, click Edit Formation. The Formation Editor opens (Figure 5-21).
3. In the Formation Editor, click Copy. The Select Formations dialog box opens (Figure 5-24).

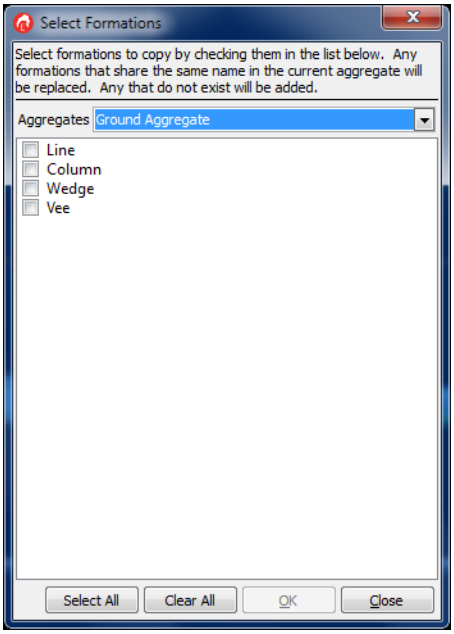


Figure 5-24. Select Formations dialog box

4. In the Aggregates list, select the aggregate whose formations you want to copy.
5. In the window, select the formations that you want to copy.
6. Click OK. The formations are copied from the selected aggregate to the currently displayed aggregate.

5.7.13. Laying Out a Formation Automatically

You can automatically distribute the entities in an aggregate into one of the built-in formations. You can specify the distance between each entity in the formation.

To lay out a formation automatically:

1. In the Aggregate Composition group box, click Edit Formation. The Formation Editor opens (Figure 5-21).
2. In the Formation Editor, select the tab for the formation that you want to lay out.
3. Click Auto Layout. The Auto Layout dialog box opens.
4. In the list, select a formation type.
5. Specify the distance, in meters, between each entity in the formation.
6. Click OK. The entities in the aggregate are reorganized to the new layout.

5.7.14. Changing a Formation's Layout by Hand

You can lay out a formation by hand. The gridline in the Formation Editor indicates the center of the formation (Figure 5-25). This is where the aggregate icon is placed when the aggregate is collapsed or aggregated.

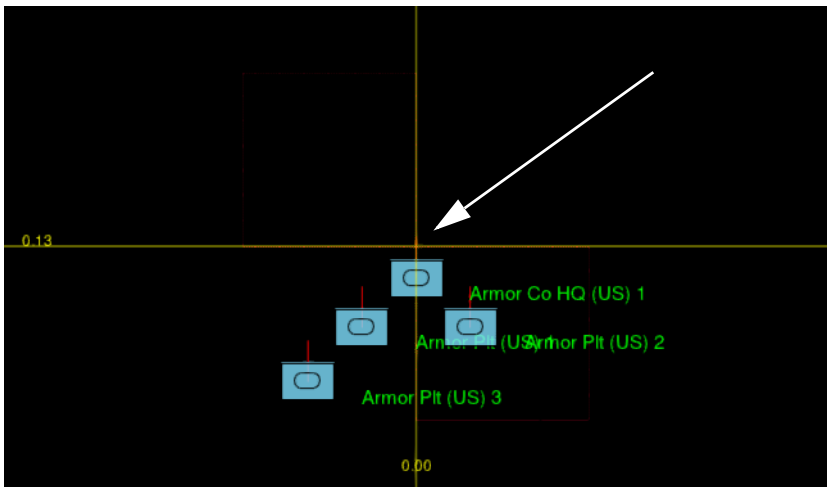


Figure 5-25. Formation Editor crosshair

To change a formation's layout:

1. In the Aggregate Composition group box, click Edit Formation. The Formation Editor opens (Figure 5-21).
2. In the Formation Editor, select the tab for the formation that you want to lay out.
3. Drag each subordinate to the location where you want it to be.

Snapping Subordinates to the Grid

When you lay out a formation you can specify that entities snap to the grid. That is, they can only be placed at the intersection of vertical and horizontal grid lines. When snap-to-grid is enabled, if you want to place entities more closely together than the grid allows, you can change the scale factor.

➤ To enable snap-to-grid for entity placement, in the Formation Editor, select Snap To Grid.

Changing the Grid Spacing

Grid spacing determines the distance, in meters, between grid lines. The default is 1000 meters.

➤ To change the grid spacing, enter a value in the Grid Spacing box.

5.8. Editing an Entity's Systems

Entities have complex capabilities, such as the ability to move, to take damage, to sense other entities, and to fire munitions. These capabilities are organized as systems. You can quickly change how an entity functions by adding, removing, and changing its systems. The Entity Editor lists the systems available in each category and only lists systems that are appropriate for the entity type (Figure 5-26). For example, a lifeform can have an M-16 or an RPG, but not a cruise missile.

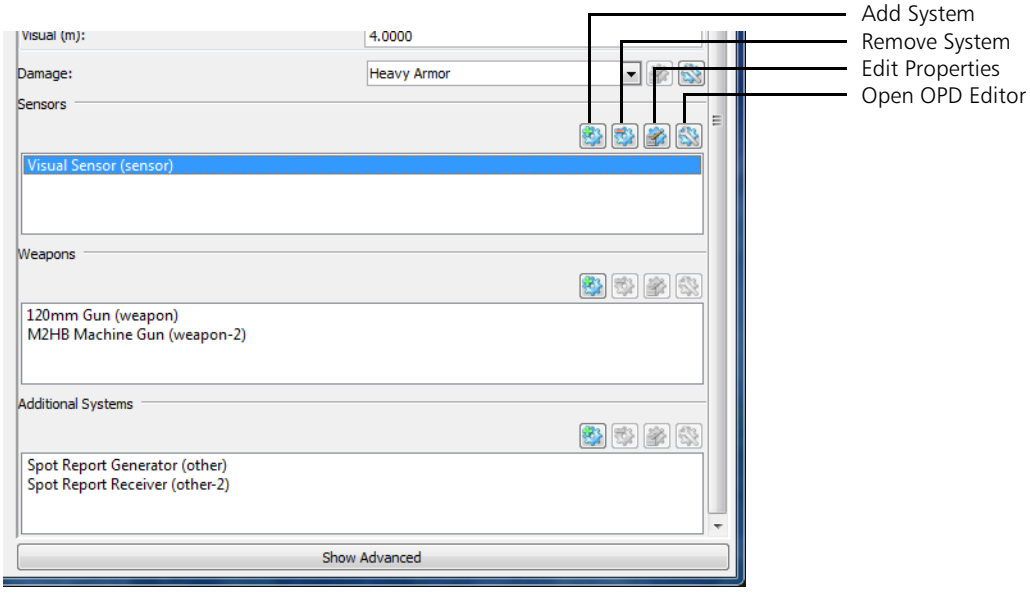


Figure 5-26. Entity systems

Some systems are interdependent. For example, if you add a weapon system to an entity, it cannot use it unless it also has a sensor system so that it can detect hostile entities. If you change or add systems, it is up to you to know if they have dependencies.

The components that make up a system have parameters and you can edit the parameters of system components by editing the properties of the system.

The Entity Editor lets you edit the following types of systems:

- Damage. You can specify the type of damage model that an entity uses. When you select a damage model, the Entity Editor configures the damage files that are appropriate for the entity type.
- Sensors. You can specify the sensors that an entity uses to locate other entities in the simulation. (By contrast, sensor signatures, which you can also set, specify the distance at which other entity sensors can locate this entity. For a list of the sensor signatures used for VR-Forces by category, please see Table 7-1.) When you add a weapon, the Entity Editor configures the components and connections necessary for the sensor to work.
- Weapons. The Entity Editor lists the weapons systems that are appropriate for the vehicle type. When you add a weapon, the Entity Editor configures the components, targets, ammunition, and connections necessary for the weapon to work.
- Movement. You can specify the type of movement system that an entity uses, for example, tracked, wheeled, pedestrian, and so on. When you select a movement system, the Entity Editor configures all of the actuators and controllers that the entity needs to implement the system.
- Other systems. This category includes spot reports and IFF transponders.

5.8.1. Adding a System

There is no specific limit to the number of sensors, weapons, or other systems that you can configure for an entity.

To add a system:

1. Click the Add System button ( ) for the system type you want to add. The Add System dialog box opens (Figure 5-27). It lists the systems of this type that are available for the entity you are editing. If you select a system in the window, the dialog box displays a brief description.

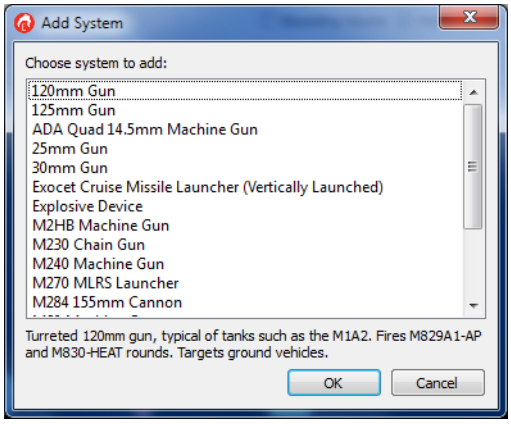


Figure 5-27. Add System dialog box

2. Select the system you want to add.
3. Click OK. The system is added to the list in the Entity Editor.

5.8.2. Selecting a Damage Model

You can only have one damage model specified for an entity.

➤ To specify a damage model, select an option from the Damage list.

5.8.3. Selecting a Movement Model

You can only have one movement model specified for an entity.

➤ To specify a movement model, in the Movement group box, select an option from the Movement Dynamics list.

5.8.4. Editing a System's Properties

Some systems have properties that you can edit.

To edit a system's properties:

1. Select the entity whose system you want to edit.
2. For sensors, weapons, or other systems, select the system whose properties you want to edit. (You do not have to select the damage or movement model, because there can only be one.) If the system has properties, the Properties button is enabled.
3. Click the Edit Properties button (). A Properties dialog box opens. The 3D model in the Visual Models group box displays a green dot on the entity where the system is located. In some cases there are multiple locations.
4. Optionally, in the Visual Models group box, select the Marker Labels check box. A label is added to the green dot to identify it.
5. Edit the properties as desired.
6. Click OK.

5.8.5. Editing a System in the OPD Editor

Systems may have attributes that you cannot edit in the Entity Editor. You can jump directly to the OPD Editor from the Entity Editor to edit these attributes. When you open the OPD Editor from the Entity Editor, only the Systems page is displayed. You cannot edit other entity attributes.

! Before you jump to the OPD Editor, you should save any changes that you have made to the simulation model set. If you make any changes in the OPD Editor, the Entity Editor is automatically updated after you save the changes in the OPD Editor.

To jump to a system in the OPD Editor:

1. Save your changes to the SMS.
2. Select the system that you want to edit.
3. Click the Open OPD Editor button next to the system ().

5.8.6. Removing a System

You can remove sensor, weapons, and additional systems.



If you remove a system that another system depends on, the other system will not work. It is your responsibility to know these dependencies.

To remove a system:

1. Select the system you want to remove.
2. Click the Remove System button ().

5.9. Configuring Scripted Entity Movement

In most cases, entities move based on the intelligence built into their components – sensors, controllers, and actuators. However there are two instances in which entity movement follows a predetermined sequence, or script. These cases are ballistic missile movement and animated movement tasks.

When you launch a ballistic missile (by creating a missile target in VR-Forces), it does not follow a route or do any path planning; it flies based on the parameters in the scripts it is configured to use. Similarly, if you give an animated movement task to an entity, it moves in whatever way the script prescribes.

Ballistic missile movement is configured using comma-delimited value (CSV) files. Animated movement tasks can be configured with CSV files or 3DS ASCII Export (ASE) files. We refer to these files generically as movement files.

A movement file specifies a time sequence and a set of parameters that define the entity's movement for each time entry. Ballistic missile movement files define lateral-distance, altitude, and range. Animated movement movement files define lateral distance, altitude, range, heading, pitch, and roll.



Ballistic missile movement files get configured in a dialog box that is shared with animated movement movement files ("Configuring Animated Movement," on page 5-41). Animated movement movement files have more parameters than ballistic missile movement files. If a ballistic missile is configured with a movement file that has these additional parameters, they are ignored.

5.9.1. Configuring Ballistic Missile Movement

When you create a Missile Target event in VR-Forces, you specify a missile type. Missile types are configured in the Entity Editor.

To configure ballistic missiles:

1. Choose **Edit** → **Ballistic Missiles**. The Ballistic Missiles dialog box opens (Figure 5-28).

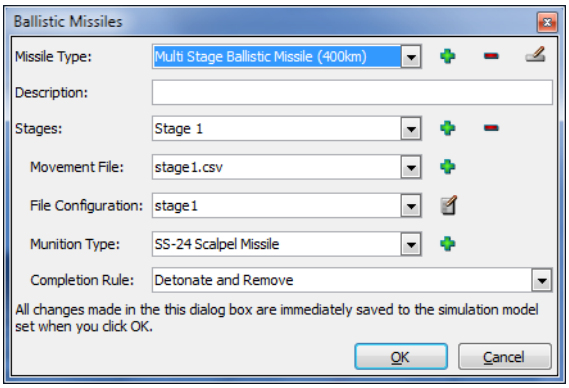


Figure 5-28. Ballistic Missiles dialog box

2. In the Missile Type list, select the missile type that you want to edit. You can add, delete, and rename missile types using the Add (+), Delete (−), and Rename (✎) buttons.
3. Optionally, in the Description text box, type a description. This description gets used as a tooltip for the Missile Type in the Create Missile Target (and Edit Missile Target) dialog boxes.
4. In the Stages list, select the stage that you want to configure. Missiles can be single stage or multi-stage. For single stage missiles, configure Stage 1. For multi-stage missiles, use the Add and Delete buttons to add or delete stages.

   For each stage, specify the following:

   – Movement File. The CSV file to use. The list lists the files in *./data/simulationModelSets/SMS_name/scriptedObjectMovement*. If you want to use a CSV file that is not listed:

     a. Click the Add button next to the Movement File list. A file chooser dialog box opens.

b. Select the CSV file that you want to use. The file is copied to *./data/simulationModelSets/SMS_name/scriptedObjectMovement*.

– File Configuration. Select a file configuration from the list. File configurations specify the type of value in each column in the movement file. For details, please see "Editing Movement File Configurations," on page 5-43.

– Munition Type. The missile to use.

– Completion Rule. The action to take when the movement in the CSV file is complete.

5. Click OK.

5.9.2. Configuring Animated Movement

The animated movement feature lets you script a sequence of entity movements. You can do this using a CSV file or a 3DS ASCII Export (ASE) file. VR-Forces includes some sample animated movement files.

Animated movement is assigned to an entity as a task from the Movement submenu. You configure the animated movement options in the Entity Editor.

To configure animated movement:

1. Choose **Edit** → **Animated Movement**. The Animated Movement dialog box opens (Figure 5-29).

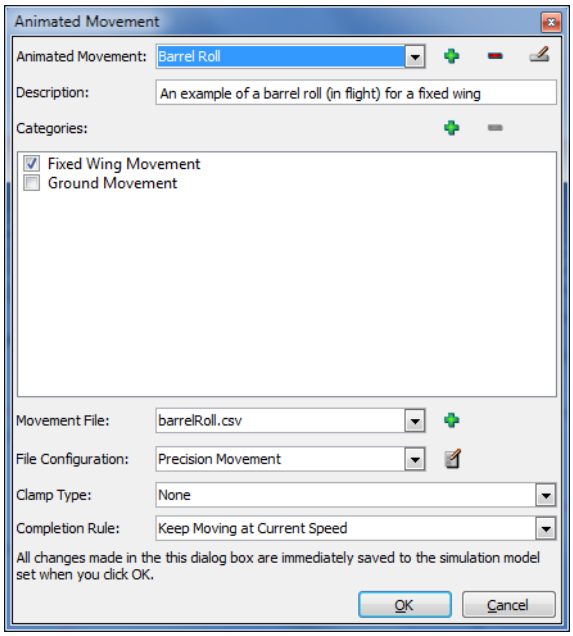


Figure 5-29. Animated Movement dialog box

2. To edit an existing animated movement, select it in the Animated Movement list. To create a new animated movement:
   a. Click the Add button next to the Animated Movement list. The New Configuration dialog box opens.
   b. Type a name for the new animated movement.
   c. Click OK.
3. Optionally, type a description for the animated movement. This description is displayed in the Animated Movement dialog box when an Animated Movement task is assigned.
4. In the Categories window, select the categories that this animated movement applies to. Use the Add and Delete buttons to add and delete categories.
5. In the Movement File list, select the movement file to use. The list lists the files in *./data/simulationModelSets/SMS_name/scriptedObjectMovement*. If you want to use a CSV file or ASE file that is not listed:
   a. Click the Add button next to the Movement File list. A file chooser dialog box opens.
   b. Select the file that you want to use. The file is copied to *./data/simulationModelSets/SMS_name/scriptedObjectMovement*.
6. If you chose an ASE file, the dialog box displays a field called Animation. Select an animation from the list.

   If you chose a CSV file, it displays a field called File Configuration. Select a file configuration from the list. File configurations specify the type of value in each column in the movement file. For details, please see "Editing Movement File Configurations," on page 5-43.
7. In the Clamp Type list, select an option for ground clamping.
8. In the Completion Rule list, select the action you want the entity to take after it completes the animated movement task.

5.9.3. Editing Movement File Configurations

VR-Forces assumes that a ballistic missile CSV file contains four columns of data that describe time, lateral distance, altitude, and range. It assumes that animated movement files have seven columns that describe time, lateral distance, altitude, range, heading, pitch, and roll. VR-Forces includes file configurations for the sample CSV files provided. They are organized in the order that the columns are listed in this paragraph. If a CSV file you are using is organized differently, you must create a file configuration that matches your file or edit one of the provided configurations.

To create or edit a movement file configuration:

1. In the Ballistic Missiles dialog box or the Animated Movement dialog box, click the Edit button next to the File Configuration list. The Edit Movement Data File Configurations dialog box opens (Figure 5-30).

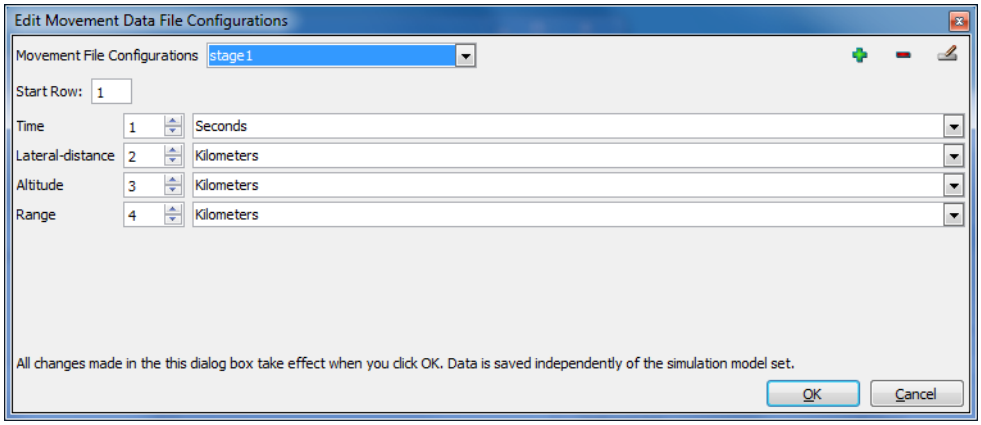


Figure 5-30. Edit Movement Data File Configurations dialog box

- Ballistic missile file configurations have four rows. Animated movement file configurations have seven rows. If you specify a seven-row configuration for a ballistic missile, it ignores the values that it does not use.
- If you are editing an animated movement that uses an ASE file, there is no File Configuration option. This only applies to CSV files.

2. In the Movement File Configurations list, select the configuration you want to edit. If you are creating a new configuration, click the Add button. The New Configuration dialog box opens.
   a. Type a name for the configuration.
   b. Click OK.
3. Optionally, change the Start Row value. This is the row in the CSV file from which VR-Forces should start reading values for entity movement.
4. Specify the column in the CSV file that has the Time value.

5. Optionally, select the time unit from the list.
6. Repeat steps 4 and 5 for each movement parameter.
7. Click OK.

5.10. Creating a New Entity

You can create a new entity by using an existing entity as a template or by building a completely new entity.

To create a completely new entity:

1. Choose **Model** → **New Model**. The Create New Entity dialog box opens.
2. Select an entity category from the Entity to Create list.
3. Type a name for the entity.
4. Click OK. The Entity Editor adds a new entry to the entity list. The editor shows default values for all the fields.
5. Specify an enumeration for the entity.
6. Optionally, specify that this entity is a favorite.
7. Specify appropriate values for the entity parameters.
8. Type a name to be used in the entity's label (marking text) in the Short Name text box.
9. Specify a movement system.
10. Specify a damage model.
11. Optionally, add weapons systems.
12. Optionally, add sensors.
13. Save the simulation model set.

5.10.1. Creating a New Entity from an Existing Entity

If you create a new entity from an existing entity, the new entity starts with all of the behavioral characteristics and systems of the original entity. It increments the entity enumeration. You just have to name it and customize it for the new entity.

To create a new entity from an existing entity:

1. In the entity list, select the source entity.
2. Choose **Model** → **New Model from Existing**. The Create New Entity dialog box opens.
3. Type a name for the entity.
4. Optionally, edit the enumeration.
5. Click OK. The new entity is added to the entity list. If you did not edit the enumeration, the original enumeration is incremented. A *.entity* file is created based on the entity name.
6. Edit the parameters to provide the new entity the characteristics you want for it.
7. Save the simulation model set.

5.11. Configuring Embarkation

If an entity allows other entities to embark on it, you can configure:

- Allowed entity types. The types of entities that can embark.
- Slots. The location on an entity where embarked entities move to. The number of slots on an entity controls how many entities can embark on it using the Embark task. For entities that are visible when they are embarked, such as humans on a truck or aircraft on an aircraft carrier, it is important to specify sensible looking slots.
- Ingress points. The locations on an entity where entities embark before moving to a slot.
- Egress points. The locations on an entity from which entities disembark.

To configure embarkation for an entity:

1. In the Entity Editor object list, select the entity that you want to configure embarkation for.
2. In the Attributes panel, if Can Be Embarked Upon is not selected, select it.
3. Click Configure. The Configure Embarkation dialog box opens (Figure 5-31).

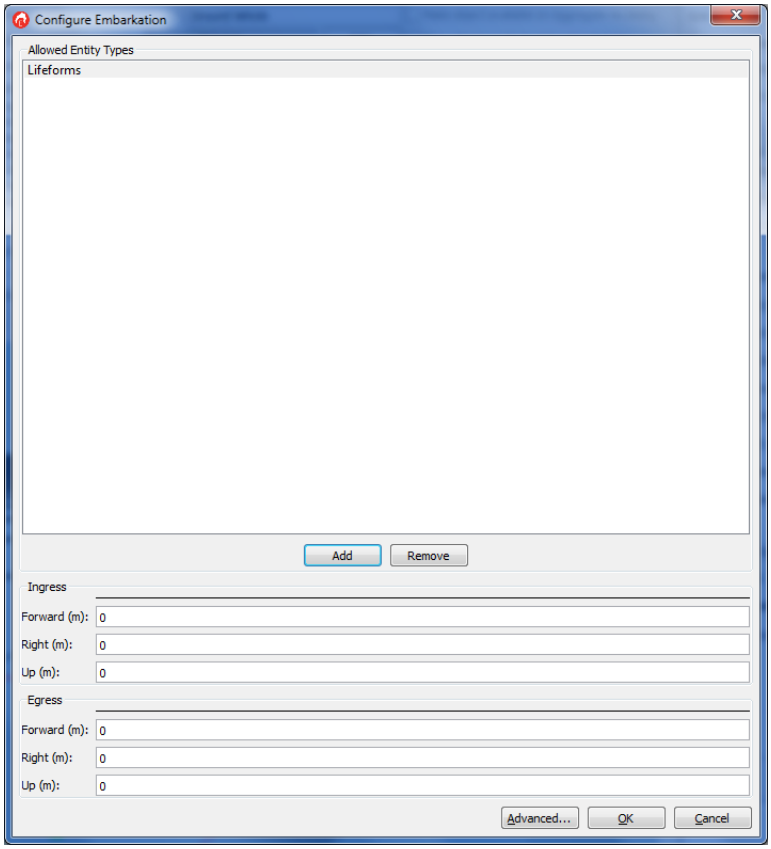


Figure 5-31. Configure Embarkation dialog box

4. Click the Add button (✚). The Add Type dialog box opens.
5. Select a type of entity that can embark.
6. Optionally, add additional entity types.
7. For each entity type listed, specify ingress and egress points. Values are in meters relative to the center of the parent entity.
8. Optionally, configure slots.
9. Click OK.

5.11.1. Configuring Slots

The Entity Editor adds a slot to the embarkation configuration for each allowable entity type that you add. The slot is configured with the entity type of the allowable entity type. You can configure several parameters for the slots. You can add and remove slots with the Add and Remove buttons.

To configure slots:

1. In the Entity Editor object list, select the entity that you want to configure embarkation for.
2. Click Configure. The Configure Embarkation dialog box opens (Figure 5-31).
3. Click Advanced. The dialog box redisplays.
4. Select the slot that you want to edit. The dialog box redisplays to show the slot's parameters (Figure 5-32).

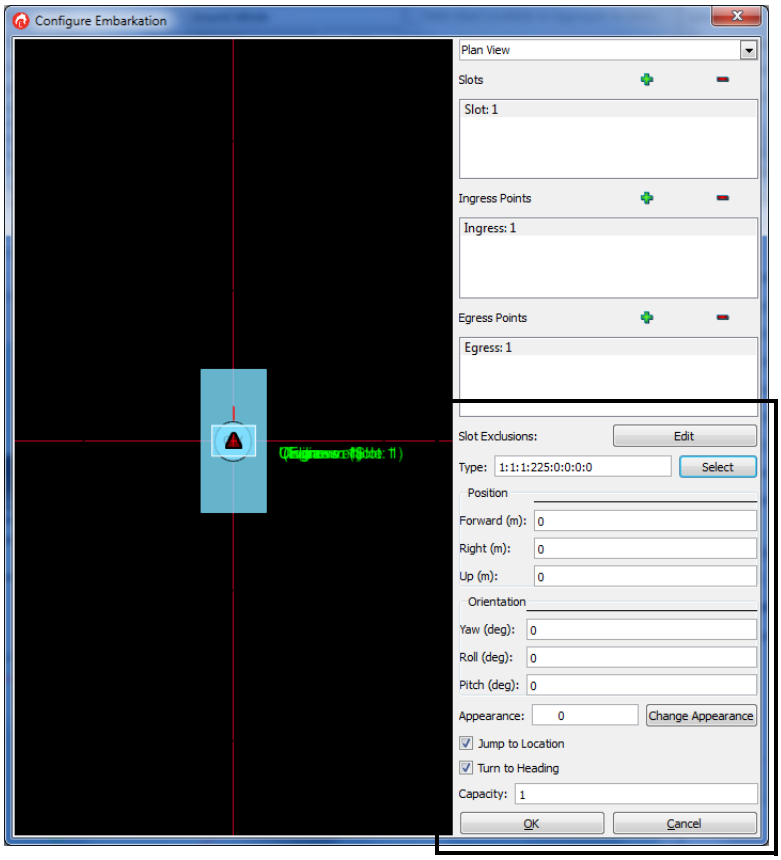


Figure 5-32. Slot parameters

5. Optionally, configure Slot Exclusions. For details, please see "Configuring Slot Exclusions," on page 5-49.

6. If you have added a new slot, in the Type field, specify the entity enumeration for the type of entity that can use this slot. If this is a previously created slot, you can edit the entity type. You can configure different entity types in different slots on an entity.
7. In the Position group box, specify the location of the slot relative to the center of the entity's bounding volume.
8. In the Orientation group box, specify the orientation of the slot relative to the center of the entity.
9. Click Change Appearance and specify the appearance of the entity type when it is in the slot. For example, a human embarked on a truck might have its posture set to Sitting.
10. If you want the embarked entity to immediately jump to the slot, select Jump To Location. If this check box is clear, the entity will move to the slot. For example, an aircraft will taxi to a slot on a carrier deck.
11. If you want the embarked entity to have the same heading as the parent entity, select Turn To Heading.
12. Specify the number of entities that can use this slot.

Configuring Slot Exclusions

A slot exclusion specifies that if a given slot is occupied, other slots cannot be occupied. For example, an entity might allow both tanks and dismounted infantry entities to embark. If no tanks are embarked, the entity can hold 20 DIs. But if a tank is embarked, it uses up 10 slots and now only 10 DIs can embark.

To configure slot exclusions:

1. On the Slot Exclusions line, click Edit. The Edit Slot Exclusions dialog box opens (Figure 5-33).

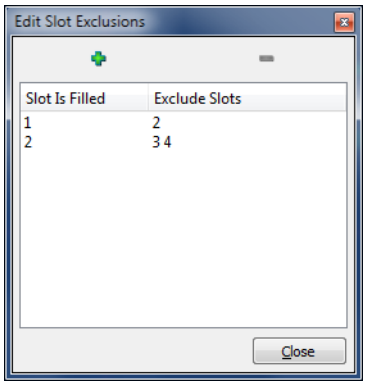


Figure 5-33. Edit Slot Exclusions dialog box

2. Click the Add button (+). A blank line is added to the list.
3. Double-click the cell in the Slot Is Filled column. The cell becomes editable.
4. Type the number of the slot that you want to configure.
5. Double-click the cell in the Exclude Slots column.
6. Type the numbers of the slots that cannot accept entities if the slot you are configuring is filled. You can enter more than one slot to be excluded. Separate the slot numbers with a space.
7. Repeat this procedure to add additional exclusions. You can also edit existing exclusions and delete them.

5.11.2. Adding Ingress and Egress Points

An ingress point specifies where an entity embarks onto another entity. An ingress point can specify a path that the entity follows to get to the ingress point and how it moves once it is on the entity. For example, a jet embarking on an aircraft carrier can taxi to its slot.

An egress point specifies where an entity disembarks from the parent entity.

You can specify that an ingress point should only support some of the slots on the entity. You might want some types of entities embarking at one ingress point and moving to certain slots, while other entities embark at a different location and use other slots. For example, if you are simulating a ferry, cars and trucks would enter at the front or rear and move below deck. Foot passengers would enter at the sides and move to the passenger decks.

When you add an allowed entity type, the Entity Editor automatically creates a slot for that entity type. The ingress and egress points that you configure for that entity type on the basic version of the Configure Embarkation dialog box are automatically associated with the same slot.

In Advanced mode, you can add additional ingress and egress points and associate them with whichever slot you want. You do not have to add them in pairs.



This procedure describes configuring an ingress point. To configure an egress point, substitute egress for ingress in each step.

To add an ingress point:

1. In the Entity Editor object list, select the entity that you want to configure embarkation for.
2. Click Configure. The Configure Embarkation dialog box opens (Figure 5-31).
3. Click Advanced. The dialog box redisplays.
4. Click the Add button () above the Ingress Points list. An ingress point is added to the list. A vertex is added to the display window at the center of the entity bounding volume (Figure 5-34). The coordinates for the ingress point are displayed at the bottom of the dialog box.

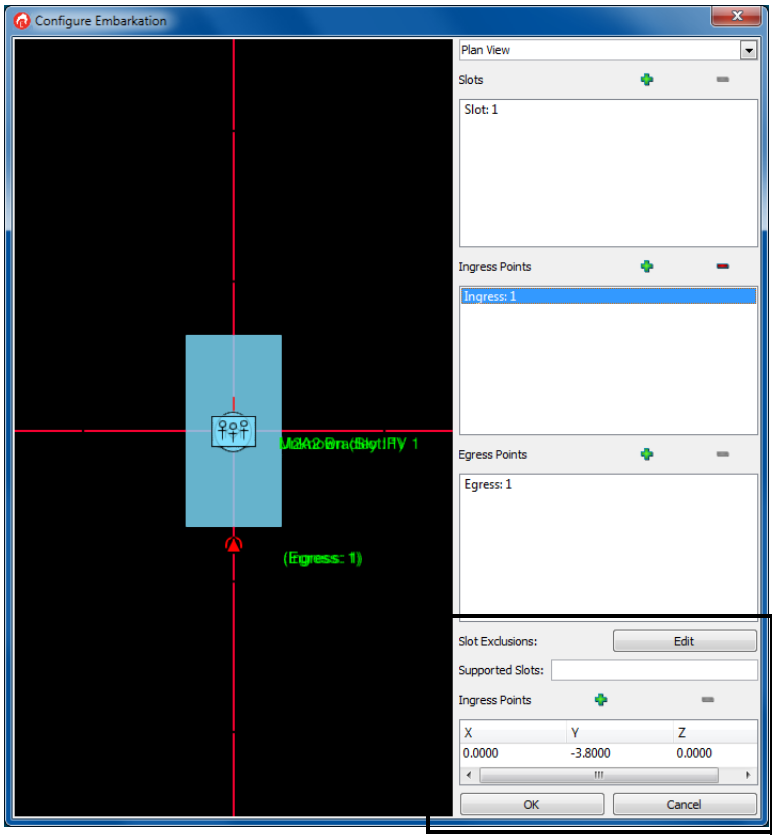


Figure 5-34. Ingress Point

5. Double click the X value for the Ingress point to make it editable.
6. Enter the X value.
7. Repeat for the Y and Z values.
8. If you want to specify a path for the embarking entity
   a. Click the Add button for the Ingress Point Coordinates list. A new coordinate is added.
   b. Specify the X, Y, and Z values for the new coordinate. The path is displayed in the window (Figure 5-35).

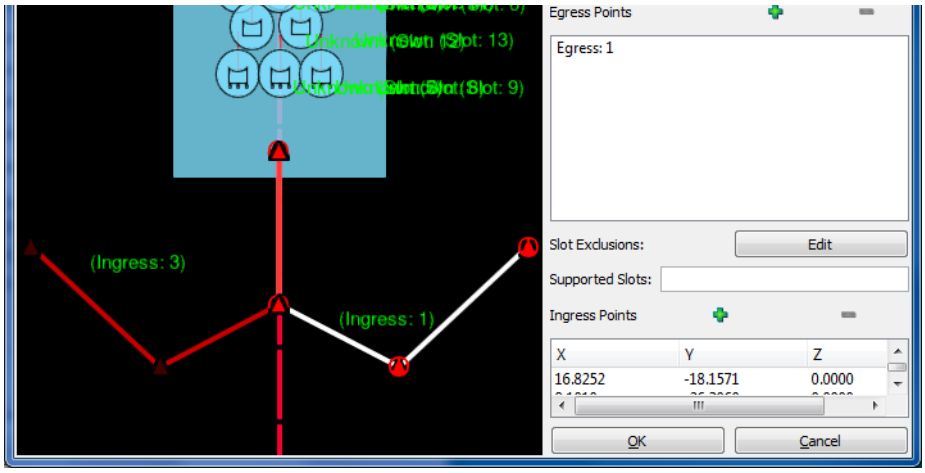


Figure 5-35. Ingress point configuration

9. Optionally in the Supported Slots field, type the numbers for the slots that should support this ingress point. If you leave the field blank, it supports all slots. If you specify more than one slot, separate the numbers with space.
10. Click OK.

5.12. Deleting an Entity Model

To delete an entity model from a simulation model set:

1. Select the entity in the entity list. (You can select multiple models using the **`Shift`** or **`Ctrl`** keys.)
2. Choose **Model** → **Delete Model** or press **`Delete`**.

5.13. Navigating Among Edited Entities

If you have viewed or edited several entities and want to return to a previous entity without finding it in the entities list, you can use the Forward and Backward arrows to navigate among previously edited entities. The arrows act like the forward and back buttons in a web browser.

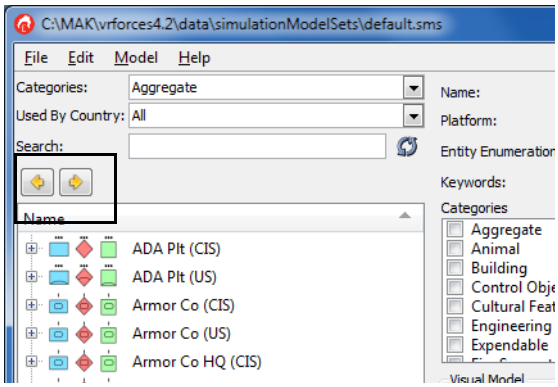


Figure 5-36. Forward and Back arrows

5.14. Editing Tactical Graphics

You can add tactical graphics and edit existing tactical graphics just like you can add and edit entities. You can create a new tactical graphic from an existing one or create a new tactical graphic using one of the basic graphic types - point, route, area, symbol, box, or circle.

When you edit a tactical graphic, you can change the default characteristics of that tactical graphic. When VR-Forces users create one of these graphics, they can edit its specific characteristics as desired.

The basic procedures for adding and editing tactical graphics are the same as for adding and editing entities. This section describes procedures that are specific to tactical graphics.

5.14.1. Editing a Tactical Graphic's Menu Icon

Most objects on the Create menu and the various object creation palettes have icons associated with them. For entities, the icon is the icon used to represent them in the front-end. For tactical graphics, the icon illustrates the type of graphic. You can change the icon associated with a tactical graphic and add icon for newly created tactical graphics.

➤ To specify the palette icon for a tactical graphic, click the Browse button (...) for the Menu Icon line and select the icon that you want to use.

➤ To remove the icon associated with a tactical graphic, click the Delete button (-) on the Menu Icon line.

5.14.2. Specifying that a Tactical Graphic Can Be Created

You can control whether or not a tactical graphic is listed on the Tactical Graphics Palette.

➤ To enable or disable creation of a tactical graphic from the Tactical Graphics Palette, select or clear the Show Object on Tactical Graphics Palette check box (Figure 5-8).

5.14.3. Setting the Default Values for Tactical Graphics Properties

When you select a tactical graphic, the Visual Model group box displays all of the properties that can be set for all of the different types of tactical graphics. Properties that do not apply to the selected tactical graphic are disabled. You can set default values for all of the properties that are applicable to the selected graphic. Setting a default value does not mean that the property will be editable in the VR-Forces front-end. The properties that are editable in the front-end are determined by keywords. For details, please see "Specifying the Properties that can be Edited in the Front-End," on page 5-55.

To set a default value for a tactical graphic property:

1. In the Categories list, select one of the tactical graphics categories.
2. In the list of tactical graphics, select the one that you want to edit. The applicable properties are enabled in the Visual Model group box.
3. Set the default values.

5.14.4. Specifying the Properties that can be Edited in the Front-End

When you create a tactical graphic in the front-end, you can edit its properties, such as line style, line width, color, and fill. The properties that you can edit in the front-end are determined by keywords that you specify in the Entity Editor.

The keywords are as follows:

- min=<num>. Specifies the minimum number of points required to create the object.
- max=<num>. Specifies the maximum number of points allowed.
- nostyle. Do not allow style editing.
- freehand. The object can be drawn freehand.
- penstyle. The user can change line style for the object.
- fill. The user can change the object's fill.
- arrow. The user can change the object's arrow style.
- arrowsize. The user can change the object's arrow size.

When you edit a tactical graphic in the front-end, VR-Forces builds an Edit Style dialog box with the properties specified by the keywords. If no editing is allowed, it removes the Edit icon from the Edit object dialog box.

➤ To allow a tactical graphic's properties to be edited, type the appropriate keyword in the Keywords text box. Separate each keyword with a semi-colon (;).

5.14.5. Editing the Visual Model for a Tactical Graphic

The visual model for a tactical graphic is based on a schema or on a texture. Schemas employ vector graphics and are best for basic lines, points, and areas. Textures apply raster images and are used primarily for specialized linear and areal graphics, such as fortified lines and minefields. (If you use a texture for a graphic, you cannot edit its style properties.)

To edit the visual model for a tactical graphic:

1. In the Categories list, select the category for the tactical graphic that you want to edit.
2. In the list of tactical graphics, select the one that you want to edit.
3. In the Visual Model group box, in the Model Sets list, select the model set that you want to edit.
4. Click the Edit button. The Select Schema for Model Set *model_set* dialog box opens (Figure 5-37).

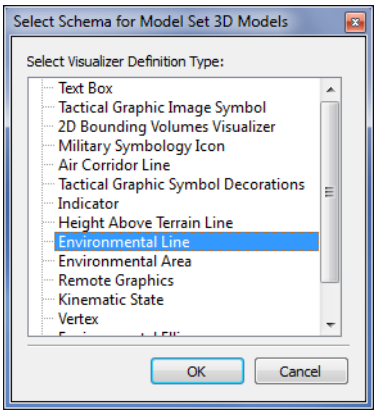


Figure 5-37. Select Schema for Model Set dialog box

5. Select the schema that you want to use.
6. Click OK.

Editing the Texture for a Tactical Graphic

When you use a texture for a tactical graphic you specify a model definition and the height and width of the texture.

To specify a texture for a tactical graphic:

1. In the Categories list, select one of the tactical graphics categories.
2. In the list of tactical graphics, select the one that you want to edit.
3. In the Visual Model group box, in the Model Sets list, select the model set that you want to edit.
4. Click the Texture button. The Select Texture dialog box opens (Figure 5-38).

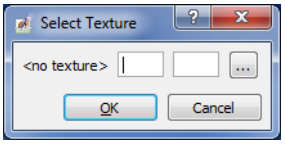


Figure 5-38. Select Texture dialog box

5. Click the Browse button (...). The Select Model Definition dialog box opens (Figure 5-39).

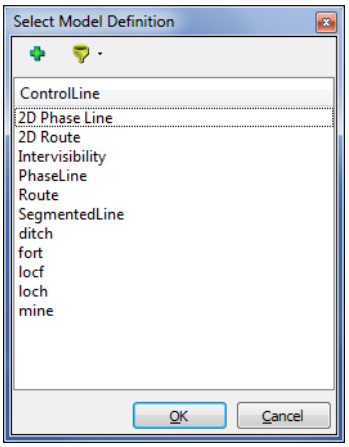


Figure 5-39. Select Model Definition dialog box

6. Select the model definition that you want to use for this texture.
7. Click OK.
8. In the Select Texture dialog box, specify the width and height of the texture, in pixels.
9. If this is an areal graphic, specify whether or not to use the texture for the outline of the area. If you do not use the texture, a regular line is used.
10. Click OK.

5.15. Editing the Category List

If you want to organize entities into categories that are not included in the default category list, you can add new categories. You can also remove and rename categories.

> The procedures in this section also apply to editing the Used By Countries list. Select Used by Countries on the Edit menu instead of Categories.

5.15.1. Adding a New Category

To add a new category:

1. Choose **Edit** → **Categories**. The Categories Editor opens (Figure 5-40).

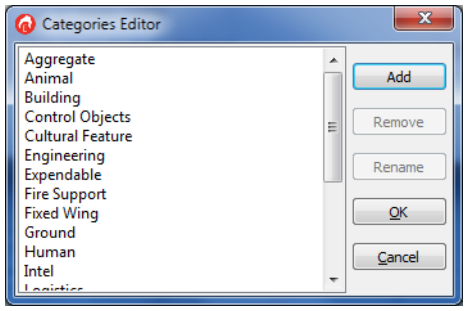


Figure 5-40. Categories Editor

2. Click Add. The New Category dialog box opens.
3. Type the name of the new category.
4. Click OK. The new category is added to the list in the Categories Editor.
5. Click OK.

> If you add a category and do not assign an entity to it, it does not get saved when you save the simulation model set.

5.15.2. Removing a Category

If you remove a category, it gets removed from any entity that is assigned to it. You must save the SMS to make the change permanent.

To remove a category:

1. Choose **Edit** → **Categories**. The Categories Editor opens.
2. Select the category that you want to remove.
3. Click Remove.
4. Click OK.

5.15.3. Renaming a Category

When you rename a category, all entities that are assigned to the old name are reassigned to the new name. The old name remains in the Categories list until you save the simulation model set, but it is not listed in the Categories Editor. If you assign an entity to the old category name before saving the SMS, the old name is retained and added to the list in the Categories Editor.

To rename a category:

1. Choose **Edit** → **Categories**. The Categories Editor opens.
2. Select the category that you want to rename.
3. Click Rename. The Rename dialog box opens.
4. Type the new name.
5. Click OK. The categories list is updated.
6. Click OK.

5.15.4. Undoing Category Changes

You can undo changes made to the category list and entity category assignments.

When you undo category changes, all changes to the categories list and all changes to entity category assignments made since the last save of the simulation model set are reversed. Be sure that this is what you want before completing this procedure.

To undo category changes:

1. Choose **Edit** → **Revert Categories**. A confirmation prompt is displayed.
2. Click Yes.

5.16. Managing the Forces List

When you create an object in the front-end, you must choose a force. You manage the list of forces available and their coloring in the Entity Editor.

5.16.1. Adding a Force

Adding new forces may be useful if you are simulating participants from multiple countries, or if you want to easily model and change force relationships for non-governmental forces such as militias or insurgent groups.

To add a force:

1. Choose **Edit** → **Forces**. The Forces Editor opens (Figure 5-41).

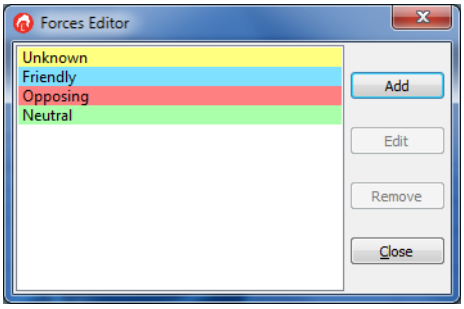


Figure 5-41. Forces Editor

2. Click Add. The Force Hostility Editor opens (Figure 5-42). The new force is assigned a force ID. You cannot edit the force ID.

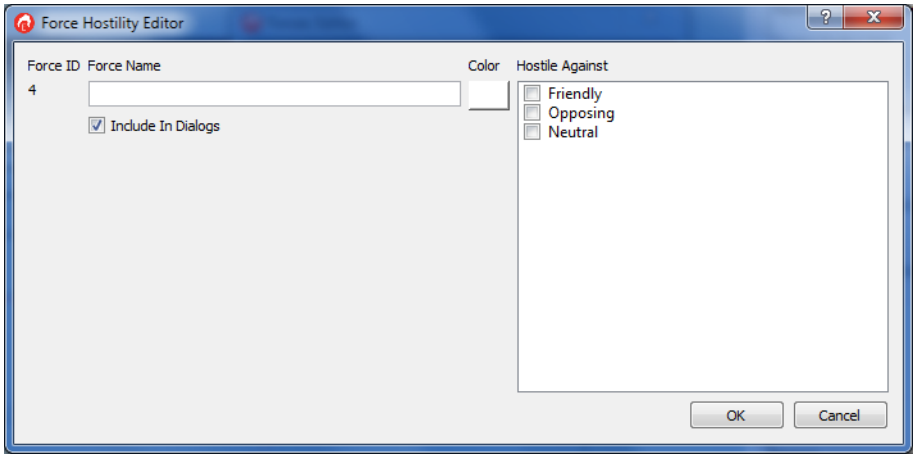


Figure 5-42. Force Hostility Editor

3. In the Force Name box, type a name for the force.
4. Click the Color button. A color picker opens.

5. Select a color for the force.
6. Optionally, in the Hostile Against window, select the forces that the new force will be hostile towards. (You can change hostility at run time in the Hostility Matrix. For details, please see Section 10.2, "Managing Force Hostility Relationships," in *VR-Forces Scenario Management Guide*.
7. If you want the force to be listed in dialog boxes that list forces, select the Include in Dialogs check box.
8. Click OK.
9. Click Close.

5.16.2. Editing a Force

You can edit a force's name, color, hostility, and use. Each force has a force number. When you edit a force, you are changing the attributes of that numbered force.

To edit a force:

1. Choose **Edit** → **Forces**. The Forces Editor opens (Figure 5-41).
2. Select the force that you want to edit.
3. Click Edit. The Force Hostility Editor opens (Figure 5-42).
4. To edit the name, change the text in the Force Name box.
5. To edit the color associated with the force, click the Color button and choose a color from the color picker.
6. To edit hostility relationships, in the Hostile Against window, select the forces that the force should be hostile towards.
7. To edit whether or not the force is listed in dialog boxes that list forces, select or clear the Include in Dialogs check box.
8. Click OK.
9. Click Close.

5.16.3. Removing a Force

If you create a scenario that has entities with a particular force and you then remove the force, the next time you open the scenario, VR-Forces still maintains that force assignment for the entity. The force will be listed in the Hostility Matrix. However, entity icons will not be colored and you will not be able to create any entities with the removed force.

To remove a force:

1. Choose **Edit** → **Forces**. The Forces Editor opens (Figure 5-41).
2. Select the force that you want to remove.
3. Click Remove. The force is removed from the list.
4. Click Close.

5.17. Importing Entity Files

If you have *.entity* files that you created with a previous version of VR-Forces or by multiple persons on different computers, you may want to import them into an SMS. The easiest way to do this is to copy the files into the *vrfSim* directory in the SMS (*./data/simulationModelSet[<sms_name>/vrfSim*). However, you can also import the files from the Entity Editor.

To import .entity files into an SMS:

1. Choose **File** → **Add Entity File**. The Add Entity File dialog box opens.
2. Select the file that you want to import.
3. Click Open. The file gets copied to the SMS.

5.18. Applying Platform Updates

All entity models reference one of the basic platforms, such as ground, fixed-wing, and point object. Most entities reference one or more system definition files. If you update the variable bindings in a platform file or system definition file, you must apply these changes to the entities of that platform type. Although you could do this by hand, as described in "Adding Variable Bindings to Platform and System Files," on page 4-21, that would be tedious and error-prone activity. The Entity Editor can apply all updates to all files automatically.

To apply platform updates:

1. Choose **File** → **Apply Platform Updates**. An information prompt opens.
2. Click OK.

6

Using the OPD Editor

This chapter describes how to use the OPD Editor to edit simulation model sets (SMS).

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Starting the OPD Editor 6-2
Loading a Simulation Model Set 6-3
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- Creating a New Platform or System from an Existing One 6-4
- Editing Individual Parameters 6-5
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Adding New Components and Parameters 6-7
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Saving Changes to the Object Parameter Database 6-10

6.1. The Object Parameter Database Editor

The Object Parameter Database Editor (OPD Editor) is a graphical user interface for editing platforms and systems. When you use the OPD Editor instead of a text editor, you do not have to worry about getting MTL or XML syntax correct in your files. It also quickly gives you access to all the platforms and systems without needing to know which particular files they use.

If you want to edit or add entities or other simulated objects, use the Entity Editor.

6.2. Starting the OPD Editor

➤ To start the OPD Editor, choose **Start** → **Programs** → **MÄK Technologies** → **VR-Forces 4.2** → **Tools** → **OPD Editor**. The OPD Editor opens (Figure 6-1).

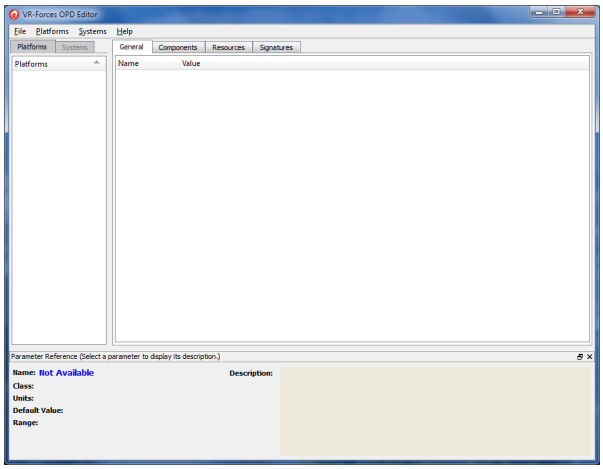


Figure 6-1. OPD Editor

To start the OPD Editor from the Windows or Linux command line:

1. Change directory to *./bin*.
2. Run *vrfOpdEditor*.

6.3. Loading a Simulation Model Set

To edit a simulation model set, you must load it into the editor.

To load a simulation model set:

1. Choose **File** → **Open Simulation Model Set**. An Open dialog box opens. By default it opens to *./data/simulationModelSets*.
2. Select the SMS you want to load, for example, *default.sms*.
3. Click Open. The SMS is loaded. Platforms are listed on the Platforms tab, systems on the Systems tab.

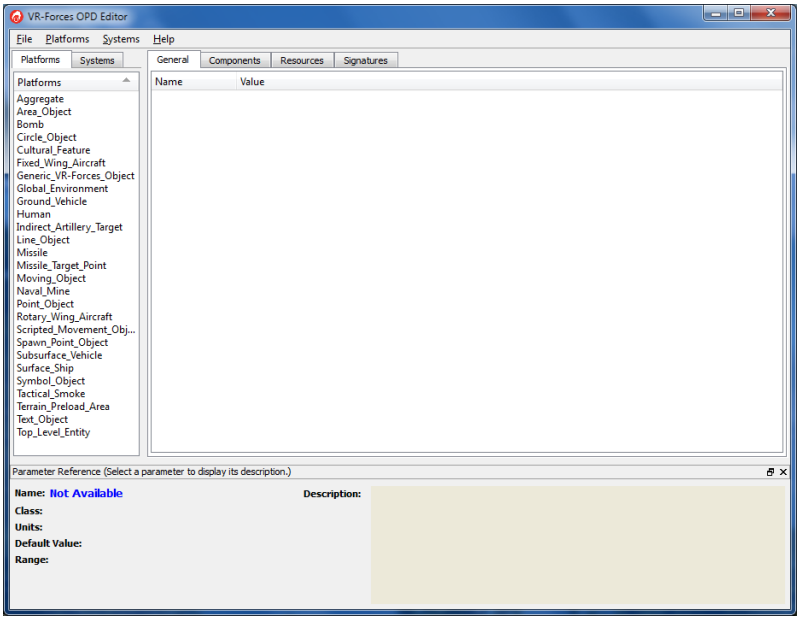


Figure 6-2. OPD Editor with SMS file loaded

6.4. Editing Platforms and Systems

Platforms and systems are similar in organization and construction. They simply configure objects at different levels. They have a set of general parameters, components, and possibly resources, signatures, subordinate objects, and a soil list. These parameters are organized into tabs. Within each tab, the parameters and their values are listed.

This section explains how to edit an object's parameters, how to delete parameters, and how to restore parameters that you have changed or deleted.

Parameter definitions are documented by component in the online help for the OPD Editor in the Object Parameter Descriptions folder. Individual parameter definitions are displayed in the Parameter Reference panel of the OPD Editor. The definitions are also in the header files and class documentation.

6.4.1. Creating a New Platform or System from an Existing One

You can add new platforms and systems to the object parameter database using an existing one as a template.

To add a new platform based on an existing platform:

1. Select the platform on which you want to base the new one.
2. Choose **Platform** → **Create Platform From Existing**. The Create New Platform dialog box opens.
3. Type a name for the new platform.
4. Click OK.
5. Edit the parameters.
6. Save the object parameter database.

To add a new system based on an existing system:

1. Select the system on which you want to base the new one.
2. Choose **Platform** → **Create System From Existing**. The Create New System dialog box opens.
3. Type a new name for the system definition file or click Browse and select an existing file name.
4. Type a name for the new system.
5. Optionally, specify configuration files to copy:
   a. Click the >>> button. The dialog box expands to display the Copy Files group box.
   b. Select the file types that you want to copy.
6. Click OK.
7. Edit the parameters.
8. Save the object parameter database.

6.4.2. Editing Individual Parameters

The various parameters in the object parameter database are all edited essentially the same way. A parameter's value is a number or string that you type, a value that you select from a list, or a filename that you edit by hand or select from a file chooser. When you edit a parameter, the name of the parameter and all its parents are displayed in bold (Figure 6-3).

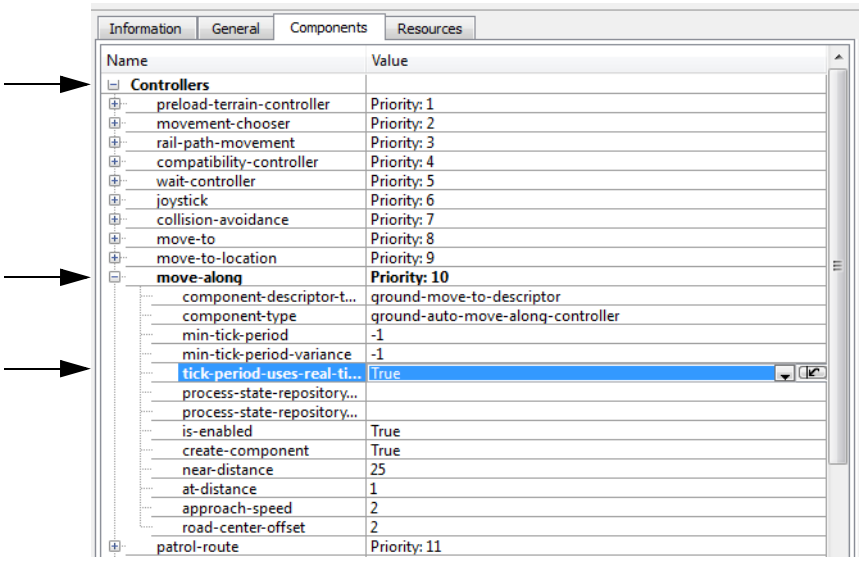


Figure 6-3. Parameter hierarchy after edits

To edit a parameter:

1. Select the parameter by clicking in the Name or Value column. The Value field becomes editable.
2. Enter the new value. In most cases you enter a new value by typing it. If a parameter value has a File Chooser button (Figure 6-4), click the button to open a File Chooser dialog box. If the value has an Edit button, click the button to open a window that allows you to edit the file.

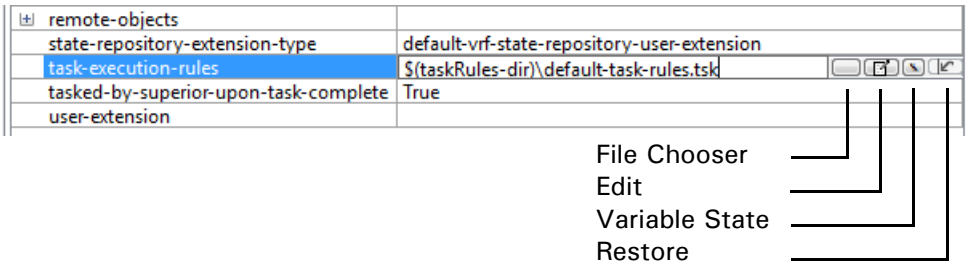


Figure 6-4. Parameter value buttons

6.4.3. Deleting Parameters and Components

The parameters on the General tab cannot be deleted. Parameters on the other tabs can be deleted.

To delete a parameter or component:

1. Select the parameter or component in the Value list.
2. Click the Delete button at the right end of the parameter entry (Figure 6-5).



Figure 6-5. Delete parameter button

6.4.4. Restoring Parameters

If you change a value or delete a parameter or component, you can restore the original value. You can restore at the individual parameter level and at any level in a given hierarchy of entries (Figure 6-3). For example, you can restore a change to the **at-distance** parameter for the **move-to** controller, all edits made to the **move-to** controller, or all edits made to all Controllers. However, since Actuators are not part of the Controllers hierarchy, restoring a change at the Actuators level would not affect changes to Controllers.

To restore a parameter or component:

1. Select the parameter to restore. If you are restoring a deleted parameter or component, select the parent component.
2. Click the Restore button (Figure 6-4).
3. To undo all changes to a platform or system, choose **Platform** → **Restore Platform** or **System** → **Restore System**.

6.5. Adding New Components and Parameters

You cannot add new parameters to the General tab. You can add new components, resources, subordinates, and signatures if an object supports them.



For most platforms, the Components tab does not list all of the components that apply to the entity. This is because many components are referenced through the systems that are attached to an instance of a platform. If you do not see a component that you are looking for in an platform's component list, look at the component list for the relevant system in the Systems List.

6.5.1. Adding New Components



Before you add a component to an platform, consider whether or not the component should be added as part of a new or existing system, rather than being added directly to the platform.

To add a component to a platform:

1. Select the Components tab.
2. Select the component type (Actuator, Controller, Sensor) you want to add.
3. Click the Add button (Figure 6-6). The Create New Component dialog box opens. The Component list lists all components that are available for this object.

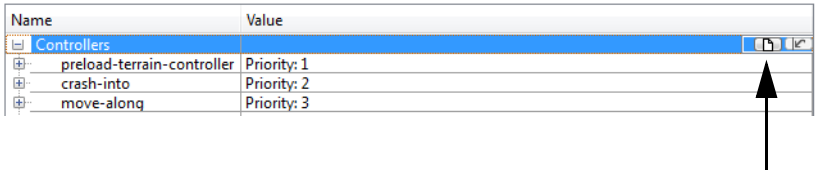


Figure 6-6. Add button

4. From the Component list, select the component you want to add.
5. Click OK. The component is added to the object.

6.5.2. Changing A Component's Priority

When you change a component's priority, the other components are reprioritized as needed. All affected components are listed in bold.

To change a component's priority:

1. Select the component you want to edit.
2. Click the up or down arrow on the value line (Figure 6-7).



Figure 6-7. Change Priority buttons

6.5.3. Creating A Connection

When you add a component, you must also add connections between the component and other components it interacts with.

To add a connection:

1. On the Components tab, select Connections.
2. Click the Add button (Figure 6-6). The Create Connection dialog box opens (Figure 6-8).

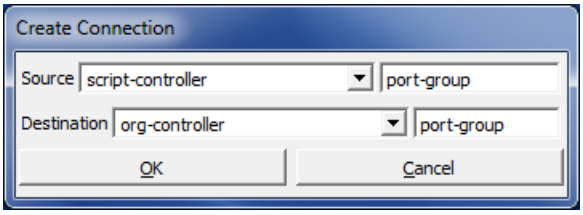


Figure 6-8. Create Connection dialog box

3. Choose a source component from the Source list.
4. Enter the port group for the source component. You must know the name of the port group you need to use. For a list of components and port groups, see the online help.
5. Choose the destination component from the Destination list.
6. Enter the port group for the destination component. You must know the name of the port group you need to use.

7. Click OK. The connection is added to the Connections list.

6.5.4. Adding New Resource Parameters

To add a resource parameter to an object:

1. Select the Resources tab.
2. Select Resources.
3. Click the Add button (Figure 6-6). The Create Resource dialog box opens.

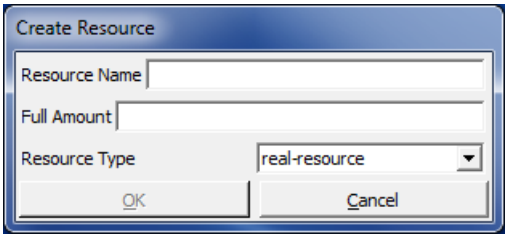


Figure 6-9. Create Resource dialog box

4. In the Resource Name box, enter the name of the resource you want to add. Resource names must start with a letter, not a number. You are responsible for knowing that this is a valid resource supported by your implementation of VR-Forces.
5. In the Full Amount box, enter the amount of the resource to assign to this object.
6. Select a resource type from the Resource Type list.
7. Click OK. The resource is added to the object.

6.6. Editing Variables

The object parameter database uses variables to specify the location of supporting files, such as ammo selection files, system definition files, and formation files. You can edit these variables. (For information about variables, please see "Adding Variable Bindings to Platform and System Files," on page 4-19.)

To edit variables:

1. Select the platform whose variables you want to edit.
2. Choose **Platforms** → **Edit Variables**. The Edit Variables dialog box opens.
3. Change the variable values as desired.
4. Click OK.

6.7. Regenerating Platform Files

If a developer adds new parameters to a component that need to be set in a platform file, the parameters need to be added to the platform file. The OPD Editor can add new parameters to all platform files in one operation.

➤ To regenerate platform files, choose **Platforms** → **Regenerate Platform Files**.

6.8. Saving Changes to the Object Parameter Database

➤ To save an edited object parameter database, choose **File** → **Save**.

7

Configuring Object Behaviors

This chapter describes configuration files that affect entity behavior and the effects of munitions.

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  - Adding a New Sensor to an Entity 7-3
  - Editing a Sensor System Definition File 7-5
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7.1. Configuring Sensors

VR-Forces includes several sensor systems and you can add them to entities using the Entity Editor or the OPD Editor. This section provides additional details about how sensors are configured. A complete sensor configuration requires the following:

- One or more `componentSystem` elements in the *.entity* file for sensor systems.
- A list of sensor signature values in the *.entity* file for the sensor types that can detect the entity type.
- A signature propagator entry in the *./data/simulationModelSets/<model_set>/physicalWorldParam.mtl* file (one per sensor type).

VR-Forces includes radar, infrared, visual, magnetic anomaly detector (MAD), and sonar sensors. The entities configured in the object parameter database are configured with appropriate sensors and sensor signatures. For details about sensor components and how they work, please see API documentation.

7.1.1. Adding a New Sensor to an Entity

It is recommended that you use the Entity Editor to add new sensors. If you want to do it manually, you can edit its *.entity* file.

All sensors provided with VR-Forces are signature-object-sensors. They are distinguished by the domain in which they operate (visual, radar, infrared, MAD, or sonar).

To add a sensor to an entity by editing its *.entity* file:

1. Copy an existing `componentSystem` element in the *.entity* file and paste it into the file.
2. Change the `systemName` to be unique, for example, sensor-2.
3. Change the name of the system definition file to point to the sensor you want to add.
4. Change the values for the variables that must be specified for the sensor.

Connecting a Sensor

If you add a sensor that has been configured to use the auto-connection feature (all sensors provided by MÄK support auto-connections), its connections are handled automatically. (For details, please see "Configuring System Connections," on page 4-18.)

If you add a new type of sensor, you must connect it to input through its input port and then send the data to its output port for the appropriate controller. The sensor gets input through its object-types-to-detect input port. It sends that data out through its detected-objects output port. The connections for the visual sensor, in *visual-sensor.sysdef* are:

```
(connect system:object-types-to-detect visual-sensor:object-types-to-
  detect)
(connect visual-sensor:detected-objects system:detected-objects)
(connect system:sensor-offset visual-sensor:sensor-offset)
```

If you were to create an infrared sensor, it's connections would look like this:

```
(connect system:object-types-to-detect infrared-sensor:object-types-to-
  detect)
(connect infrared-sensor:detected-objects system:detected-objects)
(connect system:sensor-offset infrared-sensor:sensor-offset)
```

7.1.2. Editing a Sensor System Definition File

The preferred method for editing a sensor system definition file, as with all system definition files, is to edit it in the OPD Editor. You can also edit the file by hand. The following example is from the visual sensor system definition file:

```
(visual-sensor
  (component-descriptor-type "signature-sensor-descriptor")
    (component-type  "signature-sensor")
    (min-tick-period  2.000000)
    (min-tick-period-variance  0.100000)
    (tick-period-uses-real-time False)
    (process-state-repository-name  "")
    (process-state-repository-type  "")
    (is-enabled True)
    (detect-only-hostile-forces False)
    (detection-types )
    (detect-destroyed-objects False)
    (sensor-geometry
      (in-range
        (range  $max-range)
      )
    )
    (sensor-domain  "visual")
    (sensor-offset  $sensor-position)
    (sensor-positional-error  0.000000)
    (detection-level-determinator
      (determinator-type  "signature-detection-level-determinator")
      (detection-level-to-set-hostility  3)
      (combat-identification-level-table-file
        "$(detection-dir)\std-visual-detection-table.csv")
    )
  )
)
(controllers
)
(actuators
)
(connections
  (connect system:object-types-to-detect
    visual-sensor:object-types-to-detect)
  (connect visual-sensor:detected-objects system:detected-objects)
  (connect system:sensor-offset visual-sensor:sensor-offset)
)
```

As you can see from viewing the file, most of the parameters that you would want to vary from entity to entity are variables whose values are set in the *.entity* file.

7.1.3. Specifying a Sensor Signature

A sensor signature indicates that an entity can be detected by other entities that have a sensor for that signature. The value of the signature represents the maximum distance, at which the entity can be detected. However, this value is affected by modifiers and the calculations made by the propagator. (Technically, the signature does not assume a particular measurement unit. As implemented, distance is measured in kilometers.)

The modifiers specify multipliers for that base value, based on the current state of the object. For example, an entity might have a base value of 5.0 for its visual signature, and a modifier of 1.5 when moving. This means the signature of the entity will be 7.5 when moving and 5.0 when not moving.

The following is the sensor signature block from a DI with M4:

```
(sensor-signatures
  (visual
    (base-signature  $visual-signature)
    (modifiers
      (file
        (external-file
          (filename  "signatureRules/lifeform-visual-rules.mtl")
        )
      )
      (file
        (external-file
          (filename  "signatureRules/visual-illumination-rules.mtl")
        )
      )
    )
  )
  (infrared
    (base-signature $infrared-signature)
    (modifiers )
  )
  (radar
    (base-signature $radar-signature)
    (modifiers )
  )
)
```

This sensor-signature block shows that a DI M4 can be detected by visual, infrared, and radar sensors. The base-signature values are variables. Their values come from the *.entity* file.

```
 <sensorSignatures>
  <real paramName="visual-signature">1.2</real>
  <real paramName="infrared-signature">1.2</real>
  <real paramName="radar-signature">0.25</real>
</sensorSignatures>
```

The visual sensor has two modifiers. The file *lifeform-visual-rules.mtl* is as follows:

```
(signature-modifiers
  (speed-less-than
    (speed 1.0)
    (multiplier 0.5)
  )
)
```

This indicates that if the entity's speed is less than 1 KMH, multiply the base signature by 0.5. A slowly moving entity is less likely to be seen.

For details about the visual illumination rules modifier, please see "Illumination and Time of Day," on page 7-13.

If you do not want an entity to be detectable by a particular type of sensor, remove the sensor signature from the *.entity* file. If you want it to be detectable by an additional sensor type, add its sensor signature to the *.entity* file. You can edit the values of sensor signatures in the Entity Editor. You cannot add sensor signatures in the Entity Editor. You can edit the values of sensor-signatures and add new sensor signatures in the OPD Editor.

Table 7-1 lists the sensor signatures that VR-Forces uses for general categories of entities. (These categories do not match the categories list in the Entity Editor. They represent a more granular approach to categorizing entities for the purpose of applying a consistent set of sensor signatures.)

Table 7-1: Sensor signatures

Entity Category (with example)	Visual	Radar	Infrared	Sonar Active	Sonar Passive	MAD
Military Fixed Wing - stealth technology	2.5	4	6	N/A	N/A	N/A
Military Fixed Wing - Large Jet (Cargo)	7	30	30	N/A	N/A	N/A
Military Fixed Wing - Small Jet (Fighter)	4	6	20	N/A	N/A	N/A
Military Fixed Wing - Large Prop	5	25	15	N/A	N/A	N/A
Military Fixed Wing - Small Prop	4	20	15	N/A	N/A	N/A
Military Fixed Wing - Large UAV (Predator)	5	20	16	N/A	N/A	N/A
Military Fixed Wing - Small UAV	2	2	1.5	N/A	N/A	N/A
Military Fixed Wing - Micro UAV (Hand Launch)	1	0.5	0.5	N/A	N/A	N/A

Table 7-1: Sensor signatures

Entity Category (with example)	Visual	Radar	Infrared	Sonar Active	Sonar Passive	MAD
Civilian Fixed Wing - Large (Passenger)	10	40	35	N/A	N/A	N/A
Civilian Fixed Wing - Medium (regional)	7	30	30	N/A	N/A	N/A
Civilian Fixed Wing - Small (Cesna)	5	20	12	N/A	N/A	N/A
Small Rotary Wing	4	20	20	N/A	N/A	0.3
Medium Rotary Wing	5	25	25	N/A	N/A	0.3
Large Rotary Wing	7	30	30	N/A	N/A	0.3
Military/Civilian Large Cargo Ship (tanker/cargo)	35	40	30	10	8	N/A
Military Aircraft Carrier	35	40	30	10	8	N/A
Military Cruiser	25	30	25	8	6	N/A
Military Destroyer	20	28	25	8	6	N/A
Military Frigate	18	25	25	8	6	N/A
Military Large Patrol (Corvette)	18	25	25	6	4	N/A
Military Small Patrol (covered)	10	25	25	3	2	N/A
Military Small (zodiac)	4	6	8	2	1.5	N/A
Civilian Large Commercial Passenger (Cruise)	45	50	50	10	8	N/A
Civilian Medium Commercial	25	40	35	8	5	N/A
Civilian Small Commercial (tug)	15	30	35	4	3	N/A
Civilian Private Medium	15	25	25	4	3	N/A
Civilian Private Small (24->30ft day cruiser)	10	25	25	3	2	N/A
Civilian Private Micro (jet ski)	5	9	10	1	2	N/A

Table 7-1: Sensor signatures

Entity Category (with example)	Visual	Radar	Infrared	Sonar Active	Sonar Passive	MAD
Civilian Sailboat (J-24)	15	20	10	2	0.5	N/A
Small Lifeboat (bright colors)	7	12	15	1	1	N/A
Large Lifeboat (bright colors)	10	15	15	1	1	N/A
Military Submarine -- Large (Ohio)	2	3	2	1	0.01	N/A
Military Submarine -- Medium (LA)	1.5	3	2	0.75	0.01	N/A
Military Submarine -- Small	1.5	3	2	0.5	0.25	N/A
Military Submarine -- Torpedo (non decoy)	0	0	0	1	2	N/A
Human (no camouflage)	1.2	0.25	1.2	N/A	N/A	N/A
Human (with camouflage)	0.5	0.25	0.75	N/A	N/A	N/A
Human in Water (with bright vest)	2	2	1.5	N/A	N/A	N/A
Human in Water (no vest)	0.75	2	1.5	N/A	N/A	N/A
Civilian Passenger Car	4	0.5	4	N/A	N/A	N/A
Civilian Truck/Bus	6	1	6	N/A	N/A	N/A
Military Artillery - large	3	0.75	4	N/A	N/A	N/A
Military Artillery - small	1	0.5	2	N/A	N/A	N/A
Military Large Vehicle (Logistics)	5	1	5	N/A	N/A	N/A
Military Medium Vehicle (Tank)	3	0.5	4	N/A	N/A	N/A
Military Small vehicle (Jeep/Technical)	1	1	2	N/A	N/A	N/A
Military Micro (human sized or smaller)	0.5	0.25	1	N/A	N/A	N/A

7.1.4. Adding a New Sensor Type

You can easily add new sensor types to your entities. Suppose that you want to add an acoustic sensor. You would do the following:

1. Add a block to the signature-propagator-params block in *physicalWorldParams.mtl*.
2. Add a sensor `componentSystem` element to each entity that can detect targets acoustically.
3. Add a sensor signature to each entity that can be detected acoustically.

Configuring a Signature Propagator

The *physicalWorldParams.mtl* file specifies the list of sensors available and the propagator to use for each. The following is a portion of this file:

```
(physical-world-params
  (signature-propagator-params
    (radar
      (propagator-descriptor-type "standard-propagator-descriptor")
      (propagator-type "standard-propagator")
      (check-line-of-sight True)
    )
    (visual
      (propagator-descriptor-type "standard-propagator-descriptor")
      (propagator-type "visual-propagator")
      (check-line-of-sight True)
      ...
    )
  )
)
```

If you edit the file to add an acoustic sensor, it might look like the following:

```
(physical-world-params
  (signature-propagator-params
    (visual
      (propagator-descriptor-type "standard-propagator-descriptor")
      (propagator-type "visual-propagator")
      (check-line-of-sight True)
    )
    (acoustic
      (propagator-descriptor-type "standard-propagator-descriptor")
      (propagator-type "standard-propagator")
      (check-line-of-sight False)
    )
    ...
  )
)
```

You do not have to be able to see an entity to hear it, so you do not need to check line of sight.

Adding a Sensor Component

To add a new sensor component, follow the procedure in "Adding a New Sensor to an Entity," on page 7-3. A new acoustic sensor might look like the following:

```
(acoustic-sensor
  (component-descriptor-type "signature-sensor-descriptor")
    (component-type  "signature-sensor")
    (min-tick-period  2.000000)
    (min-tick-period-variance  0.100000)
    (tick-period-uses-real-time False)
    (process-state-repository-name  "")
    (process-state-repository-type  "")
    (detect-only-hostile-forces False)
    (detection-types )
    (detect-destroyed-objects False)
    (sensor-geometry
      (in-range
        (range  $max-range)
      )
    )
    (sensor-domain  "acoustic")
    (sensor-offset  $sensor-position)
    (sensor-positional-error  0.000000)
    (detection-level-determinator
      (determinator-type  "signature-detection-level-determinator")
      (detection-level-to-set-hostility  3)
      (combat-identification-level-table-file
        "$(detection-dir)\std-acoustic-detection-table.csv")
    )
  )
)
(controllers
)
(actuators
)
(connections
  (connect system:object-types-to-detect
    acoustic-sensor:object-types-to-detect)
  (connect acoustic-sensor:detected-objects system:detected-objects)
)
```

Adding a Sensor Signature

If you add a new sensor, you need to add a signature for it to each entity that can be detected by the sensor. If you add an acoustic sensor, a sensor signature might look like the following:

```
(sensor-signatures
  (visual
    (base-signature  4.000000)
    (modifiers )
  )
  (acoustic
    (base-signature  2.000000)
    (modifiers )
  )
  ...
)
```

You can probably see entities at a greater distance than you can hear them, so we have a lower base-signature value.

7.1.5. Illumination and Time of Day

Visual sensors take into account the time of day. They do this through an illumination value that modifies the visual sensor signature. The modification value is configured in *./data/simulationModelSets/default/vrfSim/signatureRules/visual-illumination-rules.mtl*:

```
(signature-modifiers
  (environmental
    (modifier-coefficients 1.0 0.1)
  )
)
```

"Specifying a Sensor Signature," on page 7-6 shows how this file can be referenced in a sensor signature. Given this file, the modifier coefficients are applied to the illumination value, as follows:

```
Multiplier = 1.0 * illumination + 0.1
```

The illumination value is derived from the time of day based on parameters in *Global-Environment.ope*:

```
...
(actuators
  (global-environment-actuator
    ...
    (sunrise-time  21600.000000)
    (sunset-time  64800.000000)
    (daylight-illumination  1.000000)
    (night-illumination  0.100000)
    (day-night-transition-time  7200.000000)
  )
)
```

where:

- **sunrise-time** is the time at which the daylight model changes from night to day, in seconds past midnight.
- **sunset-time** is the time at which the daylight model changes from day to night, in seconds past midnight.
- **daylight-illumination** is the percent illumination during the full daylight hours.
- **night-illumination** is the percent illumination during the full night hours.
- **day-night-transition-time is** the period of time, centered on sunrise and sunset times, where the illumination value will be transitioning from daylight to night, or night to daylight. During this time period, the illumination level is a linear progression between the night and daylight illumination levels.

7.2. Detection Tables

The detection tables determine the level of knowledge that an entity has of detected entities. The detection level is used in the Detect condition in plans.

Detection tables are comma-delimited files that are most easily read in a spreadsheet. As illustrated in Figure 7-1, each column represents a detection interval, in seconds, from 0 through 160. Each row represents an apparent signature from one through 4. (An apparent signature is an entity's absolute signature after being modified by factors such as terrain and distance. For details, please see API documentation.)

	A	B	C	D	E	F	G	H	I	J	K
1	CID Table-radar	Version 1.0		Detection	Interval	(seconds)	->				
2			0	1	5	10	20	40	80	160	
3	Apparent	1	1	1	2	2	2	3	3	3	
4	Signature	1.5	1	1	2	2	3	3	3	3	
5	|	2	1	1	2	2	3	3	3	4	
6	V	2.5	1	2	2	3	3	3	4	4	
7		3	1	2	3	3	3	4	4	4	
8		4	2	3	3	3	4	4	4	4	
9											

Figure 7-1. Detection table displayed in a spreadsheet

The detection level is determined by finding the intersection of the apparent signature and the detection interval. For example, if an entity with an apparent signature of 3 has been detected for 40 seconds, its detection certainty level is 4 (full knowledge).

The apparent signature is the ratio of the sensor signature given for the entity (in kilometers) to the actual range. So if the apparent signature = 1, the detection interval shows the increase in combat ID level over time when the target is at the range given by the sensor signature. If the apparent signature is 2, the detection interval shows the detection progression at 1/2 that range, and so on.

The numbers in the table represent the certainty levels as follows:

- 1 – Detected.
- 2 – Classified.
- 3 – Identified.
- 4 – Full Knowledge.

For details about CID detection levels, please see Section 10.3, "Detecting Targets," in *VR-Forces Scenario Management Guide*.

7.3. Probability and Selection Tables for Munitions

When the entities in a scenario shoot at each other, VR-Forces uses an ammo select table to select the ammunition to be used. It uses a set of tables to calculate the probability of:

- Hitting a target (hit probability table).
- Being damaged when hit by hostile munitions (damage probability table).

7.3.1. Ammo Select Tables

The ballistic gun controller descriptor refers to an ammo select table file, which contains the ammo select table for that controller. Each entry in this file specifies a target type (using the best-match method) and a prioritized list of ammunition that should be used for that type of target (highest priority listed first). The name of the entry is not used, and so may be something descriptive for readability. Each entry has the following fields:

- **target-type** – a 7-digit entity type enumeration, which can use -1s to denote wildcards.
- **ammo** – list of ammunition entries. The names of the ammunition entries are assumed to be the resource names. If the resource name is found in the Object Resource Manager, the amount of the ammunition is decremented appropriately, and is not used if the resource amount is 0. In this case, the next ammunition entry (if any) in the ammunition list is used. Each ammunition entry has the following fields:
  - **munition-type** – 7 digit entity type enumeration. This is the entity type that is used in the fire and detonation interactions created, and should NOT contain -1s.
  - **warhead** – VR-Link warhead enumeration value to use in fire and detonation interactions for this munition.

The following is an example of an Ammo Select Table:

```
(ammo-select-table
   (default ;; matches any ground vehicle
      (target-type 1 1 -1 -1 -1 -1 -1)
      (ammo
         (M830-HEAT-120mm ;; these names need to match resource names
            (munition-type  2 2 225 2 13 3 0)
            (warhead  0)
         )
         (M829A1-AP-120mm ;; these names need to match resource names
            (munition-type  2 2 225 2 13 2 0)
            (warhead  0)
         )
      )
   )
   (battle-tank ;; matches any tank
      (target-type 1 1 -1 1 -1 -1 -1)
      (ammo
         (M829A1-AP-120mm ;; these names need to match resource names
            (munition-type  2 2 225 2 13 2 0)
            (warhead  0)
         )
         (M830-HEAT-120mm ;; these names need to match resource names
            (munition-type  2 2 225 2 13 3 0)
            (warhead  0)
         )
      )
   )
)
```

7.3.2. Hit Probability Tables

A weapon system definition file specifies a hit probability file. This file contains a hit probability table that is used by the system's actuator to determine whether or not it hits a target that it fires upon. A hit probability table has one or more entity-range entries. The name of the entity-range entry is not used, and can be something descriptive. An entity range entry has the form:

- **entity-type** – 7 digit entity type enumeration, which may use -1s as wildcards.
- **range-determinant** – a range determinant can be either a list of probability-range entries with the name "range-list", or a probability-coefficient list with the name "coefficients".
- **range-list** – a list of probability-range entries. A probability-range entry has a name, "range", a range value (in meters) and a list of probability entries. The entry applies to targets in the range from the last entry to the current one (or from 0.0 in the case of the first entry). Each probability entry has a name that the table user uses to find the probability value it is interested in and the value itself (a real number between 0.0 and 1.0.) The ballistic gun looks for the probability entry with the name "probability".



- For ranges that are greater than the last specified range, the probability is zero.
- The range for missiles is the range from the missile to the target, not from the entity that fired the missile.

- **coefficients** – a coefficient probability list is a list of coefficient probability entries. Each entry has a probability name and the coefficients of a standard polynomial that can be used with a given range to determine the specified probability. The order of the polynomial is determined by the number of coefficients provided. For example, an entry of:

  ```
  (probability -5.00000E-008 -300000E-012 1.0000)
  ```

  indicates that the formula to use for a given range *r* would be:

  $(-5.00000E-008 * r^2) + (-300000E-012 * r) + 1.0$

  Values calculated will be constrained to be between 0.0 and 1.0. Zero values are factored out, for example:

  ```
  (probability -5.00000E-008 0.0000 1.0000)
  ```

  indicates that the formula to use for a given range *r* would be:

  $(- 5.00000E-008 * r^2) + (0.0 * r) + 1.0$

The following is an example of the *M1A2MainGun.hit* hit probability table:

```
(hit-probability-table
  (entity-range
    (entity-type  1 1 -1 -1 -1 -1 -1)
    (range-determinant
      (range-list
        (range 1000.000000
          (probability 0.90000)
        )
        (range 2000.000000
          (probability 0.8000)
        )
        (range 3000.000000
          (probability 0.75000)
        )
        (range 4000.000000
          (probability 0.70000)
        )
      )
    )
  )
)
```

7.3.3. Damage Probability Tables

The damage actuator uses damage probability tables specified by its component descriptor to determine direct and indirect fire damage based on several factors. The damage probability table has a list of surface entries, which provide a sub-table for each surface upon which a round might detonate. The name of the surface entry is the surface name used in the damage model.

VR-Forces has damage probability tables for direct fire and collateral damage. A munition type does not need to have both types of probability table if one of the types is not appropriate. For example, an M16 does not have a collateral damage file. Conversely, an artillery shell does not have a direct fire probability table.

The damage actuator delivered with VR-Forces uses surfaces of front, rear, left-side, right-side, bottom, and top (other components could model the entity's geometry differently, and therefore use different surface strings). A surface entry has a list of angle-of-incidence entries. An **angle-of-incidence** entry has an angle (in radians), and a **range-determinant**. The entry is intended for use with angles of incidence that go from the previous entry's specified angle to the current one (or in the case of the first entry, from 0.) The range determinant is exactly the same as the range determinant described in "Hit Probability Tables," on page 7-16. The damage actuator provided by MÄK looks for a probability entry with the name **catastrophic-kill**, **mobility-kill**, or **firepower-kill**.



The range for missiles is the range from the detonation location to the target, not from the entity that fired the missile.

The following damage probability table fragment has two surface entries, front and rear. The first uses a coefficients range determinant, the second surface entry uses a **range-list** determinant.

```
(damage-table
  (front
    (angle-of-incidence
      (angle  0.5236) ;; 30 degrees
      (range-determinant
        (coefficients
          (catastrophic-kill -5.0000E-008   0.0000   1.0000)
        )
      )
    )
    (angle-of-incidence
      (angle  1.0472) ;; 60 degrees
      (range-determinant
        (coefficients
          (catastrophic-kill -5.0000E-008   0.0000   1.0000)
        )
      )
    )
  )
  (rear
    (angle-of-incidence
```

```
        (angle  0.523600)
        (range-determinant
          (range-list
            (range 2000.000000
              (catastrophic-kill  0.800000)
            )
            (range 3000.000000
              (catastrophic-kill  0.600000)
            )
            (range 4000.000000
              (catastrophic-kill  0.300000)
            )
          )
        )
      )
      (angle-of-incidence
        (angle  1.047200)
        (range-determinant
          (range-list
            (range 2000.000000
              (catastrophic-kill  0.800000)
            )
            (range 3000.000000
              (catastrophic-kill  0.600000)
            )
            (range 4000.000000
              (catastrophic-kill  0.300000)
            )
          )
        )
      )
    )
  )
```

The structure of a collateral damage probability file is similar to the direct damage file. However the file is processed differently. VR-Forces calculates a range around the munition impact within which other entities can be damaged.

7.3.4. Configuring an Entity to Take Damage from a Munition

If you want an entity to take damage from a particular type of munition, it must have an ammo-entry block for that type of munition in its damage-component. For example, the individual lifeform damage actuator is not configured with an entry for M107-155mm, which means it would not take damage from artillery. If you want to make individual lifeforms vulnerable to this type of munition, you must add an entry for this munition type to the entity's damage model.

7.4. Configuring Formations



Although you can create and edit formation files by hand as described in this section, the recommended way to create and edit formations is to use the Entity Editor.

The object parameter database lists the formations available to an aggregate entity in the **formations** element in its *.entity* file. Each formation is identified by its name and the path to the formation file, for example:

```
<formations paramName="formation-list" autoLayout="0">
  <formation formationName="Line" formationFile=
    "@(formation-dir)/platoonLine.frm"/>
  <formation formationName="Column" formationFile=
    "@(formation-dir)/platoonColumn.frm"/>
  <formation formationName="Wedge" formationFile=
    "@(formation-dir)/platoonWedge.frm"/>
  <formation formationName="Vee" formationFile=
    "@(formation-dir)/platoonVee.frm"/>
</formations>
```

7.4.1. Formation Files

A formation file specifies the name of the formation and has an entry for each entity in the default formation definition. Each entry specifies a **promotion-id**, a **leader-promotion-id**, and a **position-offset**, where:

- The **promotion-id** specifies the order in which entities are promoted to aggregate leader if the leader is incapacitated.
- The **leader-promotion-id** specifies the aggregate member from whom the entry's position will be offset.
- The **position-offset** specifies how many meters behind, to the right, and above the entry will follow its leader. The **position-offset** is specified in terms of the body coordinate system of its leader.

The following is a portion of the formation file for a column formation:

```
(column-formation
   (entry-0
      (promotion-id  0)
      (leader-promotion-id  -1)
      (position-offset  0.000000 0.000000 0.000000)
   )
   (entry-1
      (promotion-id  1)
      (leader-promotion-id  0)
      (position-offset  -25.000000 0.000000 0.000000)
   )
   (entry-2
      (promotion-id  2)
      (leader-promotion-id  1)
      (position-offset  -25.000000 0.000000 0.000000)
   )
   (entry-3
      (promotion-id  3)
      (leader-promotion-id  2)
      (position-offset  -25.000000 0.000000 0.000000)
   )
)
```

In a column, each entity follows the entity in front of it by 25 meters. Therefore, the **leader-promotion-id** for each entry is the **promotion-id** of the entity in front of it, and each entry has a **position-offset** of -25 meters.

The number of entries in a formation file is finite. However, it is possible to place more entities into an aggregate than there are entries in a formation file. If this happens, VR-Forces increments the **promotion-id** of the last entry in the formation file and assigns the new entity the same **position-offset** as the last entry in the formation file. For a simple formation like a column, this works well. If you are using a more complex formation, this mechanism might create unintended relationships among entities.

If you want to change the layout of the formations provided with VR-Forces, you can edit the formation files.

7.4.2. Creating a User-Defined Formation

You can create formations other than those provided by VR-Forces. It is recommended that you create formations in the Entity Editor. If you use the Entity Editor, you do not have to edit any formation files or OPE files by hand.

To create a formation:

1. Using one of the formation files supplied with VR-Forces as your template, place as many entries as you want in the formation file and specify their offsets.
2. Save the new formation under a new name.
3. Add an entry to the formation list block in the OPE file for each aggregate that you want to be able to use the formation. Be sure to use the same structure and naming conventions as the default entries. For example:

```
(my-formation-1
  (formation myFormation)
  (formation-file
    (filename ".\formation\myformation.frm")
  )
)
```

We recommend that you configure your formations so that entities follow the leader, rather than the next closest member of the formation (as is done in column formation.) This ensures that formations have the best chance of maintaining their formation as they maneuver.

7.5. Configuring Emitters

All fixed-wing aircraft have emitters as part of their radar sensor. Emitters have search modes. Search modes have a list of beams. You can configure entities with emitters that have more than one beam. You can also configure multiple emitters. The basic radar sensor with an emitter and two search modes (*./data/simulationModel-Sets/default/vrfSim/systems/sensors/active-radar-sensor.sysdef*) is as follows:

```
(active-radar-sensor-system
  (systems )
  (sensors
    (radar-sensor
      (component-descriptor-type "radar-signature-sensor-descriptor")
      (component-type  "radar-signature-sensor")
      . . .
      (sensor-domain  "radar")
      (sensor-offset $sensor-position)
      (sensor-positional-error  0.000000)
      (detection-level-determinator
        (determinator-type  "signature-detection-level-determinator")
        (detection-level-to-set-hostility  3)
        (combat-identification-level-table-file
          (filename  "$(detection-dir)\std-radar-detection-table.csv")
        )
      )
      (detection-period  0.000000)
      (publish-emitter-system True)
      (emitter-system
        (system-name-enum  5570)
        (system-function-enum  5)
        (radar-mode-list
          (search-mode
            (index  0)
            (radar-mode  "Search")
            (beam-list
              (beam-0
              (index  0)
              (type  "track")
              (frequency  4999999488.000000)
              (frequency-range  10000.000000)
              (power  70.000000)
              (pulse-repetition-frequency  0.000000)
              (pulse-width  0.000000)
              (azimuth-center  0.000000)
              (azimuth-sweep  0.523599)
              (elevation-center  0.349066)
              (elevation-sweep  0.523599)
              (sweep-sync  0.000000)
              (beam-function-enum  1)
              (beam-param-index  0)
            )
          )
        )
        (track-mode
          (index  1)
          (radar-mode  "Track")
          (beam-list
            (beam-0
```

```
                ...
              )
            )
          )
        )
      )
    )
  )
```

To configure multiple emitters for an entity, add additional radar-sensor blocks. Each block must have a unique name. For example:

```
(radar-sensor-1
  (component-descriptor-type "radar-signature-sensor-descriptor")
  (component-type  "radar-signature-sensor")
  . . .
  (emitter-system
    ...
    )
  )
)
(radar-sensor-2
  (component-descriptor-type "radar-signature-sensor-descriptor")
  (component-type  "radar-signature-sensor")
  . . .
  (emitter-system
    ...
    )
  )
)
```

To add multiple modes on an emitter, add additional mode blocks to the radar mode list. The names of radar modes (for example, track-mode and search-mode) and the value for the radar-mode parameter are arbitrary. You can name them whatever you want.

To add multiple beams on a radar mode, add additional beam-list blocks and change the name of each block. For example:

```
(search-mode
  (index  0)
  (radar-mode  "Search")
  (beam-list
    (beam-0
      ...
    )
    (beam-1
      ...
    )
  )
)
```

7.6. Configuring Radios

All radios are *DtVrfRadio* classes or subclasses. The radio is responsible for managing incoming and outgoing radio messages on a single entity. Each radio is associated with a specific communication model, and uses this communication model to send and receive messages.

Radios are configured in an entity's OPE file. The radios block in the OPE file lists all the radios on the entity and the parameters for each radio. Parameters include the type of radio descriptor and type of radio class, which are strings used to create the C++ classes from the factories. The **comm-model-name** parameter identifies which communication model a radio is associated with. Every radio must be associated with a communication model.

A typical OPE radio entry is as follows:

```
(main-radio
  (radio-descriptor-type "radio-descriptor")
  (radio-type  "default-radio")
  (comm-model-name  "default-radio-model")
  (publish-transmitter False)
  (transmitter-params
    (radio-type  7 1 225 2 1 20)
    (initial-frequency  3000000.000000)
    (power  30.000000)
  )
)
```

7.7. Configuring Emitter Volumes

You can configure how VR-Forces colors emitter volumes, how they are drawn, and how they are scaled for visibility. You can configure emitter volumes by editing the DefaultEllipsoidArc model definition or by creating customized ellipsoid arc model definitions and applying them to different entity models.

7.7.1. Configuring Emitter Volume Color

By default, emitter volumes are displayed using fixed colors for high frequency and low frequency. You can configure emitter volumes to be colored based on the emission frequency or pulse rate. When emitter volume color represents frequency, color is determined by the frequency field of the EM Emission update message. In both cases, you specify a low frequency or pulse rate value and a high value.

If the emitter frequency or pulse rate is lower than your specified low value, the emitter volume is red. As frequency rises above the specified low value, emitter volume color changes, progressing through the colors of the visible spectrum until the specified high value is reached. At the high value and above, the emitter volume is violet.

To change coloring from the default, you must add the appropriate attributes to the emitter volume visualizer for the entities whose model definitions you want to change. Table 7-2 describes the emitter volume visualizer attributes that affect emitter volume color.

Table 7-2: Emitter volume visualizer attributes

Attribute	Description
colorByFrequency	If True, color by frequency instead of using static colors.
lowFrequency	The low frequency threshold for coloring by frequency. Default: 800 MHz.
highFrequency	The high frequency threshold for coloring by frequency. Default: 1 GHz.
usePulseFrequency	If colorByFrequency is True and usePulseFrequency is True, color emitter volumes by pulse frequency.
lowPulseFrequency	The low pulse rate threshold for coloring by frequency. Default: 100 Hz.
highPulseFrequency	The high pulse rate threshold for coloring by frequency. Default: 3 KHz.

7.7.2. Controlling Emitter Volume Radius

A emitter volume's radius (that is, the distance it extends from the emitter) is based in part on emitter power and in part on elevation and azimuth sweep data obtained from EM-Emission state messages. A higher emitter power value results in a longer radius, while a wider field of view results in a shorter radius (because the radiated power is distributed over a wider area).

If VR-Forces relied exclusively on these values, the range of sizes among different emitter types could become too wide to be practical, with some emissions being barely visible, and other emissions covering the entire virtual world. Therefore, a configurable exponent weight and scale factor have been added to help fine tune the emitter beam radii. The radius exponent weight (a value between 0 and 1) slows the growth of the radius when power or area is greater than 1 and increases the growth of the radius when power or area is less than 0. The scale factor increases the radii of all beams by the given value.

To change the scale factor and exponent from the default, you must add one or both of the following attributes to the emitter volume visualizer for the entities whose model definitions you want to change:

- linearScale. The amount of linear scaling applied to all emitter volumes. Default: 100.
- exponentialScale. The amount of exponential scaling applied to emitter volumes. Default: 0.1.

How VR-Forces Calculates the Radius

VR-Forces calculates emitter volume radius by approximating the spread of the emissions based on the elevation and azimuth sweeps. If the approximate coverage is zero, it sets the value to 1. Then it applies the linear and exponential scaling values. The code for implementing this is as follows:

```
double tempVar = 8*elevationSweep*sin(2*azimuthSweep);
if (tempVar <=0) tempVar=1.0;
scale = linearScale * pow(sqrt(power/tempVar), exponentialScale );
```

7.7.3. Configuring Emitter Volume Segments

VR-Forces displays a emitter volume as a group of spherical sections projecting from the sensing device. By default, for each 10 degrees (or portion thereof) in the emitter's field of view, VR-Forces draws one segment. Figure 7-2 shows segments set to 10° (the default) and 30°.

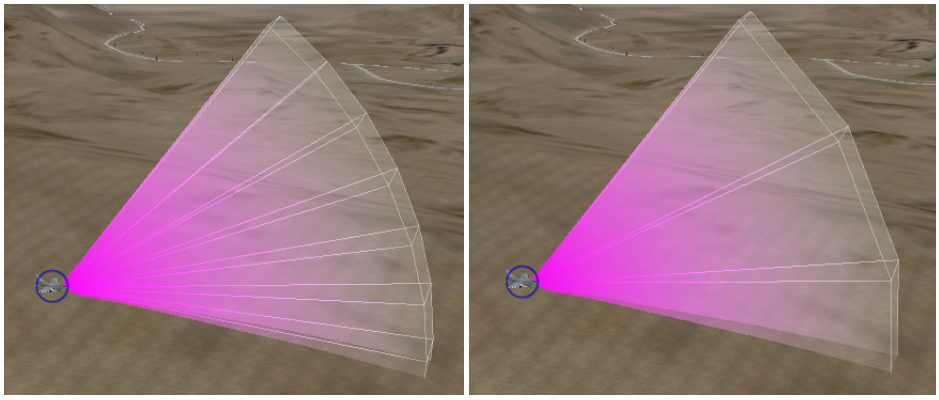


Figure 7-2. Emitter volume segments

Emitter volume segments are managed by the EllipsoidArc schema and model definitions based on it. VR-Forces ships with one ellipsoid arc model definition – DefaultEllipsoidArc. You can edit this model definition or create copies of it and customize them. If you want to have different emitter volumes for different entities, assign a different ellipsoid arc model definition to each one.

Specifying the Segment Angle

To specify the segment angle:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Model Definition Editor page.
3. Click the Filter button (▾) and select EllipsoidArc. The ellipsoid arc model definitions are listed in the window.
4. Select DefaultEllipsoidArc (Figure 7-3).

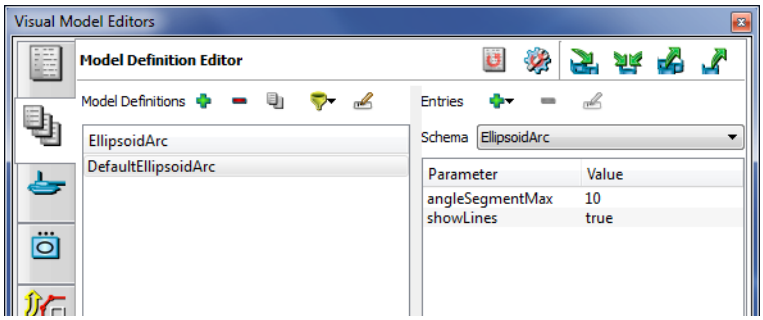


Figure 7-3. EllipsoidArc model definition

5. Change the value of the **angleSegmentMax** parameter. The minimum value is 10 (degrees); the maximum is 45.

Displaying Segment Outlines

By default, VR-Forces displays opaque outlines showing the segment edges along the surface of the emitter volume.

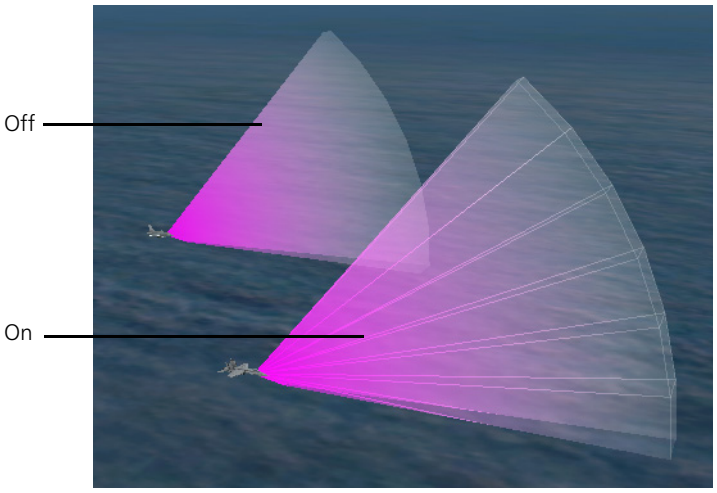


Figure 7-4. Segment outlines

To display or hide segment outlines:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Model Definition Editor page.
3. Click the Filter button (▾) and select EllipsoidArc. The ellipsoid arc model definitions are listed in the window.
4. Select DefaultEllipsoidArc.
5. Change the value of the **showLines** parameter.

Adding a Custom EllipsoidArc Model Definition

If you want to customize the segment angle and segment outlines for a particular entity without changing the values for other entities, you must create a separate ellipsoid arc model definition and add it to the entity's model definition.

To create a custom ellipsoid arc model definition:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Model Definition Editor page.
3. Click the Filter button (▾) and select EllipsoidArc. The ellipsoid arc model definitions are listed in the window.
4. Select DefaultEllipsoidArc.
5. Click the Duplicate Model Definition button (). The Duplicate Model Definition dialog box opens with a default definition name.
6. Accept the generated name or type a new name for the model definition.
7. Click OK. The model definition is added to the list.
8. Change the parameter values for the new model definition as desired.
9. Select the Entity Definition Editor page.
10. Select the entity whose emitter volume you want to change.
11. Select the 3D Sensor Volume visualizer for the entity.
12. Click the Value column for the **modeldefinition** attribute. The Choose Model Definition dialog box opens. It has a list of model definitions.
13. Select the model definition that you just created.
14. Click OK.
15. If you are connected to an exercise, disconnect and then reconnect to enable the new model definition.

7.8. Configuring Task Execution Rules

Each entity OPE file contains an entry for a task execution rule configuration file, named **task-execution-rules**. (The default rules file is *./data/simulationModel-Sets/default/vrfSim/taskRules/default-task-rules.tsk*.) The task execution rule file specifies whether or not tasks can be executed concurrently, and if so, which tasks are mutually exclusive.

The task execution rules file has the following parameters:

- **all-tasks-exclusive**. This parameter enables (False) or disables (True) use of concurrent execution of tasks. When True, the Task Manager executes only one task at a time, and the **mutually-exclusive-task-groups** parameter is ignored.
- **mutually-exclusive-task-groups**. This parameter is a list of groups. Each group contains a list of tasks that cannot be executed at the same time. Any time a task from a particular group is started by the Task Manager, any currently running task that is part of the same group is interrupted. Tasks that are part of other groups, or not part of any group, are allowed to continue running.

The task names that are listed in the **mutually-exclusive-task-groups** parameter are the names that are registered with the task factory when a task is added to the system. Groups can contain any number of tasks, and there can be any number of groups.

Tasks are always considered to be mutually exclusive with themselves. For that reason, it is impossible to execute two tasks of the same type at the same time on a single entity.



default-task-rules.tsk configures the tasks that come with VR-Forces and which were developed in C++. It does not include scripted tasks. Concurrency for scripted tasks gets set when they are created.

7.9. Configuring Joysticks

The *./appData/settings/vrfSim/joyParam.dat* file specifies the default values for joystick parameters. The parameters are:

- **joy-device-type** – Possible values are:
  - `direct-input-joydevice` – used for direct-input joysticks on Windows
  - `linux-joydevice` – used for joysticks on Linux.

  Default: `direct-input-joydevice`.
- **joy-trans-sensitivity** and **joy-rot-sensitivity**- affect the translation and rotation displacement required to make VR-Forces respond. The value should be between 0 and 1.0, with 0 being not sensitive at all, and 1.0 being the most sensitive it can be.
- **joy-trans-gain** and **joy-rot-gain** – affect the velocity of motion for a given displacement. The value is a multiplier, so the default value of 1.0 has no effect on the gain.
- **joy-trans-invert-x** (y, z) and **joy-rot-invert-x** (y, z) – allow you to invert axes on an individual basis.



- The joystick must be attached to the computer on which the entity is being simulated.
- Joystick configuration parameters are documented in the online help for the OPD Editor and in the context sensitive parameter descriptions for joystick controllers in the OPD Editor.

You can override the default values for joystick parameters for specific entity types in the object parameter database. Change the values in the joystick parameter block for the system definition file.

```
(joystick
  (component-descriptor-type "base-joy-controller-descriptor")
  (component-type "ground-move-joystick-controller")
  (joy-trans-sensitivity 0.3)
  (joy-rot-sensitivity 0.3)
  (joy-trans-gain 0.1)
  (joy-rot-gain 0.2)
)
(turret-joystick
  (component-descriptor-type "base-joy-controller-descriptor")
  (component-type  "ground-turret-joystick-controller")
  (joy-trans-sensitivity 0.8)
  (joy-rot-sensitivity 0.8)
  (joy-trans-gain 0.1)
  (joy-rot-gain 0.2)
  )
)
```

The rotary wing controller has some extra values that you can set, for example:

```
(joystick
  (component-descriptor-type "rotary-wing-joy-controller-descriptor")
  (component-type "rotary-wing-joy-flight-controller")
```

```
  ;; controller rise time. Default: 1.5
  ;; rotary-wing-joy-controller-descriptor only
  (controller-rise-time 1.6)

  ;; pitch feedback constant. Default: 1.0
  ;; rotary-wing-joy-controller-descriptor only
  (pitch-control-feedback-constant 1.0)

  ;; roll feedback constant. Default: 2.2
  ;; rotary-wing-joy-controller-descriptor only
  (roll-control-feedback-constant 2.265)

  ;; yaw feedback constant. Default: 2
  ;; rotary-wing-joy-controller-descriptor only
  (yaw-control-feedback-constant 2.1)
)
```

7.10. Configuring Obstruction Avoidance

You can configure ground entities to avoid specific entity types, vector features, or both.



The more vector feature types and entity types specified for avoidance, the more memory and processing power required.

Obstruction avoidance is influenced by the **stopping-distance-factor** and **lateral-clearance** parameters. If entities display erratic behavior, try raising the values, lowering the speed of the entities, or both.

7.10.1. Configuring Object Types

To specify the types of objects that an entity type should avoid, add or remove the appropriate object type from the obstruction sensor entry in the movement system definition file. For example, the following object types are configured for ground entities:

```
(object-type
  (object-type  1 (18 -1 -1 2 -1 -1 -1)) ;; vrfObstacles object type
  (object-type  1 (1 -1 -1 -1 -1 -1 -1)) ;; DtPlatform entity kind
  (object-type  1 (3 -1 -1 -1 -1 -1 -1)) ;; DtLifeForm entity kind
)
```

7.10.2. Configuring Vector Feature Types

Configuring avoidance of vector features relies on the attributes on the feature data as well as the named queries defined in *./appData/settings/featureconfig.txt*. To configure specific feature data for obstruction avoidance, modify the feature-types-to-avoid type list in the obstruction sensor in the appropriate system definition file. The types in this file are named feature queries, and you can add as many as you need.

Example of *human.sysdef*:

```
(obstruction-sensor
  ...
  (feature-types-to-avoid
    (type "MAK_OBSTACLE")
  )
)
```

Example of *air-cushion-default.sysdef*. This entity specifically calls out building, infrastructure, and vegetation, instead of obstacle, because obstacle also includes waterway.

```
(obstruction-sensor
  ...
  (feature-types-to-avoid
    (type "MAK_BUILDING")
    (type "MAK_INFRASTRUCTURE")
    (type "MAK_VEGETATION")
  )
)
```

7.11. Configuring Embarkation

Entities that are configured to allow other entities to embark on them have an occupancy-director-controller component. Its parameters configure embarkation, as follows:

- The locations at which entities can embark on an entity are configured as **ingress-points**.
- The locations from which entities can disembark are configured as **egress-points**.
- The number of entities that can embark on an entity is defined by the **embarkation-slots** parameter.

The **embarkation-slots** parameter has one or more **embarkation-slot-entry** parameters that identify a location on the entity where an embarked entity can be placed. The **embarkation-slot-entry** parameters also specify the orientation of the embarked entity and the types of entities that can occupy the slot.

The **ingress-points** and **egress-points** parameters each have one or more **load-entry** parameters. The **load-entry** parameters specify one or more **load-entry-point** parameters. If there is one **load-entry-point**, an embarked entity enters the parent entity at that point and is immediately placed in an available slot. If a **load-entry** has multiple load entry points, they specify the points in a route that the embarking entity follows to reach its slot. This configuration is for large parent entities, such as aircraft carriers, on which entities land and then taxi to a slot.

You configure embarkation in the Entity Editor. For details, please see "Configuring Embarkation," on page 5-45.

7.12. Configuring VR-Forces Components on Remote Entities

You can attach VR-Forces sensors, actuators, and controllers to remote (non-VR-Forces) entities. This feature allows you to add to the capabilities of the remote entity and better integrate it with the VR-Forces simulation. For example, you could add a radio to an entity or you could enable spot reporting. When you attach a component to a remote entity, you can write a plan for that entity that uses the attached components. For details, please see Section 9.9, "Writing Plans for Remote Entities," in *VR-Forces Scenario Management Guide*.

VR-Forces includes an example scenario, remoteAttachment, that uses remote attachment. Its use requires that you run an external application, the f18 example that comes with VR-Link. For details about how to run the scenario, please see the readme file in *./data/scenarios/remoteAttachment*.

When you add a component to a remote entity, the application that is simulating the entity is responsible for updating its position and health status. VR-Forces simulates the attached components. You can specify that VR-Forces simulate the components on one back-end or across all back-ends.

Simulation of components on remote entities has the following limitations:

- Only individual platforms and lifeforms can attach components. Aggregates and environmental process objects are not supported.
- VR-Forces components cannot control the remote entities. That is, they cannot alter its position or state. Therefore, you should not attach components such as movement systems to remote entities, because they will have no effect on the entities. Similarly, components that expect to be attached to a locally simulated entity such as an articulated part, may not work properly when attached to remote entities.

Components are attached to remote entities on the basis of entries in a component attachment table. The component attachment table provided by VR-Forces is *./data/simulationModelSets/default/extra/componentAttachmentTable.mtl*.

The component attachment table associates entities with attachment key-names. The following is a sample component attachment table:

```
(remote-configurations
  (attachment-entry
    ;; CIS MIG 29
    (attach-by object-type (obj-type 1 (1 2 222 1 2 1 -1)))
    (key-name "mig29-config")
  )
  (attachment-entry
    ;; US F-18
    (attach-by object-type (obj-type 1 (1 2 225 1 9 -1 -1)))
    (key-name "f18-config")
  )
)
```

The entries in this table associate the key-names mig29-config and f18-config with appropriate entity type enumerations. You can also associate a key-name with marking text, as follows:

```
(attachment-entry
  (attach-by marking-text “HMMWV 1)
  (key-name "hmmwv-attachments")
)
```

The key-names in the component attachment table have corresponding entries in *vrfSim.opd* in the remote-configurations block, as follows:

```
(remote-configurations
  (remote-configuration
    (key-name "f18-config")
    (configuration-path "$(remote-config-dir)/f18.mtl")
  )
  (remote-configuration
    (key-name "mig29-config")
    (configuration-path "$(remote-config-dir)/mig29.mtl")
  )
)
```

The key-names are associated with specific configuration files, which by default are located in *./data/simulationModelSets/default/vrfSim/remoteConfigurations*. The configuration files contain the components that are to be attached to the remote entity. For examples, please see the files in the *remoteConfigurations* directory.

8

Using VR-Forces with an External Comms Effects Server

This chapter explains how to configure VR-Forces to interoperate with an external communications effects server.

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Enabling Radio Transmitter Publishing 8-3
Enabling the External Communication Model 8-3
Configuring the External Communications Model 8-4
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Example Scenario 8-6
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8.1. Introduction

You can configure VR-Forces to use an external communications effects server to control the transmission of radio messages between VR-Forces entities. The communications effects server determines which entities are able to communicate with each other, and how long it takes a message to be transmitted from the originator of the message to the receiver of the message.

VR-Forces supports the interface specified in the file *./doc/QualNet_HLA_interface_RPR-FOM 1.0_extensions_ICD3.pdf*. This Interface Control Document (ICD) was created by Scalable Network Technologies and is distributed with their permission. Any communications effects server that conforms to this interface can be used with VR-Forces.

8.2. Configuring VR-Forces

By default, VR-Forces is configured to use a simple internal communications effects model that allows all messages to be passed to their recipients. To use an external communications effects server, you must:

- Enable the publishing of radio transmitters for any entity types that will be sending messages though the communications effects server.
- Set the external communications model as the communications model to be used by VR-Forces.
- Configure the external communications model.

8.2.1. Enabling Radio Transmitter Publishing

The external communications model requires that any entities sending or receiving messages though the communications effects server publish a DIS or HLA radio transmitter object. By default, VR-Forces entities do not publish this object. You can enable publishing of transmitters for individual entities or for all entities. Enabling publishing for all entities is done through the GUI. For details, please see "Enabling the External Communication Model," on page 8-3.

To enable publishing of the radio transmitter object for an entity:

1. In the OPE file for each entity type for which you want to enable radio transmitter publishing, locate the **radios** block.
2. Change the **publish-transmitter** parameter to True for each radio, for example:

```
(radios
  (main-radio
    (radio-descriptor-type "radio-descriptor")
    (radio-type  "default-radio")
    (comm-model-name  "default-radio-model")
    (publish-transmitter True)
    (transmitter-params
      (radio-type  7 1 225 2 1 20)
      (initial-frequency  3000000.000000)
      (power  30.000000)
    )
  )
)
```

8.2.2. Enabling the External Communication Model

You can enable external communication in the front-end or by editing *./data/simulationModelSets/<model_set>/commModelParams.mtl*. When you enable the external communication model in the front-end, VR-Forces also enables publishing of transmitters on all entities that have radios. When you change the communication model setting, it gets saved. The next time you run VR-Forces, the saved setting is used.

! When you change the communication model setting, existing transmitters are destroyed and new transmitters are created. Therefore, changing this option while running a scenario with QualNet will cause QualNet to no longer recognize the transmitters being published.

➤ To enable or disable the external communication model, choose **Settings** → **Use External Communication Model**.

Enabling the External Communication Model in *commModelParams.mtl*

To enable the External Communications Model, edit the file *./data/simulationModel-Sets/<model_set>/commModelParams.mtl*. This file defines the communication models available to the scenarios. By default, VR-Forces is configured to use the **simple-radio-comm-model**, which allows all communication between entities to be received.

➤ To use an external server for all radio communication, comment out the **simple-radio-comm-model** block, and uncomment the **external-comm-model** block.

This causes the external server to be used for all radio communication.

8.2.3. Configuring the External Communications Model

If you enable the external communications model, you can set the following configuration options in *commModelParams.mtl*:

- **use-actual-message-size** specifies how the size of the messages will be modeled. When a message is sent using the external communications model, a message size is sent to the external communications effects server, and that number may affect how long it takes for the message to reach its recipient. If this parameter is set to True (the default), the actual number of bytes of the VR-Forces message is used for this size value. This includes the VR-Forces message header of the sender or recipient and the contents of the message. If this parameter is set to False, the size specified by **substitute-message-size** is used for all messages.
- **substitute-message-size** specifies the message size, in bytes, to send to the external communications effects server. It is used only if **use-actual-message-size** is False.
- **message-timeout** specifies the timeout value, in seconds, for messages sent to the communications effects server. Messages that are not delivered to the server by the end of the timeout period are dropped.

8.3. Using VR-Forces with QualNet

To use VR-Forces with QualNet, it must be configured to use the external communications effects server, as described in "Configuring VR-Forces," on page 8-2. Please note the following requirements:

- QualNet only supports particular network configurations. Please refer to the QualNet documentation for details.
- If you are using the MÄK RTI, you must run the rtiexec.
- You must create a QualNet scenario that matches the VR-Forces scenario to be run using QualNet as the communications effects server. You can do this by hand, or using the QualNet HLA Extractor tool. Please see the documentation provided with the HLA Extractor for instructions on its use.



A version of QualNet is available that is specially configured to work well with VR-Forces. Please contact your QualNet or MÄK salesperson for details about this version of QualNet. Other versions of QualNet are also compatible with VR-Forces, but require additional configuration to work with it. Please see QualNet documentation and or contact QualNet support to configure it to work with VR-Forces.

8.3.1. Running VR-Forces with QualNet

To use VR-Forces with QualNet, the two programs must be loaded and scenarios started in the following sequence:

1. If you are using the MÄK RTI, start the rtiexec. If you are using a different RTI, run its equivalent server application.
2. Start QualNet and load the desired QualNet scenario. (Right click the *.config* file, and choose Run.)
3. Start VR-Forces, and load the VR-Forces scenario.
4. After all entities have been displayed in the VR-Forces GUI, click the Play button on the QualNet interface.
5. Run the VR-Forces scenario.

- If you want to load a new VR-Forces scenario, you must stop the QualNet scenario and load a new QualNet scenario using the procedure described in this section.
- The VR-Forces rewind functionality does not work correctly with QualNet. To replay a scenario you must restart QualNet and VR-Forces as described in the procedure.

8.4. Example Scenario

VR-Forces includes an example VR-Forces scenario and a matching QualNet scenario to demonstrate the interoperability of VR-Forces and QualNet.

In the scenario, the M1A2 1 tank commands the UAV to fly over the area where the opposing forces are and send back spot reports. When the first tank receives spot reports, it commands the second one to move to the waypoint, and also moves there itself. All commands and spot reports are sent though the radio, which is passed though QualNet. View the plans for M1A2 1 and UAV 1 to see the details of how they are communicating.

If none of the entities start moving after 10 seconds of running, there is probably an error communicating with QualNet.

8.4.1. Running the Scenario

To run the scenario, use the following steps:

1. Start your RTI. If you are using the MÄK RTI, run the rtiexec.
2. Run QualNet.
3. In the QualNet window, select the Scenario Designer tab.
4. Expand the file system tree for the *scenarios* folder.
5. Expand the tree for the *vrforces-CommsDemo* scenario.
6. Right-click *vrforces-CommsDemo.config*. A menu is displayed.
7. Choose **Run Scenario**. QualNet loads the scenario and creates a federation.
8. Start VR-Forces. Be sure that you use a simulation connection that matches the protocol that QualNet is using. If you are using HLA, be sure that you connect to the same rtiexec as you did for QualNet.
9. Choose **Settings** → **Use External Communication Model**.
10. Click OK.
11. Open the *NetworkCentricForces/vrforces-CommsDemo* scenario. When the scenario is fully loaded, the Run button on the QualNet toolbar should become enabled. If it does not, there may be a communication problem between the two applications.
12. Click the Play button on the QualNet toolbar.
13. Run the scenario in VR-Forces.

9

Display Engine Configurations

This chapter explains how to add and configure windows and channels and how to save display engine configurations.

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9.1. The Display Engine

The VR-Forces front-end has a component called a display engine. The display engine renders 3D and 2D data and can display data in one or more windows, which can each have zero or more channels. The windows and channels being rendered at any particular time make up a display engine configuration. You can save display engine configurations and can load them to quickly recreate a particular configuration.

9.1.1. Window Types

VR-Forces supports the following types of windows:

- Full screen. A full screen window uses the entire area of a monitor. It does not have any menus, panels, or other GUI controls.
- Resizable. A resizable window can be moved, resized, maximized, and minimized. It does not have any GUI controls. An inset view is an example of a resizable window. (For information about inset views, please see "Inset Views," on page 8-9, in *VR-Forces Users Guide* .)
- Embedded. An embedded window is part of an application. The main display window in the VR-Forces front-end is an embedded window. The application provides a variety of controls that affect the view in the window. You could, if you wanted to, change VR-Forces's window to a different type, in which case it would no longer be embedded in the ~~-~~main application~~VR-Forces~~ window.

A window can have zero or more channels. Each channel defines a viewable area on the screen. You must have at least one channel to see a rendered image in the window. Each channel can have its own observer.

9.2. Managing Display Engine Configurations

A VR-Vantage application has one display engine. You can add windows to the display engine and you can add channels to the windows. The windows and channels make up a display engine configuration. You can save a display engine configuration and load a saved configuration.

9.2.1. Adding a Window

You can add as many windows as you want. New windows are named Window 2, Window 3, and so on. Each window is created with one channel. You can add new windows from the File menu or in the Display Engine Configuration Editor.

➤ To add a window from the File menu, choose **File** → **New Stealth Window** (or **New Plan View Window**). A new window opens (Figure 9-1).

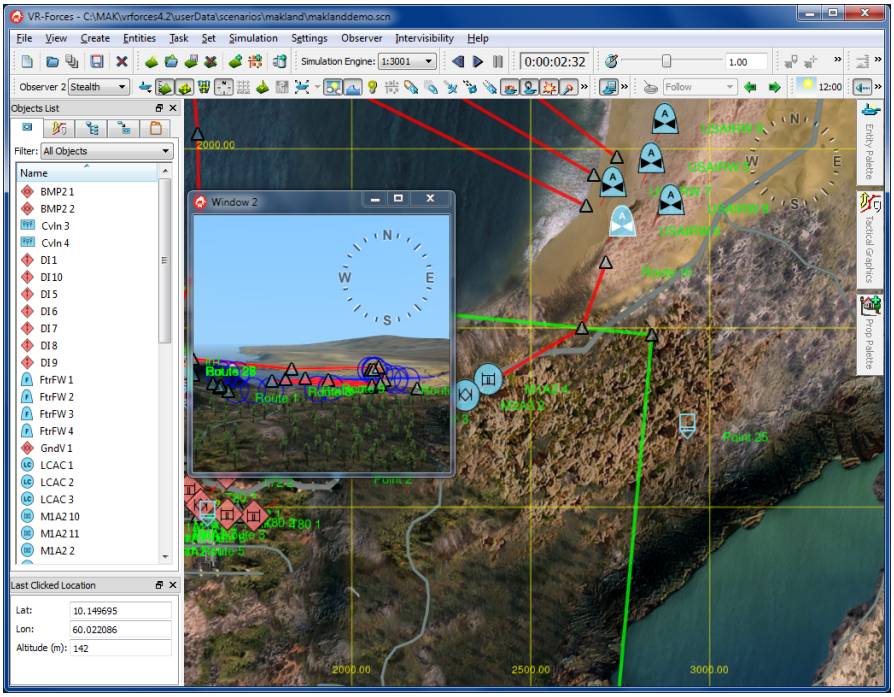


Figure 9-1. New window

To add a window from the Display Engine Configuration Editor:

1. Choose **View** → **Display Engine Configuration Editor Panel**. The Display Engine Configuration Editor Panel is added to the VR-Forces window (Figure 9-2).

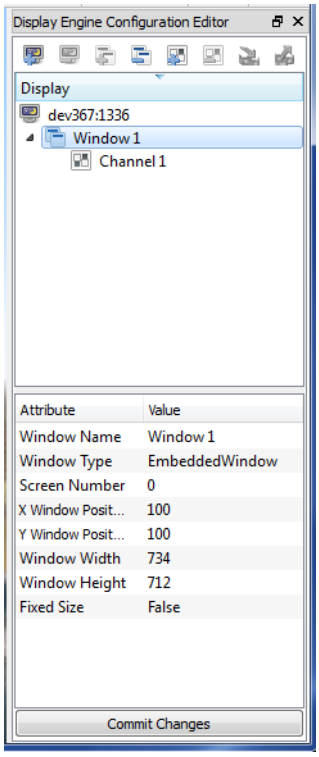


Figure 9-2. Display Engine Configuration Editor Panel

2. Select the display engine at the top of the Display tree.
3. Click the Add a Window ~~icon~~button (), or right-click the display engine name and choose **Add a Window** on the context sensitive menu. A new window opens and is listed in the Display Engine Configuration Editor Panel (Figure 9-3).

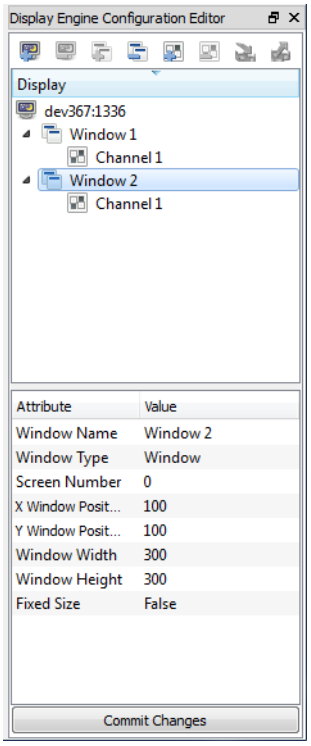


Figure 9-3. New window

9.2.2. Adding a Channel to a Window

Adding a channel to a window lets you configure multiple views within that window.

To add a channel to a window:

1. In the Display Engine Configuration Editor Panel, select the window to which you want to add a channel.
2. Click the Add a Channel ~~icon~~button (), or right-click the window name and choose **Add a Channel** from the menu.



To see a difference between the channels, change the attributes of the new channel (Figure 9-10). For details about editing channel attributes, please see "Changing a Channel's Attributes," on page 9-8.

9.2.3. Removing a Window

To remove a window:

1. In the Display Engine Configuration Editor Panel, select the window that you want to remove.
2. Click the Remove Window ~~icon~~button (), or right-click the window name and choose **Remove Window** from the menu.

9.2.4. Removing a Channel

To remove a channel:

1. In the Display Engine Configuration Editor Panel, select the channel that you want to remove.
2. Click the Remove Channel ~~icon~~button (), or right-click the window name and choose **Remove Channel** from the menu.

9.2.5. Saving a Display Engine Configuration

You can save a display engine configuration so that you can easily replicate the configuration at a later time.

To save a display engine configuration:

1. Click the Save Display Engine Configuration ~~icon~~button (), or right-click the name of the display engine and choose **Save Display Engine Configuration** on the menu. The Save Display Engine Configuration dialog box opens.
2. Type a name for the display engine configuration.
3. Click Save.

9.2.6. Loading a Display Engine Configuration

To load a display engine configuration:

1. In the Display Engine Configuration Editor Panel, select the display engine at the top of the window.
2. Click the Load Display Engine Configuration ~~icon~~button (), or right-click the name of the display engine and choose **Load Display Engine Configuration** on the menu. The Load Display Engine Configuration dialog box opens.
3. Select the display engine configuration you want to load.
4. Click Open.

9.3. Changing a Window's Attributes

You can change the following attributes of a window:

- Window Name.
- Window Type (for details about window types, please see "Window Types," on page 9-2).
- Screen Number.
- Position (X, Y coordinates of upper left corner, in screen pixels).
- Width and height, in pixels.
- Fixed size.

To change a window's attributes:

1. Select the window in the Display Engine Configuration Editor Panel. A list of attributes is displayed at the bottom of the editor (Figure 9-2).
2. Click the value of the attribute that you want to change.
3. To change a numeric value, type or select a ~~new~~ value ~~or use the spin control to change the value~~.

   To change the Window Type or Fixed Size, select a value from the ~~drop down list~~list.

   To change the name, type a new name.
4. Click Commit Changes. The window is updated.



You can also change a window's position by dragging it to a new location. You can change its size by resizing the window directly. The new values are shown in the attributes list the next time you select the window in the Display Engine Configuration Editor Panel.

9.4. Changing a Channel's Attributes

You can change the following attributes of a channel:

- Channel Name.
- Observer Name.
- Sensor. Use the sensor configured for the current observer, or override the observer and use one of the listed sensors.
- Projection Units – field of view, in angles, or database, in meters.
- Projection Resize Policy – fixed, vertical, or horizontal.
- Frustum (Left, Right, Top, and Bottom) (field of view).
- Z Near and Z Far (clipping planes).
- Near Far Clip Policy.
- Reduce Z Fighting Ratio.
- Dynamic Near Clip Attached Policy
- Attached Near Clip Altitude.
- Fixed Near Clip When Attached.
- Dynamic Water Visibility Enabled.
- Dynamic Water Visibility Maximum.
- ~~Dynamic Near Far Planes.~~
- ~~Parent Channel.~~
- Camera Position Offset (X, Y, Z).
- Camera Orientation Offset (Psi (heading), Theta (pitch), Phi (roll)).
- Viewport (Left, Right, Bottom, Top).
- Keywords – keywords to associate with the channel, for example, "showCockpits".

To change a channel's attributes:

1. Select the channel in the Display Engine Configuration Editor Panel. A list of attributes is displayed at the bottom of the editor (Figure 9-4).

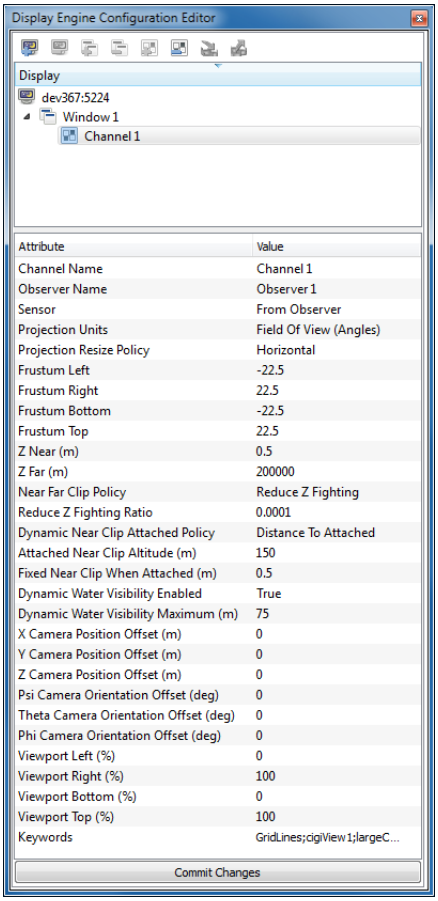


Figure 9-4. Channel attributes

2. Click the value of the attribute that you want to change.
3. To change a numeric value, type or select a new value ~~or use the spin control to change the value~~.

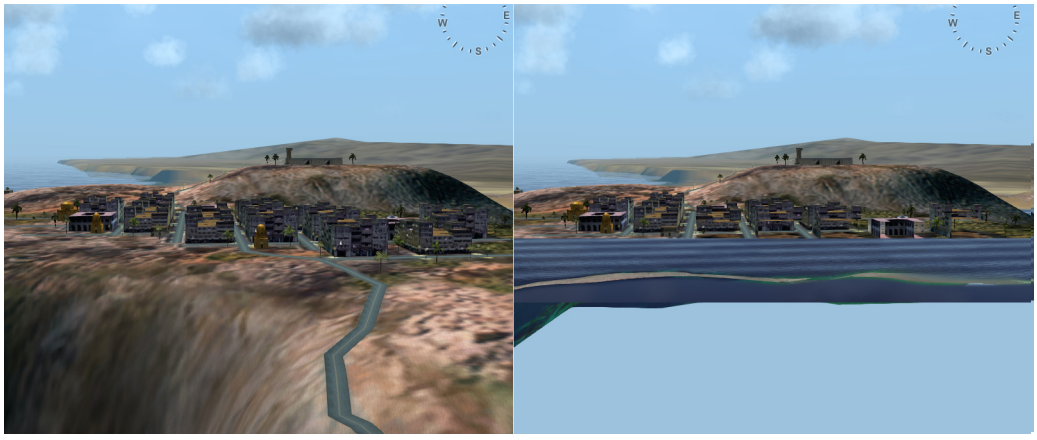
   To change the Observer Name, Sensor, Project Units, Projections Resize Policy, or Parent Channel, select a value from the ~~drop-down list~~list.

   To change the Channel Name, type a new name. (For details about some of these attributes, please see the sections that follow this one.)
4. Click Commit Changes. The window is updated.

9.4.1. Setting the Clipping Planes

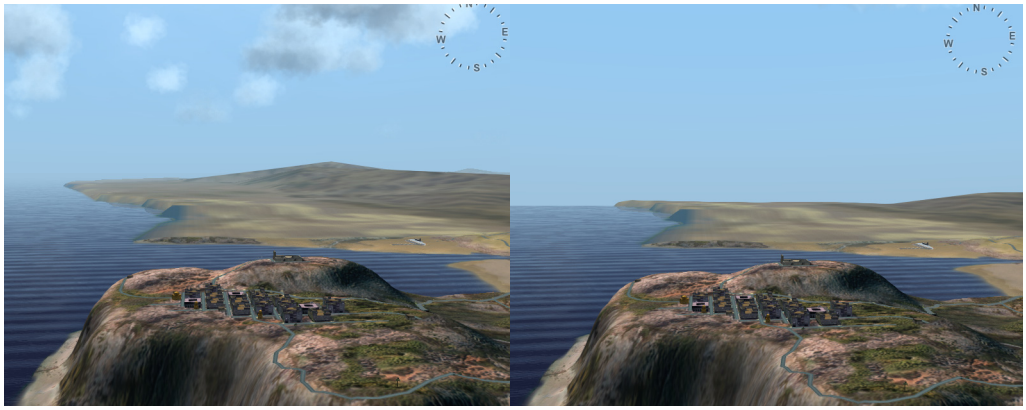
To improve performance, the graphics engine does not render anything that falls outside of a specified range of distances from the observer. This range is determined by the near and far clipping planes. Clipping planes are set an a per-channel basis.

Figure 9-5 illustrates the effect of changing the near clipping plane (the attribute). Figure 9-6 illustrates the effect of changing the far clipping plane (the Z Far attributes).



Z Near = 1 Z Near = 500

Figure 9-5. Near clipping



Z Far = 10000000 Z Far = 10000

Figure 9-6. Far clipping

The ratio between the far clipping plane and the near clipping plane determines the precision with which the renderer can determine differences in depth. If this ratio becomes too small, then terrain and objects that are distant may not sort correctly, resulting in what is referred to as Z-fighting. VR-Forces provides different policies for managing the way near and far clipping planes are determined.

VR-Forces sets the clipping planes using one of the following policies (the Near Far Clip Policy attribute), plus their modifiers:

- Fixed. Clipping planes are set explicitly using the Z Near and Z Far attributes.
- Reduce Near Clip. Clipping planes are adjusted dynamically based on the observer's altitude. The near clipping plane is increased slightly as the observer rises to 20,000 meters, but stays under 1.5 meters. When the observer rises above 20,000 meters, the near and far clipping planes gradually increase. The Reduce Near Clip policy can be modified by the Dynamic Near Clip Attached Policy.
- Reduce Z Fighting. Clipping planes are set based on a ratio of the near clipping plane to the far clipping plane (the Reduce Z Fighting Ratio attibute). The near clipping plane can get as large as needed to maintain the ratio. This policy is the default clipping plan policy. The Reduce Z Fighting policy can be modified by the Dynamic Near Clip Attached Policy.

The Reduce Z Fighting clipping plane policy greatly reduces Z-fighting when you are using dynamic ocean. However, if the observer is attached to an entity and its altitude is moderately high, it may be closer to the entity than the near clipping plane and the entity may be clipped away. You can adjust the ratio to provide the best results. If you are not using dynamic ocean or you are frequently attaching to entities, you may want to use one of the other clipping plane policies.

If you set the Near Far Clip Policy to Reduce Z Fighting or Reduce Near Clip and the observer is attached to an entity, VR-Forces can dynamically change the near clipping plane based on the Dynamic Near Clip Attached Policy, as follows:

- Ignore Attached. Do not take entity attachment into account when setting the near clipping plane.
- Fixed Near Clip. Set the near clipping plane to the value of the Fixed Near Clip When Attached attribute if the observer altitude is >= the value of the Attached Near Clip Altitude attribute.
- Distance To Attached. Use the distance between the observer and the attached entity to determine the near clipping plane if the observer altitude is >= the value of the Attached Near Clip Altitude attribute. When this policy is selected, VR-Forces compares the near clipping value without this modifier to the value with it and uses the smaller of the two values. This is the default policy.

9.4.2. Specifying the Projection Resize Policy Attribute

The Projection Resize Policy determines how a channel behaves when you resize it. The options are:

- Fixed. Keep the aspect ratio the same regardless of how the window is resized.
- Horizontal. Maintain the horizontal aspect ratio when the window is resized.
- Vertical. Maintain the vertical aspect ratio when the window is resized.

Figure 9-8 illustrates the effect of different resize policies, as follows:

- In the window with the fixed resize policy, all of the visual data in the initial view is still in the resized view, although the vertical dimensions are distorted.
- In the window with the horizontal resize policy, the field of view is widened to maintain the correct aspect ratio of the visual data.
- In the window with the vertical resize policy, the field of view is shortened.

You can change the projection resize policy for individual channels by editing the Projection Resize Policy attribute. You can also change the projection resize policy for all channels.

To change the projection resize policy for all channels:

1. Choose **Settings** → **Display**. The Display Settings dialog box opens.
2. Select the Render Settings page (Figure 9-7).

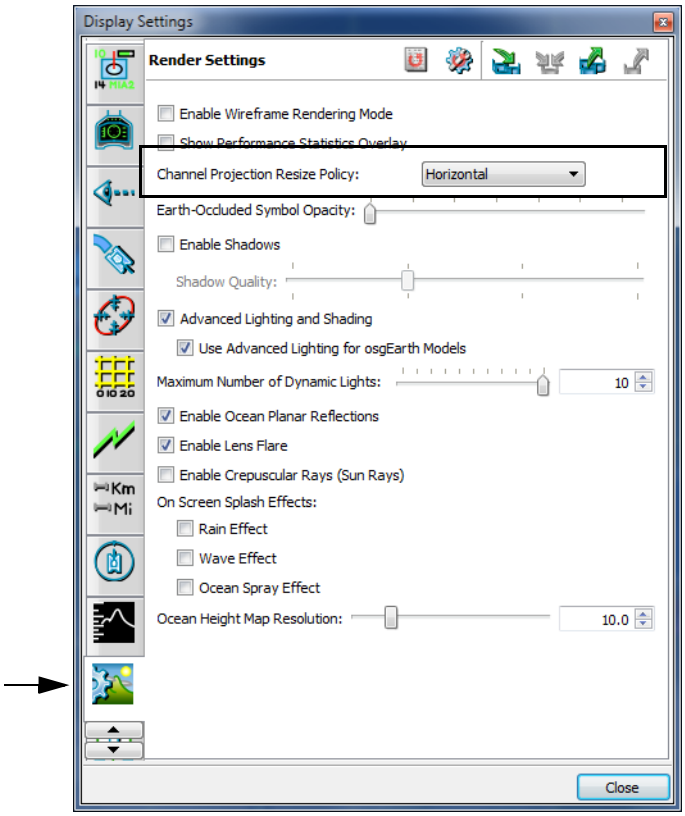
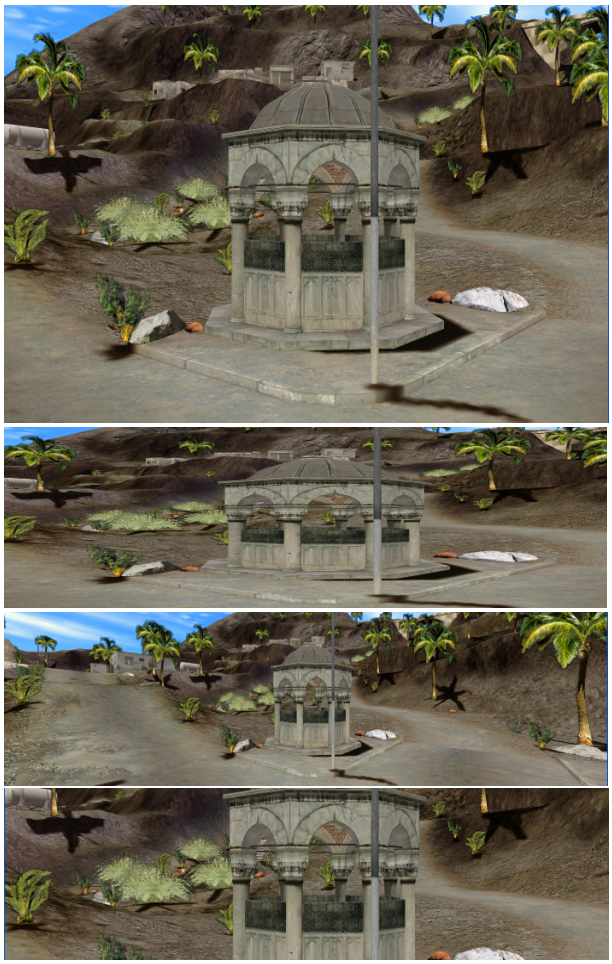


Figure 9-7. Display Settings, Render Settings page

3. Select an option on the Channel Projection Resize Policy ~~drop-down list~~list.



Initial view

Resized with Fixed resize policy

Resized with Horizontal resize policy

Resized with Vertical resize policy

Figure 9-8. Effect of different projection resize policies

9.4.3. Changing a Channel's Frustum (Field of View)

The field of view setting affects perspective in a manner similar to a camera lens.

A wide field of view creates an effect like that of a wide-angle lens. Objects appear smaller and farther away from the observer, since the observer coverage spans a wider area. Depth distances between objects become exaggerated.

A narrow field of view creates an effect like that of a telephoto lens. Objects appear larger and closer to the observer, and the overall scene depth appears flattened. The distances between objects appears compressed.

Figure 9-9 illustrates different field of view settings. The view on the left has frustum values -30, 30, -30, 30. The view on the right has the frustum values -10, 10, -10, 10.

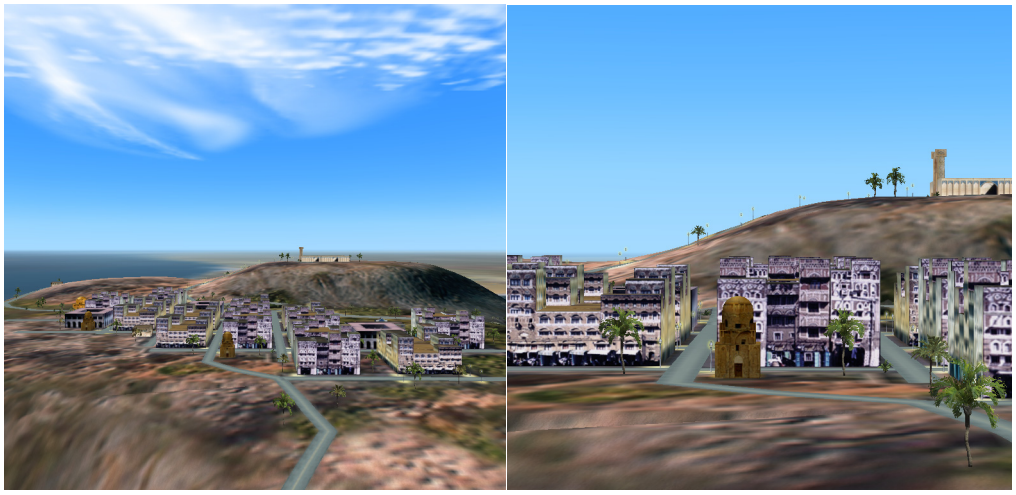


Figure 9-9. Field of view

➤ To change a channel's field of view, edit the frustum values in its attributes list.

9.4.4. Changing the Viewport

When you change the viewport of a channel, you change the portion of the window in which the channel is displayed. This does not change the extents of the scene. A narrow viewport compresses the scene width. A short viewport compresses the height. Figure 9-10 shows a window that has three channels, each with a different viewport. (The arrows show which portion of the window corresponds to each channel.) Notice that each channel has the same field of view.

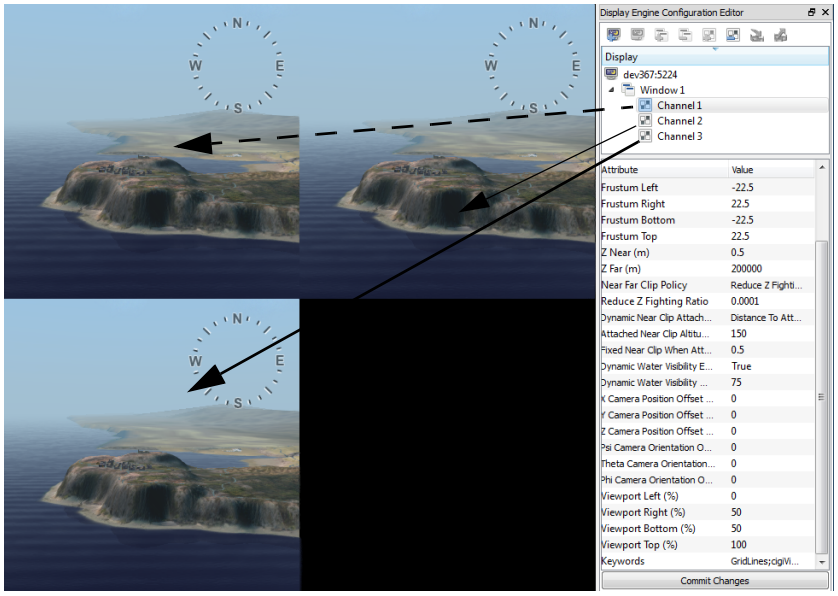


Figure 9-10. Window with three channels and three viewports

Viewports are specified as a percentage of the window from left to right and top to bottom. Figure 9-11 shows the percentage allocation for the viewports in (Figure 9-10).

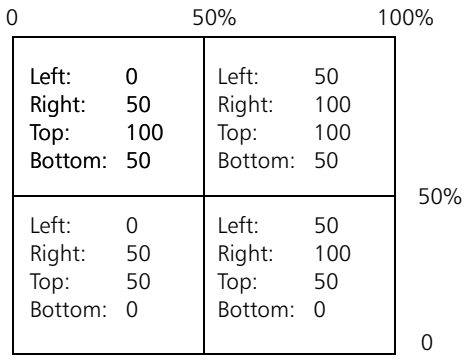


Figure 9-11. Viewport configuration



When you change viewports, the window might not completely refresh. To see the changes, resize the window.

9.4.5. Configuring Water Visibility

The water visibility attributes (along with the surface transparency setting on the Scene Settings dialog box) are designed to reduce Z fighting. Z-fighting occurs when the altitude of the ocean surface and the depth of the ocean floor are very close to each other, usually around coastlines that have bathymetry data. The likelihood of Z-fighting decreases as the difference between the ocean surface and ocean floor increases, but it increases as the observer's altitude increases (because the ocean surface and ocean floor are proportionally closer to each other). Therefore there is a dynamic relationship as these factors change.

Adding transparency to the water reduces Z-fighting. The Dynamic Water Visibility Enable attribute is used to increase transparency automatically as the observer's altitude increases. Dynamic Water Visibility Max specifies the maximum depth to which transparency is added (Figure 9-12).

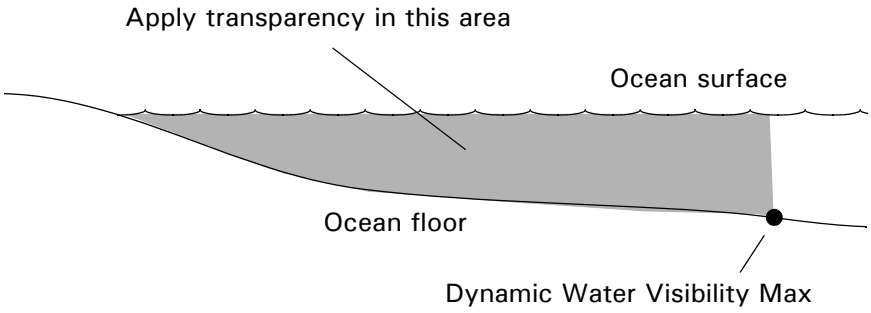


Figure 9-12. Dynamic water visibility

Dynamic water visibility is enabled by default. When Dynamic Water Visibility is enabled, VR-Forces increases the water visibility depth from the value set in the Scene Settings Dialog Box (at 0 meters altitude), to the maximum value specified here at the current Ocean LOD Elevation. The default depth is 75 meters. This value provides reasonable performance given the default Ocean LOD Elevation (5000 meters), the altitude above which VR-Forces stops displaying dynamic ocean. If you change the Ocean LOD Elevation so that dynamic ocean is displayed when the observer is higher than 5000 meters, Z-fighting may increase and you may need to increase the Dynamic Water Visibility Max value. (For details about setting the Ocean LOD Elevation, please see Section 10.5.3, "Setting the Ocean LOD Elevation,".)

There is no performance cost to enabling this attribute when you are not using dynamic ocean. If there are no underwater terrain polygons, these attributes have no effect.

9.5. Configuring Multichannel Displays

People running simulations often want to set up a multichannel configuration using multiple monitors (on one or more computers) to display exercises. Typical configurations are a horizontal alignment, which widens the view, and the angled alignment, which surrounds the observer to simulate an out-the-window view (Figure 9-13).

You could set up these display configurations by having one computer with several monitors attached, or you could have multiple computers, each running a VR-Forces front-end. You might also want to have a 2D view on one monitor and a 3D view on another.

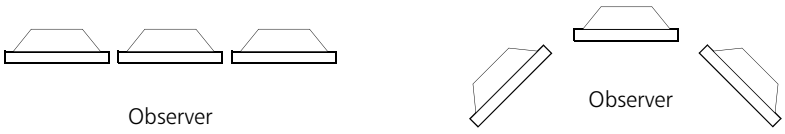


Figure 9-13. Multi-channel displays (top-down view)

By default, all windows and channels show the same view of the terrain (Figure 9-15, default window views). Therefore, if you want a setup in which each channel shows a different view of the terrain, you must configure the channels to calculate an offset from the master view.

The distribution of the view across multiple channels is controlled by the frustum. Figure 9-14 illustrates the default frustum for Channel 1. It has a 60° field of view, from -30° to +30°.

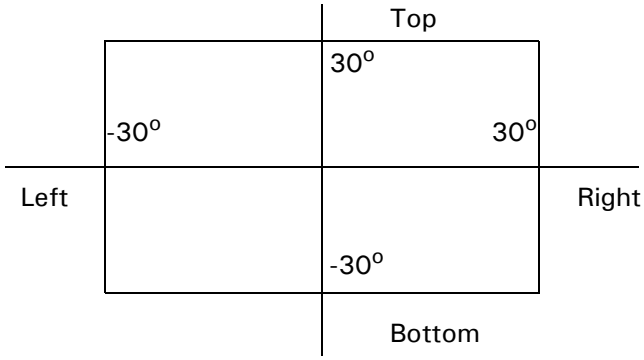


Figure 9-14. Default frustum for Channel 1

If you wanted to split the view into, for example, three horizontal channels, you would edit the left and right frustum values for each channel, as shown in Figure 9-15. The field of view is the same: -30° to +30°. However, now each channel shows a 20° segment of the total field of view.

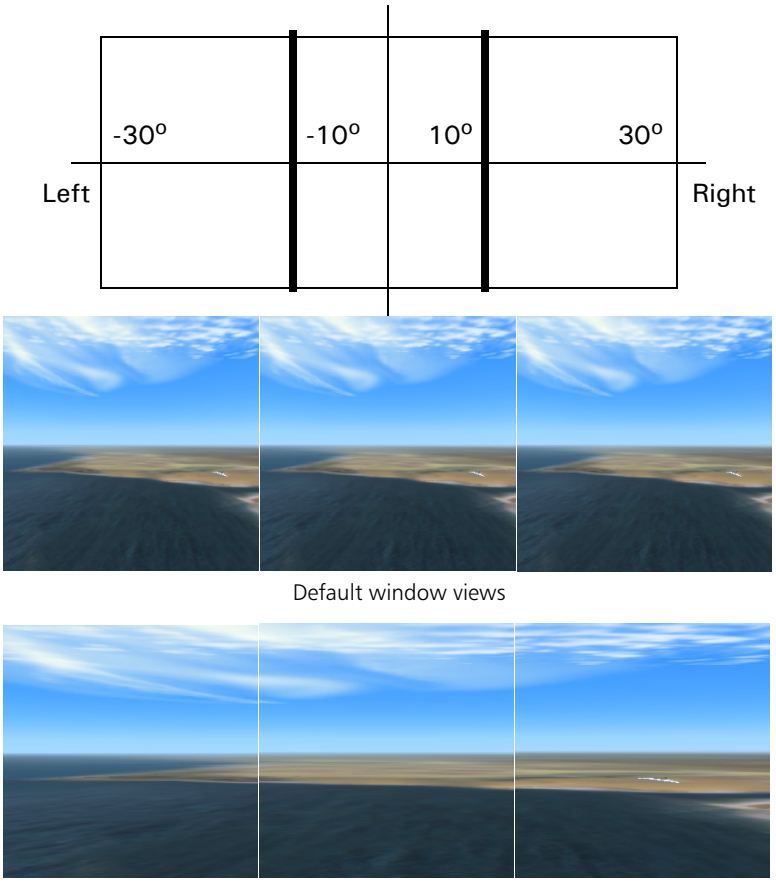


Figure 9-15. Frustum values for three channels

Once you configure the windows and channels you need to create the views you want, save the display engine configuration on each computer that you have configured. The next time you run the scenario, load the appropriate display engine configurations on each computer.

9.5.1. Changing the Camera's Position and Orientation Offset

Changing the frustum affects how much of the database is in the view. Changing the camera's position and orientation affects the point from which you look at the view. For example, imagine you are simulating the view from a vehicle, as in vehicle 1 in Figure 9-16. (The camera location is represented by the binoculars.)

If you wanted to show the view as experienced by a gunner riding in the back of the vehicle, or in a turret, you would change the X, Y, and Z camera position offsets in the channel's attribute list (vehicle 2).

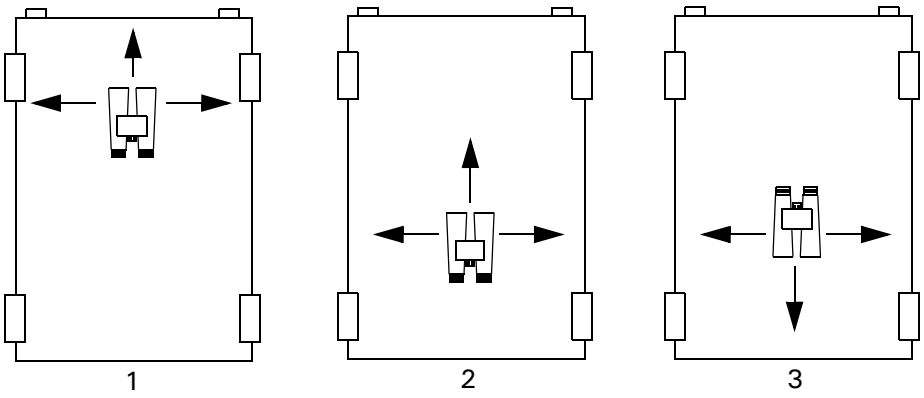


Figure 9-16. Position and orientation offsets

If you wanted the gunner to look out the rear of the vehicle, you would change its orientation, with the Psi (heading), Theta (pitch), and Phi (roll) Camera Orientation Offsets (vehicle 3).

9.6. Stereoscopic Displays

Stereoscopic display produces realistic three dimensional imagery by showing each of the viewer's eyes a different image, rendered from that eye's point of view. A stereoscopic display requires a system that can render two channels, one for each eye, and a method of displaying the correct channel to the correct eye of the viewer. Three common display methods are active stereo, polarized display, and anaglyphic stereo. OpenSceneGraph can support all three of these methods, and since VR-Forces uses OpenSceneGraph for most of its rendering, all three should be possible in VR-Forces.

- Active Stereo: In an active stereo setup, frames are alternated on the display for the left eye and the right eye, and a pair of shutter glasses blocks light to either the left or right eye in synchronization with the display. This method requires hardware support to synchronize the glasses to the display, along with a graphics card capable of quad buffering, and a display that can refresh at twice the desired frame rate. Active stereo should be possible with VR-Forces, but has not been tested.
- Anaglyphic Stereo: Anaglyphic stereo is the cheapest and simplest method to use. A typical setup is a display showing a red channel and a cyan channel simultaneously, along with a pair of glasses with one red lens and one cyan lens for the viewer. This will work with no special hardware aside from the inexpensive glasses. It is also the simplest method to set up in VR-Forces, requiring only that some OpenSceneGraph environment variables be set.
- Polarized Stereo: A polarized display shows the frames for both eyes simultaneously, but with their light polarized in different directions. The viewer wears glasses that have lenses polarized to match the two different frames, allowing each eye to see only the frame intended for it. Polarized stereoscopy requires some specialized equipment to display the images with the correct polarization. One simple method for producing this kind of display is to use two projectors with polarizing filters, projecting onto a rear projection screen. Monitors are available that can polarize the two frames. It is easy to configure a polarized display with VR-Forces.

9.6.1. Configuring Anaglyphic Stereo

You can configure OpenSceneGraph for anaglyphic stereo rendering through environment variables. To use VR-Forces in anaglyphic mode, run it with the environment variables described in Table 9-1.

Table 9-1: Environment variables for anaglyphic stereo

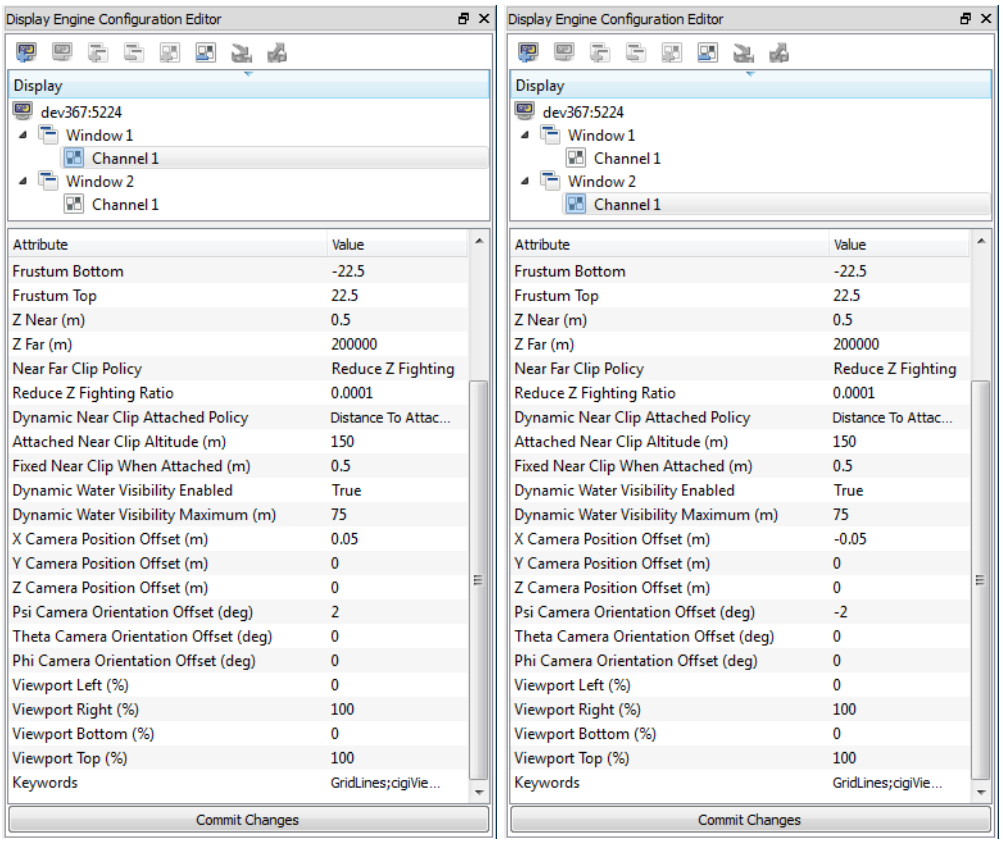
Environment Variable	Description	Default
OSG_STEREO	Turn stereo on.	ON
OSG_STEREO_MODE	Use anaglyphic stereo when in stereo.	ANAGLYPHIC
OSG_SCREEN_DISTANCE	Specifies the distance, in meters, that the viewer is from the screen.	0.50
OSG_SCREEN_HEIGHT	Specifies the height of the image, in meters, on the screen.	0.26
OSG_SCREEN_WIDTH	Specifies the width of the image, in meters, on the screen.	0.325
OSG_EYE_SEPARATION	Specifies the eye separation (interocular distance).	0.06

For more information, pleases see the OpenSceneGraph documentation at http://www.openscenegraph.org/projects/osg/wiki/Support/UserGuides/StereoSettings.

9.6.2. Configuring Polarized Stereo

You can configure polarized stereo by taking advantage of VR-Forces's ability to produce multichannel displays. You configure one channel per eye. Each channel renders with a camera that is at a slight offset from the other channel's camera to represent the spacing between the viewer's eyes.

Varying the eye spacing and focal length can produce different effects, and the best values may depend on what the viewer is looking at. Figure 9-17 shows an example configuration.



Left channel Right channel

Figure 9-17. Polarized stereo channel configurations

To compute the correct channel configuration values:

1. Pick a focal length, `L`. Objects at this distance will appear to be in the plane of the display. Objects that are further away will appear behind the display, and objects closer will appear in front of it.
2. Pick an eye spacing, `E`, to represent the distance between the viewer's eyes. Human eyes are typically about 0.063m apart (http://www.cl.cam.ac.uk/~nad10/pubs/EI5291A-05.pdf).
3. Set the X Camera Position values to `–E/2` meters for the left channel and `E/2` meters for the right channel.
4. Set the Psi Camera Orientation values to `–arctan(E/2)/L` degrees for the left channel and `arctan(E/2)/L` degrees for the right channel.

10

Composing Terrains

This chapter explains how to combine various types of data to build a terrain. For basic conceptual information about terrain agility, please see Section 3.11, "Terrain Databases," in *VR-Forces Users Guide*. "Composing a Terrain," on page B-2 is a tutorial that steps you through the entire process of creating a terrain.

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10.1. Creating a Composed Terrain

The general procedure for composing a terrain is as follows:

1. Choose **File** → **New Terrain**, or click the New Terrain button () on the Terrain Toolbar. If any terrain data is loaded, it is removed.
2. Add elevation data, as described in "Adding Elevation Data (Terrain Patches) to a Terrain," on page 10-5.
3. Optionally, add imagery, as described in "Adding Images to a Terrain," on page 10-7.
4. Optionally, add feature data, as described in "Adding a Feature Layer," on page 10-11.
5. Optionally, add a dynamic ocean layer, as described in "Adding a Dynamic Ocean Layer," on page 10-13.
6. Optionally, add props or extract props, as described in "Adding Props from a Feature Layer," on page 10-31 and "Extracting Props from a Terrain Patch," on page 10-29.
7. Save the terrain, as described in "Saving a Terrain," on page 10-4.

"Composing a Terrain," on page B-2 demonstrates how to create a composed terrain.

10.1.1. Considerations and Limitations for Building Terrains

As you compose a terrain, consider the following issues:

- VR-Forces supports DTED level 0, 1, and 2. DTED is loaded using a Flat Earth projection. The default post spacing for DTED level 0 is 1. For other levels it is 5. You can load a 1 degree cell.
- If you load more than one DTED cell, they will be placed on top of each other. If you need to load multiple DTED cells, use the MÄK Terrain Database Tool (TDB Tool) to create a GDB terrain composed of the DTED cells. Then load the GDB terrain into VR-Forces.
- The larger a terrain database is (as measured by the number of polygons), the more it will affect performance.

Loading DTED

By default, when you load DTED files as terrain patches, the files are loaded with their altitude referenced to WGS84. If you want the altitude to reference a different vertical datum (most likely EGM96), you must provide a geoid grid file for that vertical datum. If you use a geoid grid file, the altitudes in the DTED file are adjusted based on the information in the grid file.

To use a geoid grid file, set the environment variable MAK_GEOID_GRID to the path of the file.



This section does not apply to terrains loaded using an Earth file.

For information about EGM96 and geoid files, please see the following URL:

http://earth-info.nga.mil/GandG/wgs84/gravitymod/egm96/egm96.html

10.1.2. Saving a Terrain

When you save a terrain, VR-Forces saves information about the terrain patches, imagery, and feature layers that you used to create the terrain. Saving a terrain does not save out data to a file format comparable to OpenFlight or GDB that can be loaded into other applications or converted into other formats. If accelerated file loading is enabled, the data gets saved in a format that can be loaded more quickly than from its native format. (For details about accelerated file loading, please see "Configuring File Caching," on page 10-36.) Terrains get saved with the extension *.mtf*.



When you save a terrain to MTF, if an MTD file of the same name exists, a dialog box explains your options for saving the file. If you need to process the terrain in the TDB Tool, you can save it as GDB.

To save a terrain:

1. Choose **File** → **Save Terrain**, or click the Save Terrain button () on the Terrain Toolbar. The Save Terrain dialog box opens.
2. Type a name for the terrain.
3. Click Save.

10.2. Adding Elevation Data (Terrain Patches) to a Terrain

To build a terrain database, you load elevation data, imagery, and feature data. Then you save the data collection in MTF format. Elevation data is added as terrain patches. Note the limitations in "Considerations and Limitations for Building Terrains," on page 10-3.

! Each time you add a terrain patch, VR-Forces resets the origin and coordinate system. Therefore, if you add multiple terrain patches, any patches whose origin and coordinate system do not match the patch that is loaded last will not be usable.

To add a terrain patch to a terrain database:

1. Choose **Settings** → **Terrain**, or click the Add Terrain Patch button ( ) on the Terrain Toolbar.The Terrain Settings dialog box opens.
2. Select the Terrain Contents page(Figure 10-1).

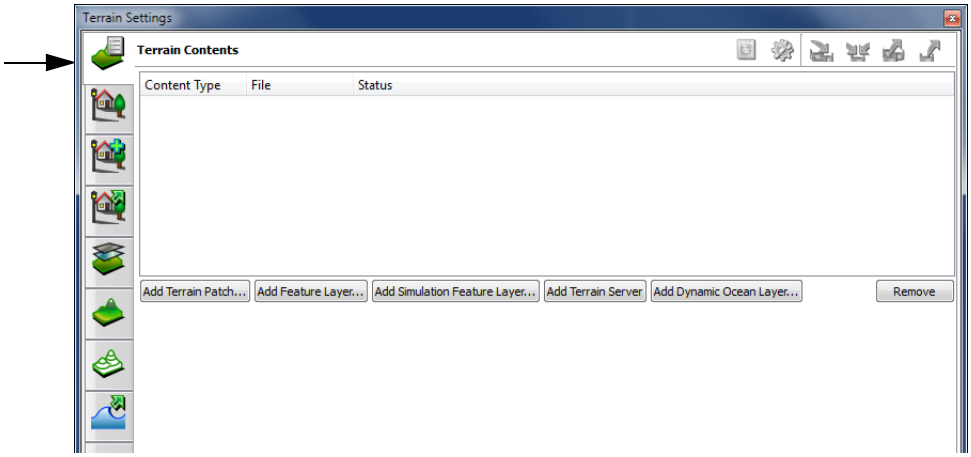


Figure 10-1. Terrain Contents page

3. Click Add Terrain Patch. The Add Terrain Patch dialog box opens and an Open dialog box opens on top of it.
4. Select a file in a supported format.
5. Click Open. The Add Terrain Patch dialog box displays details about the terrain patch (Figure 10-2).

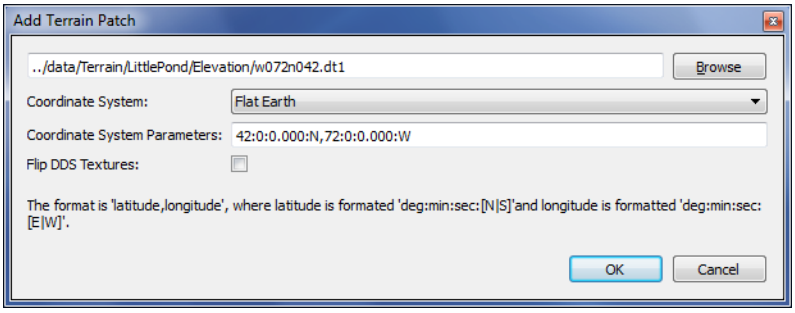


Figure 10-2. Add Terrain Patch dialog box

6. If the terrain patch has DDS textures that are upside down relative to VR-Forces's expectations, select Flip DDS Textures. This setting does not affect paged terrains. (For information about DDS textures, please see "Displaying DDS Textures Correctly," on page 10-38.)
7. Click OK. The terrain patch is added.
8. Optionally, add additional terrain patches.
9. Save the terrain.

10.3. Adding Images to a Terrain

Depending on your terrain source, you may have terrain polygonal data, but no texture data or feature data to provide a realistic 3D display. You can drape images (raster maps) over the terrain to provide a more pleasing display.

Adding very large images (multi-100 GB) may cause VR-Forces to crash. If you need to load very large images, load them using a *.earth* file and the GDAL driver. The *SanLuisObispo-Imagery.earth* file demonstrates how to load an image using this method. You can also use the GDAL driver to load raster formats that VR-Forces cannot load directly. For a list of formats supported by GDAL, go to http://www.gdal.org/ and select the Supported Formats link.

To add raster maps to the terrain:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Raster Maps page.
3. Click the Add button (+) that is above the list of raster maps. A line is added to the Raster Maps list (Figure 10-3).

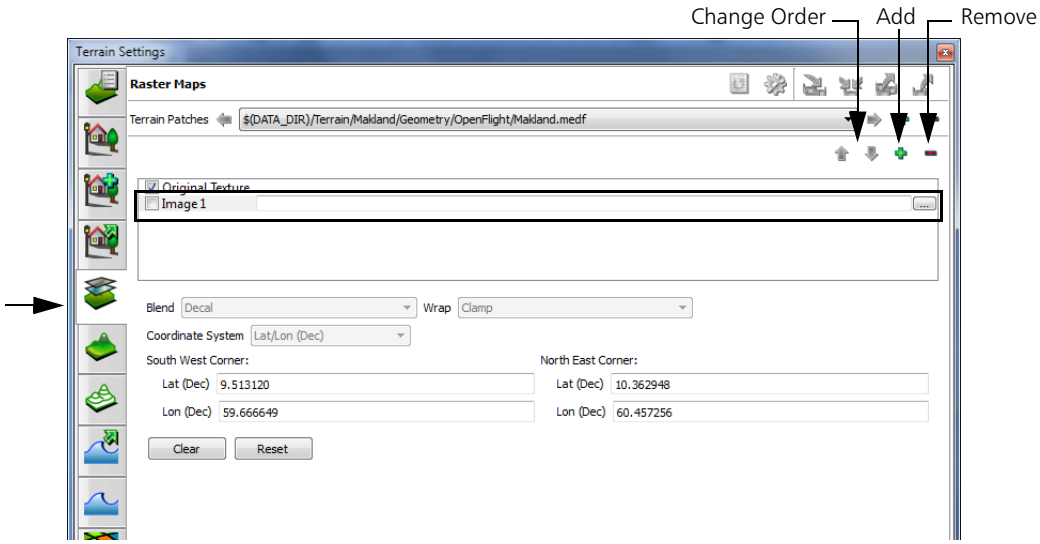


Figure 10-3. Raster Maps page

4. Click the Browse button to the right of the new line. The Image File dialog box opens.
5. Select the raster image that you want to add to the terrain.

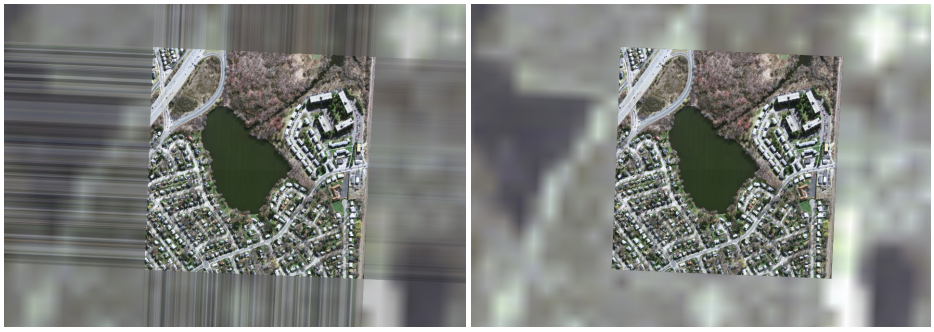
6. Click OK. The image is listed in the Raster Maps window. To view it in the window, select the check box to the left of the entry (Figure 10-4).



Figure 10-4. Making an image visible

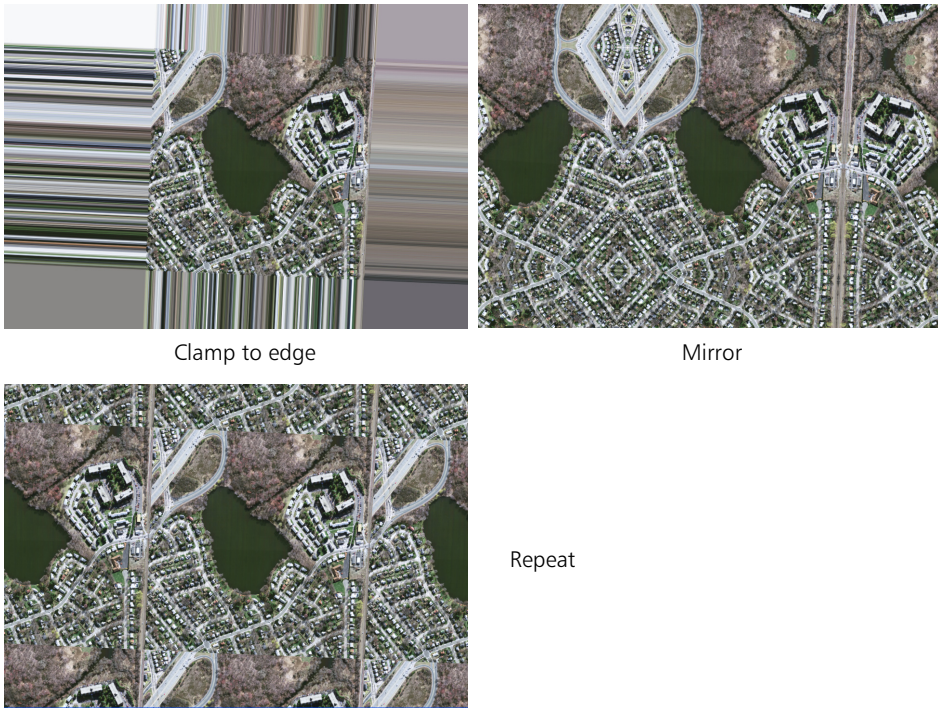
7. Optionally, specify the attributes of the image, as follows:
   - Blend specifies how the image interacts with underlying images, as follows:
     - Decal: covers the polygons with the image. Use it to apply an opaque texture or a texture with transparency. (This is done using an alpha channel.)
     - Modulate: color values of the image modify the intensity of the colors of the polygon.
     - Blend: blends polygon and texture colors.
     - Replace: similar to decal.
     - Add: adds the pixel values of the source and base colors.
   - Wrap specifies whether or not the image is repeated, and if so, how it is repeated, as follows, and as illustrated in Figure 10-5 and Figure 10-6:
     - Clamp: extends the border pixels of the image to the edge of the terrain or the next continuous image, blending them with the pixels of other images. It does not obscure underlying images.
     - Clamp to Edge: extends the border pixels over the entire terrain, obscuring any other image.
     - Clamp to Border: places the image once, at the specified coordinates.
     - Repeat: tiles the image onto the terrain.
     - Mirror: tiles the image onto the terrain, alternating between the true image and a mirror image.
   - Coordinate System specifies the coordinate system to use to place the image. Most options are self-explanatory. The Texture coordinate system specifies UV (X,Y) coordinates for placing textures on the terrain.

– Location specifies the coordinates for the Southwest (SW) and Northeast (NE) corners of the image. If the image is a GeoTIFF, the coordinates are in the image file. If the image file does not have coordinates, VR-Forces stretches it to cover the terrain patch. If you do not want the image to cover the entire terrain, you can specify the coordinates.



Clamp | Clamp to border

Figure 10-5. Raster image wrap effects (Clamp and Clamp to Border)



Clamp to edge | Mirror | Repeat

Figure 10-6. Raster image wrap effects (Clamp to Edge, Mirror, Repeat)

10.3.1. Changing the Display Order of Raster Maps

Raster maps are displayed in the order in which they are listed in the Terrain Settings dialog box, Raster Maps page. If they overlay the same portion of the terrain, the topmost image is displayed. You can change the order in which image files are listed, thereby changing which one is displayed in VR-Forces.

Figure 10-7 shows two views of the detailed portion of the LittlePond terrain, one with the default image order, and one with the order of raster images reversed.



Figure 10-7. Changing the raster map order

To change the order of a raster map.

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Raster Maps page (Figure 10-3).
3. Select the raster image whose order you want to change.
4. Click the Up Arrow or Down Arrow above the upper right corner of the list of raster maps. The image moves in the list and the window changes as appropriate.

10.4. Adding a Feature Layer

A feature layer is a file that contains data about geographic features on the terrain. This includes linear features, such as roads, and point features, such as trees and buildings. You can create props from point features. A feature layer can be a MÄK Terrain Format (GDB) file, a shapefile (SHP), or DFAD data (DFD).

The front-end and back-end use different mechanisms to import feature data and they handle it differently.

When the front-end imports a shapefile, it uses the name of the shapefile to indicate what type of feature it contains. Filenames are mapped to feature types in *./appData/importConfig/filename_shp_map.txt*. For example, the file name *ROADL.shp* is mapped to feature 129, which is a road. If the shapefiles that you need to import are not listed in *filename_shp_map.txt*, you can add them by editing the file.

Loading large feature layers into the front-end can cause it to hang and scenario data can be lost. To avoid this problem, you can choose to load feature layers only in the simulation engine. In this case, you will not be able to visualize the feature data, but the simulation engine will handle it correctly.

When the back-end imports feature data, it configures it based on a configuration file called *./appdata/settings/featureconfig.txt*. For details about this file, please see Appendix I, *Configuring Feature Data*.

The preferred method for adding feature data in the back-end is via shapefiles. Loading shapefiles in the back-end, as compared to loading feature data from a GDB file, provides better performance. If you have feature data in GDB files and you need to import it into VR-Forces, you can extract it from the GDB to a shapefile using the vectorNetworkToShapeFiles utility. For details, please see "Extracting Feature Data from GDB to Shapefiles," on page I-6.

- Adding a feature layer does not, by itself, make any visible difference to a terrain. To take advantage of the feature data, you must extract the data as props and map the props to model definitions. For details, please see "Adding Props to a Terrain," on page 10-29.
- The number of layers you can add depends on your graphics card. If you add a layer and it does not appear, try reducing the number of layers you have.
- Feature layers in *.earth* files are added automatically.
- VR-Forces supports S-57 data. The recommended way to load S-57 data is to convert it to shapefiles and load the shapefiles. You could load them as feature layers as described in this section. However, since each S-57 file is converted to multiple shapefiles, it may be easier to load them using *.earth* files than as individual shapefiles. VR-Forces includes one terrain that has S-57 data, VR-TheWorld Online - Massachusetts Maritime.mtf.

To add a feature layer:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Terrain Contents page (Figure 10-8).

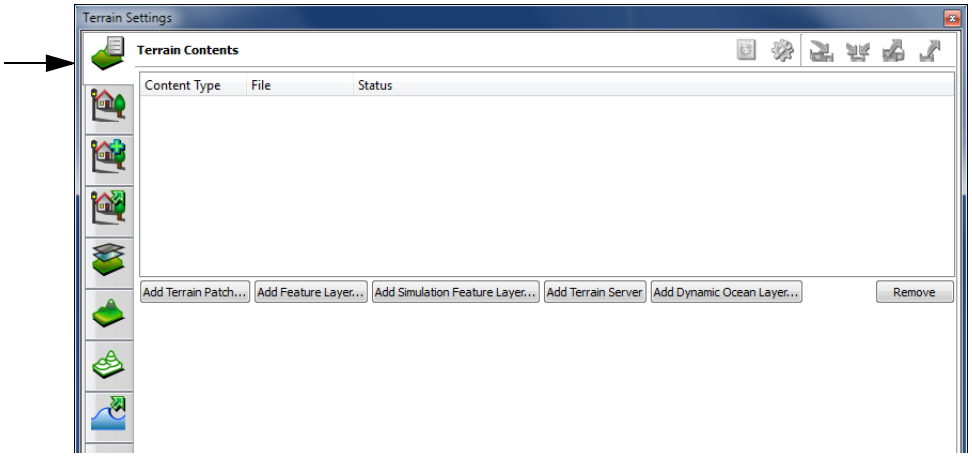


Figure 10-8. Terrain Contents page

3. Click Add Feature Layer to load a feature layer in the front-end and back-end. Click Add Simulation Feature Layer to add a feature layer only in the back-end. The Select Source File for Feature Layer dialog box opens.
4. In the Select Source File for Feature Layer dialog box, select the file that you want to use for this feature layer.
5. Click Open. The source file is added to the list of terrain contents. The Status column indicates whether the feature layer is for visualization and simulation (Visualized) or just simulation (Not Visualized)(Figure 10-9).

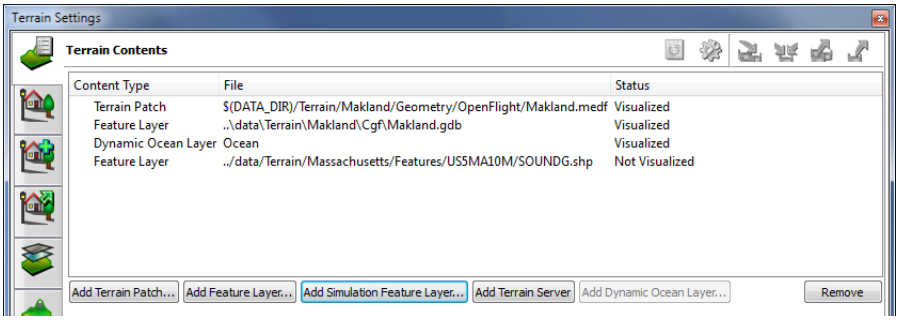


Figure 10-9. Terrain contents status

10.5. Adding a Dynamic Ocean Layer

VR-Forces can simulate dynamic ocean effects, such as waves, swell, and chop. To simulate the ocean, your terrain must have a dynamic ocean layer. You can add an ocean layer directly or you can add one as part of the process of extracting water textures.

If your terrain has textures assigned to water polygons, then you should extract them. They will be replaced by the ocean layer. If you do not extract the water textures and you simply add an ocean layer, the ocean layer and the water texture will interfere with each other in a process called Z-fighting and create an unacceptable display (Figure 10-10). This problem occurs because the ocean layer and the texture are both at the same height (0, or sea level).

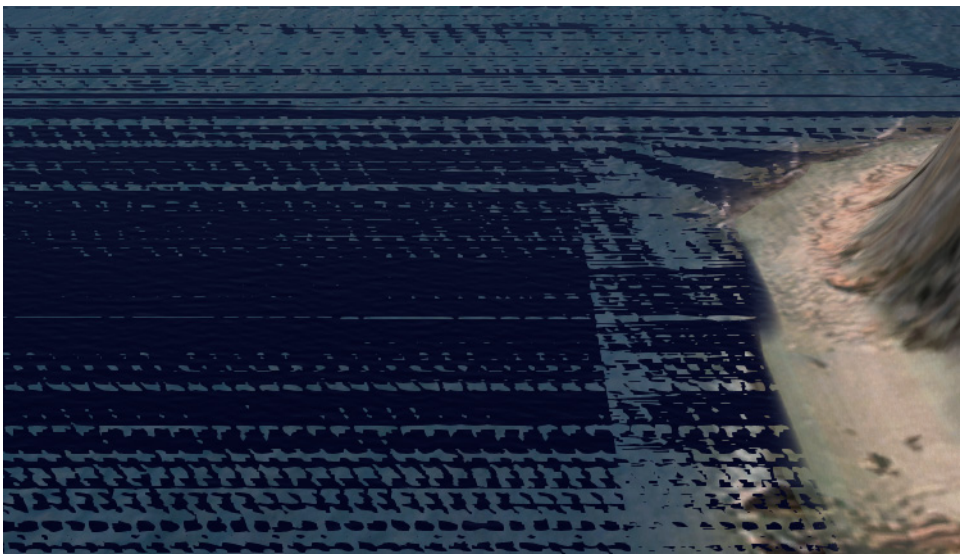


Figure 10-10. Z-fighting

If your terrain does not have a specific water texture assigned to polygons, your only option is to add an ocean layer directly. However, since the ocean layer will be at the same elevation as the terrain texture, you may experience Z-fighting. You may also have to raise the ocean height to actually see the ocean effects.

Figure 10-11 shows the Makland terrain with a water texture and an ocean layer. In the left view, the ocean layer has a height of 0 meters. You cannot see it. In the right view, the ocean layer is set to 1 meter. Now it is visible.

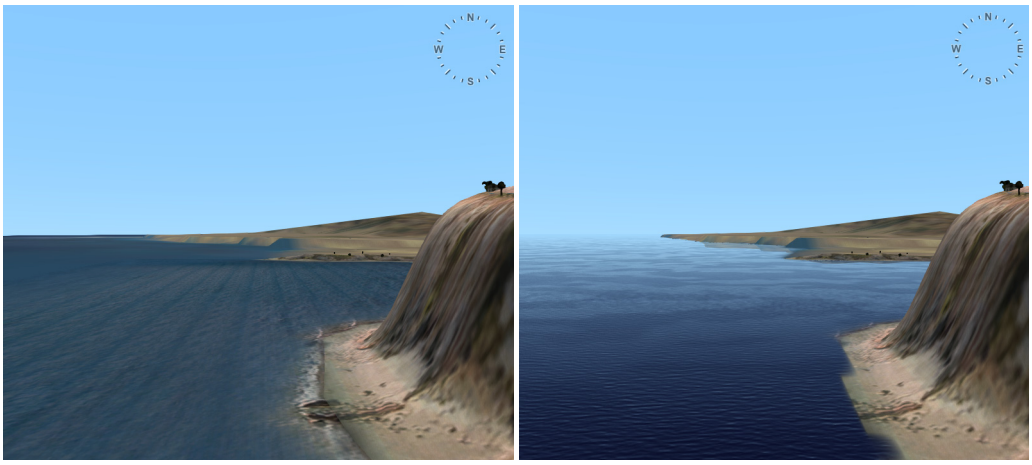


Figure 10-11. Ocean height

10.5.1. Extracting Water Textures and Adding an Ocean Layer

To extract textures and add an ocean layer:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Extract Ocean page (Figure 10-12).

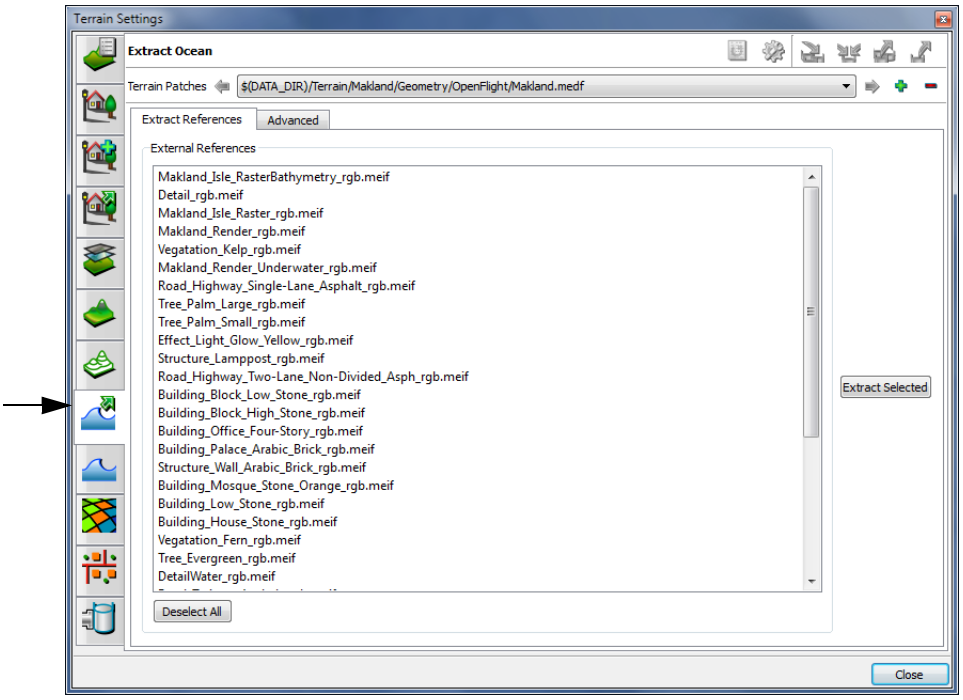


Figure 10-12. Terrain Settings dialog box, Extract Ocean page

3. In the External References list on the Extract References tab, select the water textures that you want to extract.
4. Click Extract Selected. The textures are removed and an ocean layer is added to the Terrain Contents page.
5. Select the Terrain Contents page (Figure 10-13).
6. Adjust the Ocean Height so that the dynamic ocean is visible. This might require raising the ocean above sea level.
7. Optionally, adjust the Ocean LOD Elevation. For information about the Ocean LOD Elevation, please see "Setting the Ocean LOD Elevation," on page 10-16.

10.5.2. Adding a Dynamic Ocean Layer Directly

Ocean layers get created at a height of 0 meters, that is, mean sea level.

To add a dynamic ocean layer:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Terrain Contents page.
3. Click Add Dynamic Ocean Layer. (You can only have one ocean layer.) A layer is added to the Terrain Contents list and two parameters are added to the bottom of the dialog box (Figure 10-13).

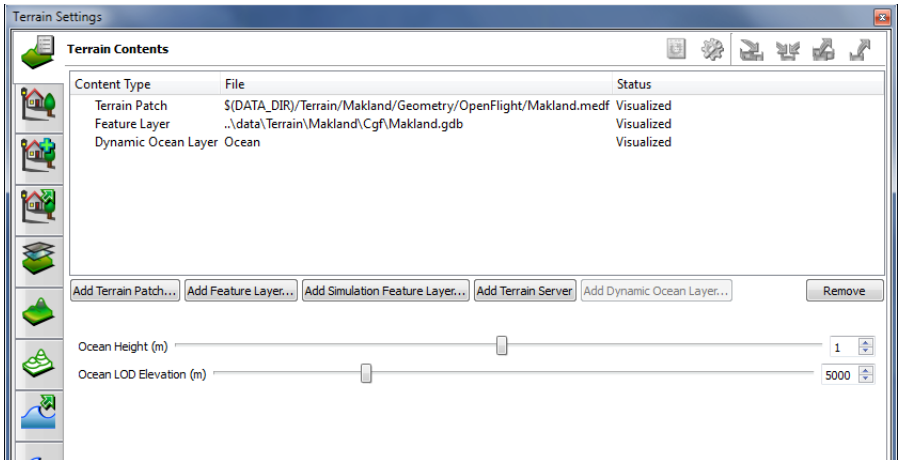


Figure 10-13. Terrain Contents with dynamic ocean layer

4. Adjust the Ocean Height so that the dynamic ocean is visible. This might require raising the ocean above sea level.
5. Optionally, adjust the Ocean LOD Elevation. For information about the Ocean LOD Elevation, please see "Setting the Ocean LOD Elevation," on page 10-16.

10.5.3. Setting the Ocean LOD Elevation

Enabling dynamic ocean can affect performance. Since the effects are hard to see once the observer is high above the ocean, VR-Forces stops displaying them when the observer is more than 5000 meters above sea level. You can change this cutoff point by adjusting the Ocean LOD Elevation.

To set the ocean LOD elevation:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Terrain Contents page (Figure 10-13).
3. Adjust the Ocean LOD Elevation slider or change the value in the box.

10.5.4. Setting the Ocean Height Map Resolution

You can configure the resolution of ocean height map information. The ocean height map is used to blend the water with the coastline. When you change the resolution, you change the area within which blending takes effect. Lowering the resolution spreads the effect over a greater geographical area, but results in blocky or imprecise water depth resolution.



Setting the surface transparency also affects visualization of the shoreline. Experiment with the two values to achieve the best results. For details about water transparency, please see Section 12.5.2, "Configuring Marine Conditions," in *VR-Forces Scenario Management Guide*.

If you are working with a small terrain or scenes in which the observer is close to sea level, you may want to use a higher resolution. If you are less interested in how the coast line looks, you can use a lower resolution.

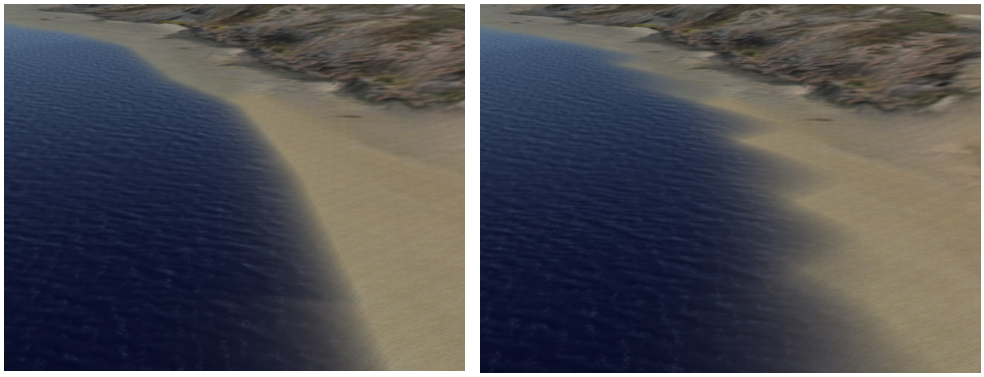


Figure 10-14. Ocean height map resolution

To set the ocean height map resolution:

1. Choose **Settings** → **Display**. The Display Settings dialog box opens.
2. Select the Render Settings page.
3. Adjust the Ocean Height Map Resolution slider, or enter or select a value in the box.

10.6. Specifying Simulation Ocean Settings

VR-Forces can determine the depth of the ocean floor from:

- Underwater polygons, if present.
- From feature data, such as S-57 data.
- As a fixed depth.

If a terrain has underwater polygons, VR-Forces always automatically uses that data. You can enable and disable use of feature data that sets the ocean depth. If you have both types of data, VR-Forces uses the shallowest depth of the two types of data for any given point.

You can also specify that VR-Forces use a fixed depth for any area that does not have underwater polygons or feature data.



Changing the simulation ocean setting is not a dynamic change. After changing the settings, you must save the terrain to an MTF file and reload the scenario.

To specify ocean depth:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Simulation Ocean Settings page (Figure 10-15).

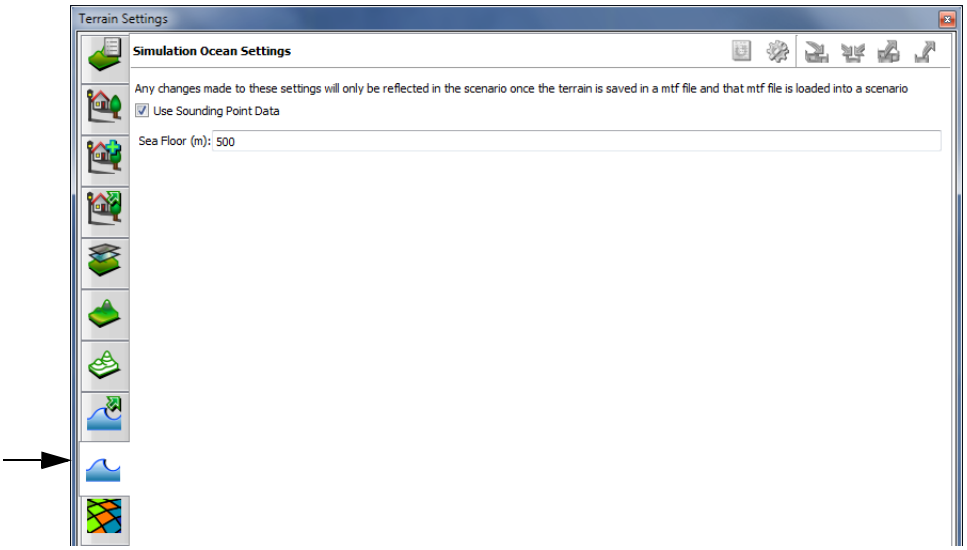


Figure 10-15. Simulation Ocean Settings page

3. To enable or disable use of feature data, select or clear the Use Sounding Point data check box.

4. To specify the ocean depth for areas that do not have underwater polygons or feature data, type a value in the Sea Floor text box.
5. Save the terrain.
6. Reload the scenario.

10.7. Using Shader-based Effects Maps

VR-Forces supports several types of shader-based effects texture maps. Shaders are computer programs that simulate the effect of light on the terrain and objects in the simulation. VR-Forces makes extensive use of them for visualization effects.

Texture maps are raster images that apply highly realistic textures to the terrain and models. By applying different types of texture maps to terrain and models, you can improve the visual qualities of your simulation without the overhead of high polygon counts.

VR-Forces supports the following types of shader-based effects maps:

- Normal, or bump, maps. Normal maps give terrains the appearance of relief, such as a rocky landscape.
- Specular maps. Specular maps affect the highlight color of objects.
- Ambient occlusion maps. Ambient occlusion maps model areas that do not receive direct light, such as cracks and crevices and shaded areas of terrain and models. These areas are lit only by ambient light.
- Reflection maps. Reflection maps affect the reflectivity of surfaces, such as windows. Reflection maps reflect objects in the sky, not the terrain.

You can include effects maps as part of an OpenFlight model or terrain or as raster maps (on the Raster Maps page of the Terrain Settings dialog box). VR-Forces uses a naming convention for effects map files that lets it process the files properly without any additional configuration. To specify the type of map file, use the following naming conventions:

- Normal map: *filename_NML.png*
- Ambient Occlusion map: *filename_AO.png*
- Specular map: *filename_SPC.png*
- Reflection map: *filename_RFL.png*.



The map code must be uppercase on Linux.

To see the effect of effects maps, you must enable advanced lighting and shading. For details, please see Chapter 17, *Lighting Effects*, in *VR-Forces Configuration Guide*.

10.8. Connecting to Terrain Servers

VR-Forces supports the osgEarth libraries for creating terrains from remote or local data sources (Figure 10-16). Terrain servers support streaming of terrain data and are, therefore, ideal for displaying terrains that have large amounts of data.



Figure 10-16. Geocentric terrain

You can manipulate the terrain from the keyboard and mouse and can save it as an MTF terrain for quick loading.

VR-Forces includes several terrain server configurations for servers that are accessible over the internet, including a server hosted by VT MÄK (*VR-TheWorld.earth*, which connects to VR-TheWorld Online). It also includes server configurations that stream terrain files included with VR-Forces. These servers, such as, *Local World.earth* and *SanLuisObispo.earth*, are examples of how you can use *.earth* files to load local data.

"Adding a Terrain Server," on page B-13, is a tutorial that shows how to create a terrain server connection that serves local data.



When you view a geocentric terrain and move the observer more than 6 million meters or so from the earth's surface, the view is forced to focus toward the center of the earth. The practical effect of this mode is that the left and right movement keys orbit the observer around the earth, rather than moving the entire earth to the left or right.

Integration of osgEarth into VR-Forces allows you to connect to data sources. However, it does not provide a license to use any data sources. It is your responsibility to comply with the licensing provisions of any site to which you connect.

To connect to a terrain server:

1. Choose **New** → **Scene**. The current terrain closes.
2. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
3. Select the Terrain Contents page (Figure 10-17).

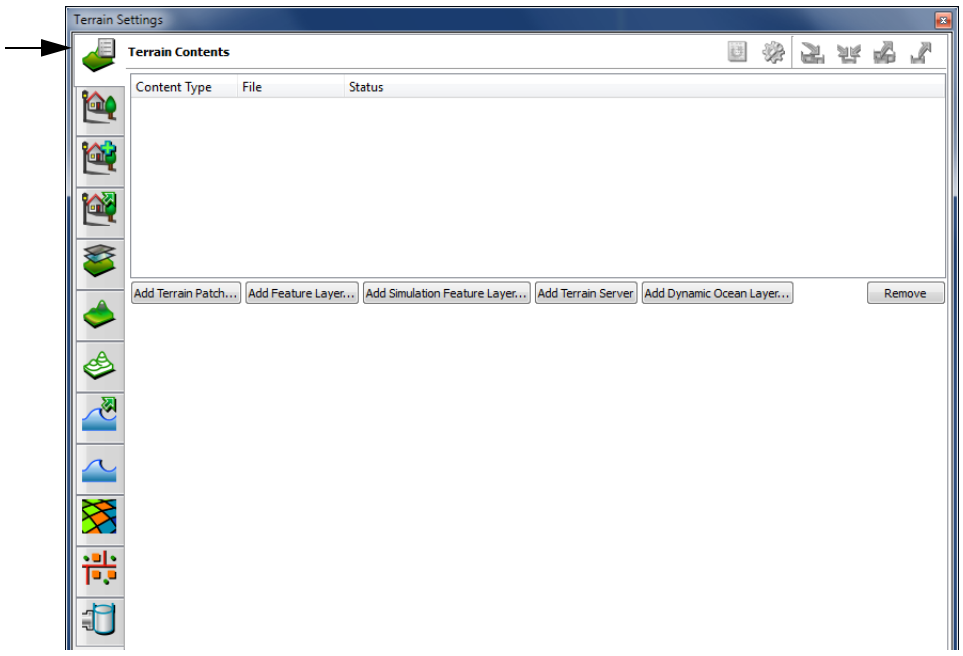


Figure 10-17. Terrain Contents

4. Click Add Terrain Server. The Add Terrain Server dialog box opens (Figure 10-18). The dialog box contains information about the selected terrain server. It is not editable. (For information about editing terrain server configurations, please see "Editing a Terrain Server Configuration," on page 10-24.)

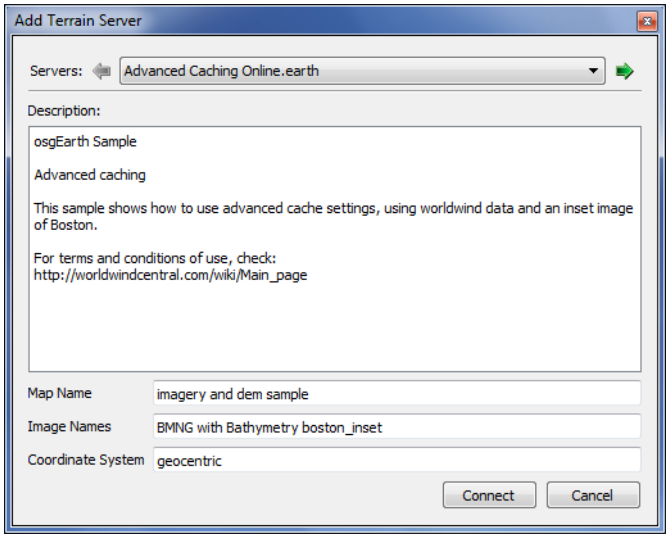


Figure 10-18. Add Terrain Server dialog box

5. Select a server from the Servers list.
6. Click Connect. If the terrain data is available (remote sources might not always be accessible), it is displayed.

You can save a terrain server as part of a terrain or scene. For details, please see "Saving a Terrain," on page 10-4.

10.8.1. Adding Terrain Server Connections

You can add additional terrain server connections to the list provided with VR-Forces. Terrain server connections are configured in XML files according to the requirements of the osgEarth libraries. It is beyond the scope of this manual to fully describe the configuration process. However, the server configurations included with VR-Forces are examples of what you can do. We recommend that you add new servers by copying an existing configuration that is similar to what you want and then editing it to point to your data. (Appendix H, *Editing Earth Files*, provides a brief introduction to Earth file syntax.)

"Adding a Terrain Server," on page B-13, is a tutorial that shows how to create a terrain server that serves local data.

To add a terrain server connection:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Server Settings page (Figure 10-19). The dialog box displays the contents of the configuration file for the selected server.

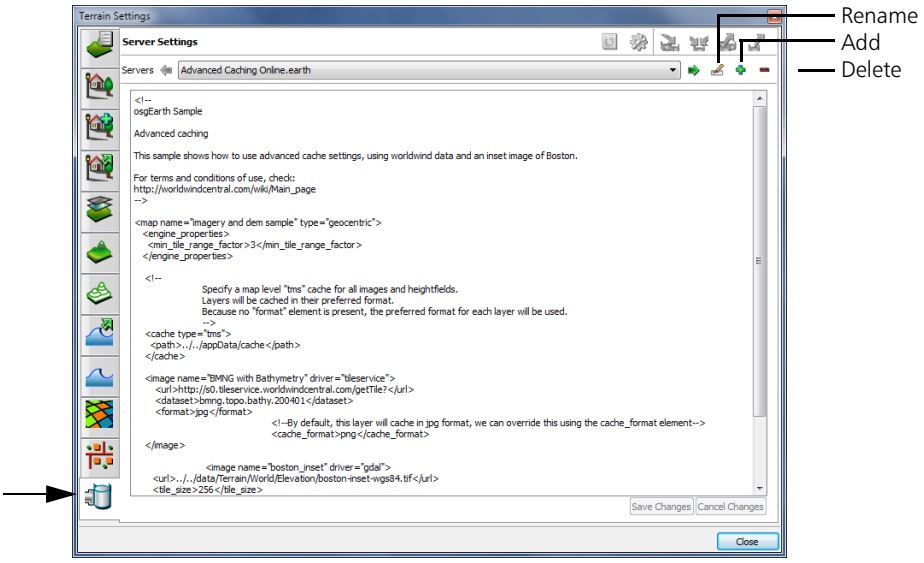


Figure 10-19. Server settings page

3. Select a terrain server configuration that is similar to the one that you want to add.
4. Click the Add button (+). A new configuration file is added to the list. It copies the contents of the previously selected configuration and names the server in the format *oldServerName*_1.
5. Make whatever changes are necessary to configure your new server. This would usually mean changing the URLs that point to the data. A URL can be an internet URL, a path to a directory, or a path to a specific file.

6. Optionally, click the Rename button (✎) and rename the server.
7. Click Save Changes. New server files are saved to *./userData/servers*.

10.8.2. Editing a Terrain Server Configuration

VR-Forces provides a text editor interface that lets you edit the osgEarth terrain server configuration files. You can also edit them in any text editor. You are responsible for ensuring proper syntax.

To edit a terrain server:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Server Settings page (Figure 10-19). The dialog box displays the contents of the configuration file for the selected server.
3. In the Servers list, select the terrain server configuration that you want to edit.
4. In the text window, edit the file.
5. Click Save Changes.

10.8.3. Connecting to Terrain Servers through a Proxy

If you connect to the network through a proxy, you may need to set some environmental variables to be able to connect to external terrain servers. VR-Forces has limited proxy capability. It supports basic authentication and may support domain authentication if your proxy allows it to be accessed through basic authentication. To set up authentication, set the following environmental variables:

- OSG_CURL_PROXY. Specifies the proxy machine.
- OSG_CURL_PROXYPORT. Specifies the proxy port.
- OSGEARTH_CURL_PROXYAUTH=username:password. Specifies the user name and password for the proxy.



When you start VR-Forces, the Scenario Startup window indicates whether the selected terrain server is available. However if you are connecting through a proxy, the server status feature does not work, even if you have set up the proxy environment variables correctly. So terrain servers will be listed as unavailable. However, you can still connect to a terrain server. To do so, add the *.earth* file as a terrain patch. The filter in the Open dialog box does not include *.earth* files, so you will have to select All Files to see your *.earth* files in the file chooser.

10.8.4. Cutting in Sites for a Terrain Server

Users of terrain servers, such as VR-TheWorld Server, often want to add high resolution sites of particular interest while using the lower resolution terrain provided by the terrain server for the rest of the world. You can add a high resolution terrain patch to a terrain server, but it overlays the terrain provided by the server and this can cause unexpected visual problems. Ideally, you would cut out the relevant areas of terrain provided by the server and add your high resolution terrain to the cut out area. VR-Forces includes a tool, the Boundary Tool that helps you do this.

The Boundary Tool takes an OpenFlight file and calculates the bounding geometry of the file. It returns the coordinates in a text file. The general process of cutting in a site is as follows:

1. Run the Boundary Tool against an OpenFlight file.
2. Insert the output of the of the Boundary Tool in a mask element in your *.earth* file. (For details about mask elements, please see "Cut-in Sites – The mask Element," on page H-7.)
3. Load the terrain.
4. Add the FLT file as a terrain patch.
5. Save the terrain.

Running the Boundary Tool

To run the Boundary Tool:

1. Open a console window.
2. Change directory to *./bin*.
3. Run the Boundary Tool:

```
boundary_tool [--out file_name --no-geocentric
  --convex_hull --verbose --view --latlon-precision
  precision --height-precision precision] model_file
```

Table 10-1 describes the options.

Table 10-1: Boundary Tool command-line options

Option	Description
`--convex_hull`	Calculate a convex hull instead of a full boundary.
`--height-precision` *precision*	Specifies a fixed point precision for height. Default: 3
`--latlon-precision` *precision*	Specifies a fixed point precision for lat-lon. Default: 8

Table 10-1: Boundary Tool command-line options

Option	Description
`--no-geocentric`	Skips geocentric reprojection. Use for flat databases.
`--out` *file_name*	Specifies the output file for boundary geometry. Default: *boundary.txt*
`--verbose`	Prints progress messages to the console.
`--view`	Show the result in a 3D window.

The output from the tool, in *boundary.txt* or the output file you specified, looks similar to the following:

```
POLYGON((-157.91489143 21.32914026 3.016, -157.91525638 21.32914026
  3.016, -157.91666238 21.32912541 3.016, -157.91697822 21.32934847
  3.016, -157.91709263 21.32968744 3.016, -157.91709263 21.32968744
  7.016, -157.91709263 21.32968744 11.016, -157.91709263 21.32968744
  15.016, -157.91710262 21.32968706 15.016, -157.91697822 21.32934847
  16.016, -157.91709263 21.32968744 16.016, -157.91710262 21.32968706
  15.016))
```

The first two vertices are the latitude and longitude. The third vertex is the height, in meters. The remainder of the vertices map the outline of the geometry.

Adding a Mask Element to an Earth File

A mask element in a *.earth* file looks similar to the following:

```
<mask name="HonoluluRunway26R-8L-mask" driver="feature" >
  <features driver="ogr">
    <geometry>
      POLYGON((-157.91489143 21.32914026 3.016, -157.91525638
  21.32914026 3.016, -157.91666238 21.32912541 3.016, -157.91697822
  21.32934847 3.016, -157.91709263 21.32968744 3.016, -157.91709263
  21.32968744 7.016, -157.91709263 21.32968744 11.016, -157.91709263
  21.32968744 15.016, -157.91710262 21.32968706 15.016, -157.91697822
  21.32934847 16.016, -157.91709263 21.32968744 16.016, -157.91710262
  21.32968706 15.016))
    </geometry>
  </features>
</mask>
```

To cut out a section of terrain from the terrain server, add a mask element to the *.earth* file. Use the output from the boundary tool for the data in the geometry element.

10.9. Loading MetaFlight Terrains

VR-Forces supports MetaFlight terrain databases. To load a MetaFlight terrain, add a terrain patch, as you would for any other terrain. However, before you can load a MetaFlight file, you must first process it using the mftTool and medfTool. For details, please see Appendix G, *Processing MetaFlight Files*.

When you load a MetaFlight file, VR-Forces is actually loading many individual OpenFlight files. If file caching is enabled, VR-Forces caches the OpenFlight files to disk in a quick-loading, encrypted format so that the files can load more quickly the next time you load the terrain. The cached files are handled the same way that any other cached files are handled. For details, please see "Configuring File Caching," on page 10-36.

10.10. Preprocessing Paged Terrains

VR-Forces supports preprocessing external references used by paged terrains. VR-Forces does not require terrain formats such as TerraPage or pagable IVE to be preprocessed. However these terrains may use external references in formats such as OpenFlight, which load slowly. Although VR-Forces can accelerate these files at run-time using the accelerated cache feature, the first time you load one of these terrains you can experience significant performance issues. You can use the medfTool to preprocess these external references and save them in MEDF format. Thereafter, VR-Forces will load the accelerated version at all times.

For example, if a TerraPage terrain references */externals/tree.flt*, preprocessing will create a file called */externals/tree.medf*. When VR-Forces loads the terrain, it will load the MEDF version instead of the OpenFlight version.

We recommend that you preprocess all data to minimize load times and maximize run-time performance. For details about the medfTool, please see "Compressing Model Files," on page 11-7.

10.11. Manually Paging-In Terrain

VR-Forces pages in terrain based on the location of simulated objects and an algorithm that predicts where terrain will be needed. In most cases VR-Forces can predict the need for terrain and page it in without affecting the performance of the exercise. However there may be cases where it cannot, for example if there are many entities over a wide area or many fast-moving entities. Therefore, VR-Forces also lets you specify areas where you want the terrain to be paged in.

Terrain page-in areas are created just like any other tactical graphic area. You can create them as the scenario progresses or you can include them in global or entity plans so that the terrain gets paged in when you know the scenario will need it. You can also attach a terrain page-in area to an entity to ensure that terrain in front of the entity gets paged in.

Terrain page-in areas are supported for paged IVE files and supported versions of the MetaFlight format.



Terrain page-in areas only affect the back-end.

To create a terrain page-in area:

1. Open the Tactical Graphics palette.
2. In the Categories list, select Control Objects.
3. In the Force list, select the force you want this area to be assigned to.
4. In the list of control objects, select Terrain Page-in Area.
5. Create the area as described in Section 2.1, "Creating Objects," in *VR-Forces Scenario Management Guide*.

10.12. Adding Props to a Terrain

Props are objects like buildings, lampposts, or trees that exist independently of the underlying terrain elevation data. You can extract props from a terrain patch or add them from a feature layer. You can view a list of the props in the terrain, specify their opacity, and enable or disable their visibility. You can change a prop's type and you can change the model definition used to render it. You can also create new prop types to meet your simulation needs.



In VR-Forces you can create buildings and cultural feature objects from the Entity Palette that look like similarly named props in the 3D view. Cultural features are not the same things as props. Props are saved as part of the terrain. Cultural features are saved as part of the order of battle. They are a mechanism for placing objects into a scenario for visualization or simulation purposes.

10.12.1. Extracting Props from a Terrain Patch

When you extract props from a terrain patch, you have to tell VR-Forces where to find prop data, what type of prop to use, and what model definitions to map the props to, as follows:

- Where to search: A terrain patch, such as an OpenFlight terrain, often references multiple files that define models that are incorporated into the geometry of the terrain. VR-Forces lets you specify the external files from which to extract props or you can specify a search expression that looks in all referenced files. If you select a referenced file, the process is quicker because VR-Forces searches for props only in the specified file.
- What prop type to use: You can select a prop type from a list, specify a type of your choice, or let VR-Forces auto-generate prop types. If you choose Auto Generate, VR-Forces makes the prop type match the name of the referenced file. For example, a prop extracted from the *Bridge_Arch_Stone.flt* file would be given the prop type *Bridge_Arch_Stone.medf*.
- Model definition to use: You can select a model definition from a list, or choose Use Extracted Geometry. If you accept the default value, Use Extracted Geometry, VR-Forces creates props using the geometry in the terrain patch. For example, if you chose *Trees.flt* as the referenced file, VR-Forces creates props using the tree geometry in that file.

VR-Forces extracts props only from the selected terrain patch. If your terrain has multiple terrain patches, you must repeat the procedure for each terrain patch from which you want to extract props.

For an example of how to extract props from a terrain patch, please see "Extracting Props from a Terrain," on page B-18.

To extract props from a terrain:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Extract Props page (Figure 10-20).

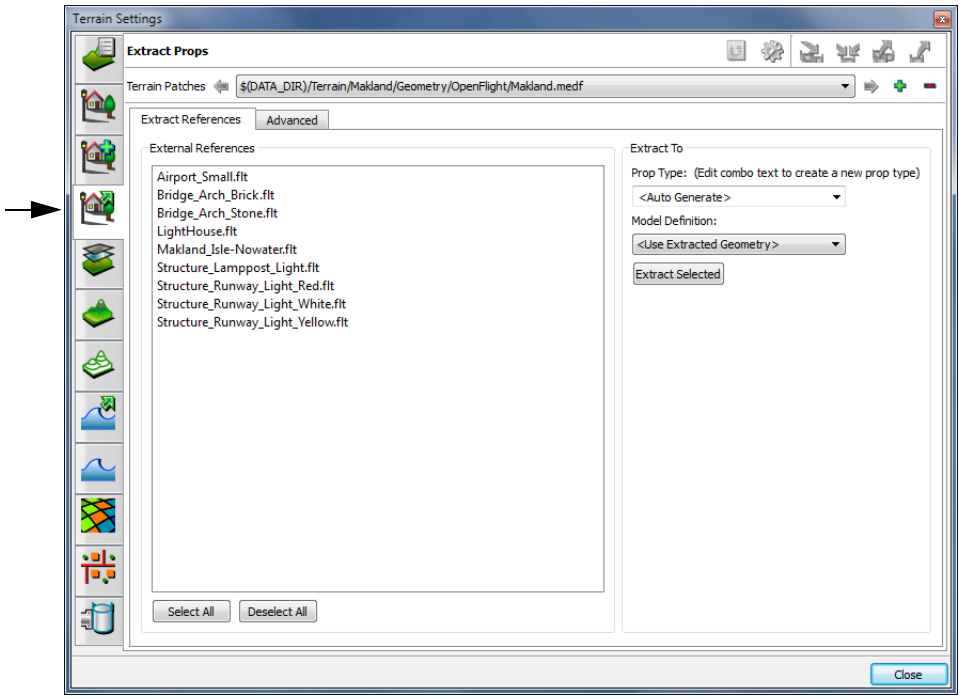


Figure 10-20. Extract Props page

3. In the Terrain Patches box, select the terrain patch from which you want to extract props.
4. To extract props by specifying external files, select the Extract References tab. To extract props using a search expression, select the Advanced tab.
5. If you chose the Extract References tab, in the External References list, select the files from which you want to extract props.

   If you chose the Advanced tab, type the search expression in the Search Expression box. Select the Regular Expression check box if you are using a regular expression.



VR-Forces uses perl regular expression syntax.

6. Optionally, in the Prop Type box, select the type that you want to assign to the extracted props or type a prop type.
7. Optionally, in the Model Definition box, select the model definition that you want to apply to the extracted props.
8. If you are using the Advanced tab, click Extract. If you are using the Extract References tab, click Extract Selected. VR-Forces extracts the props, if any. You can view the list of props in the Props list on the Edit Existing Props page.

10.12.2. Adding Props from a Feature Layer

A feature layer source file contains information about point, line, or areal features. Feature information is stored in a table in which each row is a feature and each feature is defined by the values in an arbitrary number of columns. To add a prop from a feature layer, you must build a rule that specifies the column headings and values for the feature you want to import. Then you must associate a prop type and model definition with the prop. You also must specify whether or not to ground clamp the prop.

Please see "Add Props," on page B-9 for an example of adding props from a feature layer.

To add a prop from a feature layer:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Add Props page (Figure 10-21).

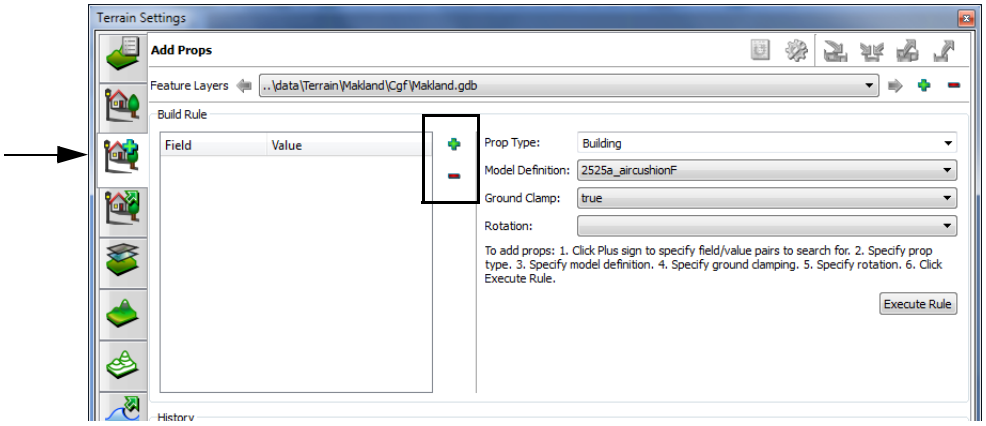


Figure 10-21. Terrain Settings, Add Props page

3. In the Feature Layers list, select the feature layer from which you want to import the props.
4. Click the Add button (+) to the right of the Field/Value window (Figure 10-21). The Build Field/Value Pair dialog box opens (Figure 10-22).

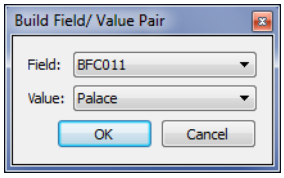


Figure 10-22. Build Field/Value Pair dialog box

5. In the Field list, select a field. Fields are the column headings in the feature definition.
6. In the Value list, select a value. Values are one or more values from the definition table that are available for the column heading.



It is your responsibility to understand the feature definitions for the features that you want to import as props.

7. Click OK. The Field/Value pair is added to the window (Figure 10-23).

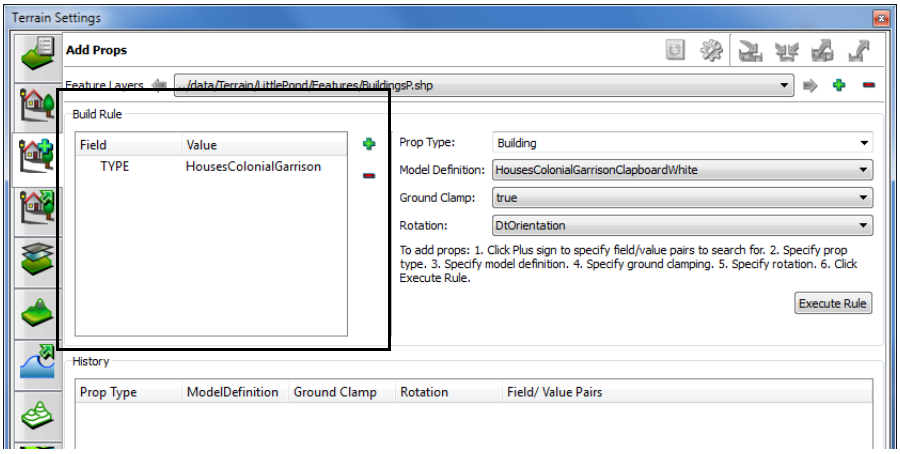


Figure 10-23. New Field/Value pair

8. Add additional Field/Value pairs as needed to define the prop that you want to add.
9. In the Prop Type list, select the prop type to assign to the prop you want to add.
10. In the Model Definition list, select the model definition you want to use for this prop.
11. In the Ground Clamp box, specify whether or not to ground clamp this prop.
12. Optionally, set the rotation.
13. Click Execute Rule. The prop is extracted from the feature layer and is listed in the History window.

10.12.3. Viewing a List of Props

To view a list of the props in the terrain:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Edit Existing Props page (Figure 10-24).

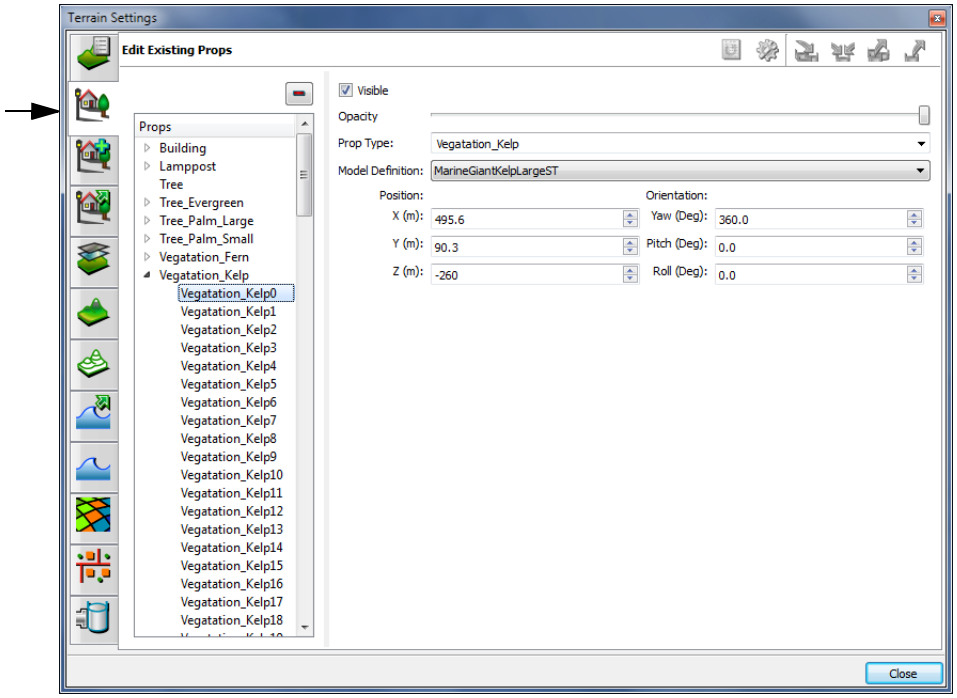


Figure 10-24. Edit Existing Props page

3. Expand the list to view the entries under a particular type of prop.

10.12.4. Selecting Props

➤ To select a prop, click it in the window or select it in the list of props on the Terrain Settings dialog box, Edit Existing Props page.

Press **`Ctrl`**+click to select multiple props.

10.12.5. Setting the Opacity of Props

You can set the opacity of props. This can be useful if you want to see what is inside a building or behind a prop. Figure 10-25 illustrates a building at two levels of opacity.



100% 40%

Figure 10-25. Prop opacity

To set a prop's opacity:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Edit Existing Props page (Figure 10-24).
3. In the list of props select the props whose opacity you want to change, or select a prop in the window. The Opacity slider is enabled.
4. Slide the Opacity slider to the right to increase opacity. Slide it to the left to decrease opacity.

Making a Prop Fully Transparent or Opaque

You can quickly set a prop to be fully transparent or opaque.

➤ To make a prop fully transparent, right-click the prop and on the popup menu, choose **Make Transparent**.

➤ To make a transparent prop fully opaque, right-click the prop and on the popup menu, choose **Make Opaque**.

10.12.6. Changing a Prop's Type

Every prop has a type. Props are organized by type in the list on the Edit Existing Props page.

To change a prop's type:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Edit Existing Props page (Figure 10-24).
3. In the list of props, select the props whose type you want to change.
4. Select a prop type from the Prop Type list, or type a new type name. The selected props are moved to the new prop type in the Props window.

10.12.7. Changing a Prop's Position or Orientation

You can change a prop's position and orientation. You can change the orientation of multiple props at the same time without affecting their position. However, if you select multiple props and change position, they are all placed in the same position.

To change a prop's position or orientation:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Edit Existing Props page (Figure 10-24).
3. In the list of props, select the prop whose position or orientation you want to change.
4. To change position, type or select new values in the X, Y, or Z boxes.
5. To change the orientation, type or select new values in the Yaw, Pitch, or Roll boxes.

10.12.8. Changing a Prop's Model Definition

You can change the model definition used to render a prop in the scene. For information about model definitions, please see Chapter 12, *Model and Element Definitions*. For an example of changing a prop's model definition, please see "Test the Model Mapping," on page C-10.

To change a prop's model definition:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Edit Existing Props page (Figure 10-24).
3. In the list of props, select the prop whose model definition you want to change.
4. In the Model Definition list, select a model definition. The selected props are rendered using the new model definition.

10.13. Configuring File Caching

When file caching is enabled, VR-Forces stores information about the terrain and models in a format that enables it to be loaded quickly. This improves loading time the next time the cached objects are loaded. If caching is disabled, terrains and models must be loaded from their native formats, which may take longer.



When VR-Forces processes a request to load a a file, such as an external reference in a terrain, it checks the cache and the directory of the requested file for an MEDF version of the file. If it does not exist, it loads the file in the original format.

To enable or disable file caching:

1. Choose **Settings** → **Application**. The Application Settings dialog box opens.
2. Select the File Caching Settings page (Figure 10-26).

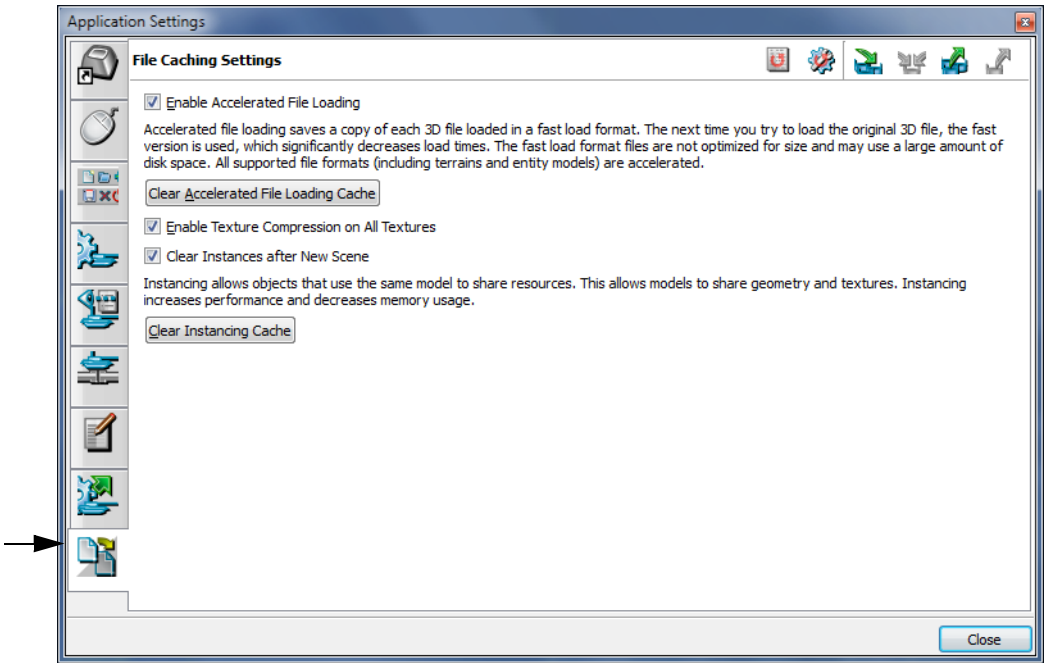


Figure 10-26. File Caching Settings page

3. Select or clear the Enable Accelerated File Loading check box.

10.13.1. Caching Terrain Server Data

When file caching is enabled, VR-Forces caches data from terrain servers in the default locations. You can override this by specifying an alternative caching location in the <cache> element in the *.earth* file or in the OSGEARTH_CACHE_PATH environment variable.

10.13.2. Enabling Texture Compression

When texture compression is enabled, textures are converted internally to a compressed format (DXT). Compressing textures decreases memory use and increases rendering performance.

To enable or disable texture compression:

1. Choose **Settings** → **Application**. The Application Settings dialog box opens.
2. Select the File Caching Settings page (Figure 10-26).
3. Select or clear the Enable Texture Compression On All Textures check box.

10.13.3. Clearing the File Cache

You can clear the file cache if you need to free disk space.

The cache is normally configured to be in *./appData/cache*. You can delete files from this directory if you want to. The most likely reason to do this is if you load a terrain and realize that it should have had its DDS textures flipped, but has now been saved with them oriented the wrong way. You could delete the cache, then reload the terrain and toggle DDS Textures to the opposite setting.

To clear the file cache:

1. Choose **Settings** → **Application**. The Application Settings dialog box opens.
2. Select the File Caching Settings page (Figure 10-26).
3. Click Clear Accelerated File Loading Cache.

10.14. Displaying DDS Textures Correctly

DDS is a DirectX bitmap format that is often used for textures. DirectX expects the origin of the image to be at the top left corner. OpenGL expects the image origin to be at the bottom left cornet. By default, VR-Forces assumes that images have the OpenGL orientation. However, sometimes images are not oriented properly and therefore you may have to tell VR-Forces to flip them.

You can change the DDS textures setting as follows:

- On a per-model basis. (For details, please see "Flipping DDS Textures for a Model," on page 12-35.)
- When you add a terrain patch. (For details, please see "Adding Elevation Data (Terrain Patches) to a Terrain," on page 10-5.)
- As a global setting. (For details, please see "Flipping DDS Textures Globally," on page 10-39.)

10.14.1. Flipping DDS Textures Globally

You can specify that the DDS textures setting apply to all terrains. This setting is primarily beneficial for paged terrains because you cannot know ahead of time if textures need to be flipped, as you could for a model or terrain patch. If a paged terrain has DDS textures that are upside down relative to VR-Forces's expectations, the textures can be flipped when the terrain gets paged in.

To enable or disable DDS texture flipping for all terrains:

1. Choose **Settings** → **Display**. The Display Settings dialog box opens.
2. Select the Loader Settings page (Figure 10-27).

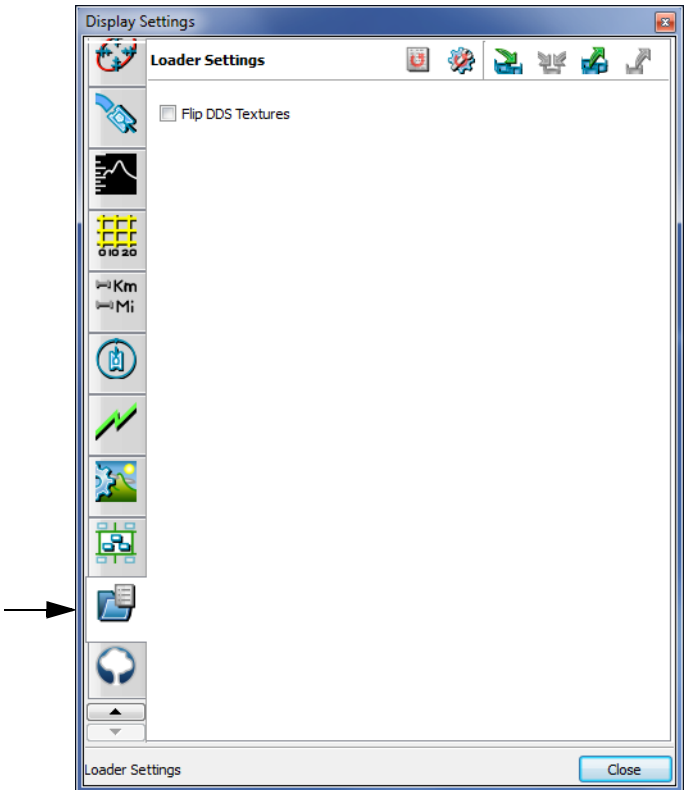


Figure 10-27. Loader Settings page

3. Select the Flip DDS Textures check box.
4. Click Close.

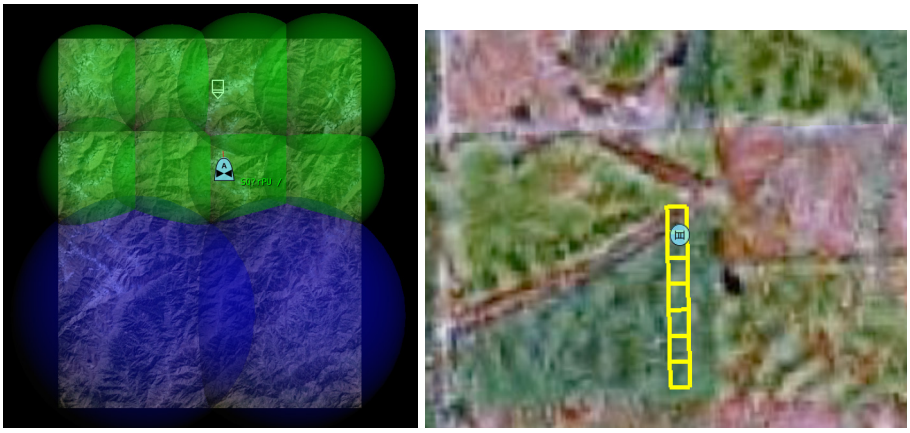
10.15. Displaying Information About Paged and Streaming Terrains

By default, when you enable the display of terrain paging information, VR-Forces displays the portions of the terrain that are paged into the back-end as tiles for streaming terrain, and as bubbles for paged terrains. Figure 10-28 shows the paged-in terrain for a paged terrain (*HarrisAghanVillageFlatEarthMetaFlight*) and a streamed terrain (VR-TheWorld). In the paged terrain, green spheres represent the area that is paged in. Blue spheres represent area that is not paged in. In the streamed terrain, yellow squares show the tiles that have been paged in as an entity moves over the terrain.



Drawing of paged terrain tiles is done using shared memory. Therefore, you can draw them only if the front-end and back-end are running on the same computer.

You can display different information by entering commands on the back-end console.



HarrisAghanVillageFlatEarthMetaFlight.mtf VR-TheWorld Online.mtf

Figure 10-28. Paged-in terrain

When you display terrain paging information, you can also display the features that are loaded in the back-end. You specify which features to draw using console commands, as described in "Displaying Additional Terrain Paging Information," on page 10-41.We recommend that you display features this way only in Plan View mode.

➤ To enable or disable display of terrain paging information, choose **Settings** → **Simulation Terrain Paging Information**.

10.15.1. Displaying Additional Terrain Paging Information

You can display the additional terrain paging information by entering commands on the back-end console. You can also display information about feature sets if they are present. Table 10-2 lists the commands and their results.

Table 10-2: Terrain paging information commands

Command	Result
`features config`	Print queries and transforms from *featureconfig.txt*. For details about feature configuration, please see Appendix I, *Configuring Feature Data*.
`features draw` *feature_set_index ...*	Draws the feature sets specified by the list of feature set indexes. Separate the indexes by spaces.
`features help`	Prints the syntax of feature commands.
`features info`	Prints generic information about the feature sets, such as the number of paged in features and the coordinate system.
`features list`	Lists all feature sets. The index of each set is used on the commands that take lists of feature sets.
`features pageout`	Pages out all unused feature tiles.
`features print` *index* [*number*]	Prints the feature sets as text. Optionally, specify the maximum number of features to print.
`terrain drawmode` *mode*	Specifies a bitmask that controls what information to display, as follows: ◆ 0 — Turn off information display. ◆ 1 — Display polygons (Figure 10-29). ◆ 2 — Display collision object bounding boxes (paged terrains) (Figure 10-30). ◆ 4 — Display spheres (paged terrains). ◆ 8 — Tile extents (streaming terrains). ◆ 12 — Show spheres for paged terrain and tiles for streamed terrain (the default). ◆ 15 — Display all terrain paging information.
`terrain PSG`	Prints the contents of the scene graph to the console. You can display the same information in the front-end by opening the Scene Graph Nodes Panel.
`pageout`	Pages out all tiles. Tiles that are needed are then paged back in.
`terrain save` *filename*	Saves the paged-in tiles to an MTF file. This is useful for quickly and easily saving a portion of a large terrain to a smaller database. The default filename is *simTerrain.mtf*.

Table 10-2: Terrain paging information commands

Command	Result
`pbv`	Prints page bounding information to the console.
`terrain addlayer` *`layer`*	Displays information in the layer specified by layer. Developers can write plug-ins to create new layers and add keywords to display them. The timer layer, included with VR-Forces causes the console to display how long it takes to perform terrain intersections. This information can be useful when diagnosing performance issues.

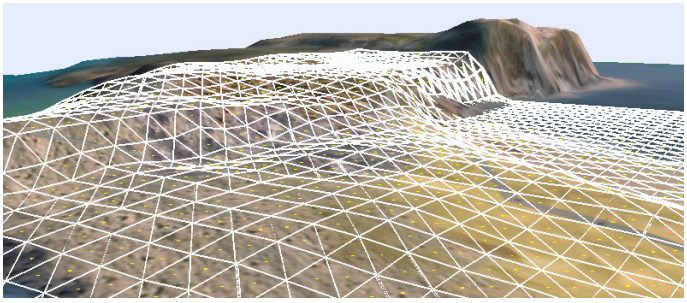


Figure 10-29. Polygon display

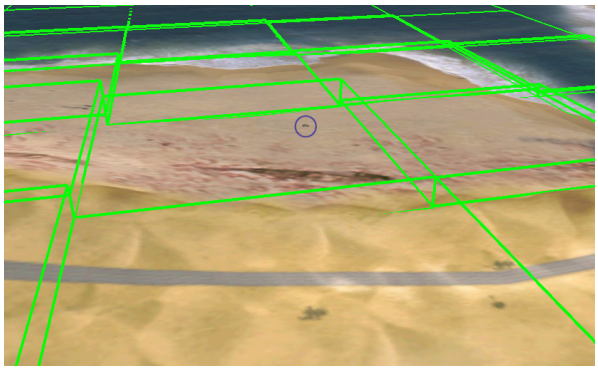


Figure 10-30. Collision objects display

To execute a console command:

1. Open the back-end console.
2. Type the command. You can type commands even if the console is displaying status messages. It will remember what you typed.
3. Press Enter.

10.15.2. Configuring Terrain Paging for the Back-End

You can configure terrain paging for the back-end in the *./appData/settings/vrfSim/terrainOptions.mtl* configuration file. Of particular note, you can configure the total number of triangles to be paged in at any one time. If the number of triangles exceeds this threshold, VR-Forces begins to page out triangles based on the priorities described in Section 3.11.5, "Using Large Terrain Databases," in *VR-Forces Users Guide*. The parameters that you can configure are described in comments in the file. (To configure terrain paging in the front-end, use the procedures described in "Loading MetaFlight Terrains," on page 10-27.)

10.16. Building Efficient MetaFlight Terrains for VR-Forces

VR-Forces can only load MetaFlight terrains built with certain tools. All MetaFlight files must be pre-processed by VR-Forces tools before they can be loaded. The following are recommendations for constructing MetaFlight terrains that can be processed and loaded into VR-Forces:

- The MetaFlight terrain can contain one or more Geometry Grid Datasets (GGDS).
- The MetaFlight terrain can contain one or more Virtual Texture Datasets.
- The MetaFlight terrain can contain one or more Cultural Feature Datasets.
- The MetaFlight terrain can be built in the following coordinate systems: Geodetic, Geocentric, UTM, or Flat Earth.
- For the best conversion of Virtual Textures into a tiled texture GGDS, match every Virtual Texture layer with a geometry layer.
- For optimal performance the GGDS should be set up in a Pyramid structure (Level 1: 1x1, Level 2: 2x2, Level 3: 4x4, and so on).
- For optimal performance levels 1-4 should be made of FILE LOD GEOM tiles only. Do not put any children LOD GEOM tiles in these levels.
- For optimal performance the terrain should be balanced so that any single FILE LOD GEOM is not too large and can be paged in real-time (based on machine speed and video card). In other words, keep any single file small.
- For optimal performance any single FILE LOD GEOM should not contain too many LOD GEOM nodes as children.
- Geometry Grid Tile size (in meters) should match Virtual Texture Tile coverage (in meters.)
- For optimal performance limit the number of external references. This will reduce cull times. (For example, instead of having 10 individual buildings, externally reference one city block with all 10 buildings.)

11

Mapping Models and Effects

This chapter explains how to map element definitions to DIS and HLA entity types. Appendix C, *Model Tutorials* walks you through the process of adding a model.

Introduction to Entity Type Mapping 11-2
- Adding an Entity Type Mapping 11-2
- Editing an Entity Type Mapping 11-4
- Filtering the Element Definition List 11-5
- Deleting an Entity Type Mapping 11-5
- How VR-Forces Maps DI-Guy Models 11-5

Clearing the Model Instancing Cache 11-6

Compressing Model Files 11-7

11.1. Introduction to Entity Type Mapping

In order to visualize a scene element (entity, aggregate, detonation, and so on), VR-Forces must map its entity type enumeration to an element definition. This section explains how to do that. For conceptual background, please see Section 4.3.3, "Mapping Entity Types to Element Definitions," in *VR-Forces Users Guide*.



When you add entities and other scene elements in the Entity Editor, it creates model definitions and handles entity type mapping. Although this chapter explains all of the details of the Entity Type Mappings dialog box, using the Entity Editor to add entities is the preferred method.

You map entity types to element definitions in the Entity Type Mappings dialog box. It has pages for mapping:

- Aggregate entities.
- Cockpit displays.
- Detonation effects.
- Entities.
- Firing effects.
- Tactical graphics.
- Tactical smoke.

The mapping process is the same for all entity types. You can add new entity type mappings, edit existing mappings, and delete mappings.



- You can map more than one element definition to an entity type. If you do this, when entities of this type appear in a simulation, VR-Forces randomly assigns one of the element definitions to the entity.
- You can map an element definition to more than one entity type.

11.1.1. Adding an Entity Type Mapping

This procedure describes how to map an element definition to an entity type enumeration. The element definition must already exist. The procedure is the same for any page on the Entity Type Mappings dialog box.

To add an entity type mapping:

1. Choose **Settings** → **Entity Type Mappings**. The Entity Type Mappings dialog box opens.
2. Select the Entity Mapping Settings page (Figure 11-1). The page shows a list of entity type enumerations in the Entity Type column. The entity definition mapped to the entity type is listed in the Entity Definition column.

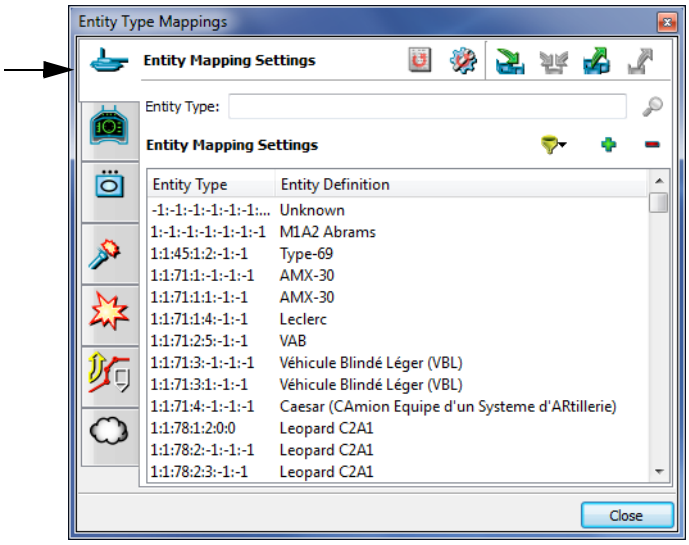


Figure 11-1. Entity Mapping Settings page

3. Click the Add button (+). The Create New Entity Type Model Mapping dialog box opens (Figure 11-2). It lists a default entity type enumeration.

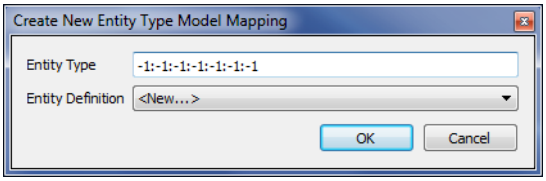


Figure 11-2. Create New Entity Type Model Mapping dialog box

4. In the Entity Type text box, type the enumeration you want to map to a model. (Separate each value with a colon(:).)
5. In the Entity Definition list, select the entity definition that you want to map to this entity type.
6. Click OK.
7. The new model mapping is added to the list.

11.1.2. Editing an Entity Type Mapping

This procedure describes how to edit an entity type mapping. The procedure is the same for any page on the Entity Type Mappings dialog box.

To edit an entity type mapping:

1. Choose **Settings** → **Entity Type Mappings**. The Entity Type Mappings dialog box opens.
2. Select the Entity Mapping Settings page (Figure 11-1).
3. Select the model mapping that you want to edit. If you know the entity enumeration that you want to edit, you can type the enumeration in the Entity Type text box and click the Search button (🔎). VR-Forces highlights the entry for that enumeration, if it is present.
4. To change the enumeration associated with an element definition:
   a. In the Entity Type column, click the enumeration to make it editable.
   b. Change the values of the enumeration.
   c. Click someplace else in the window.
5. To change the element definition associated with an enumeration:
   a. Optionally, filter the list of available element definitions. (For details, please see "Filtering the Element Definition List," on page 11-5.)
   b. In the Entity Definition column, click the element definition to make it an editable list (Figure 11-3)).
   c. Select the new element definition from the list.
   d. Click someplace else in the window.

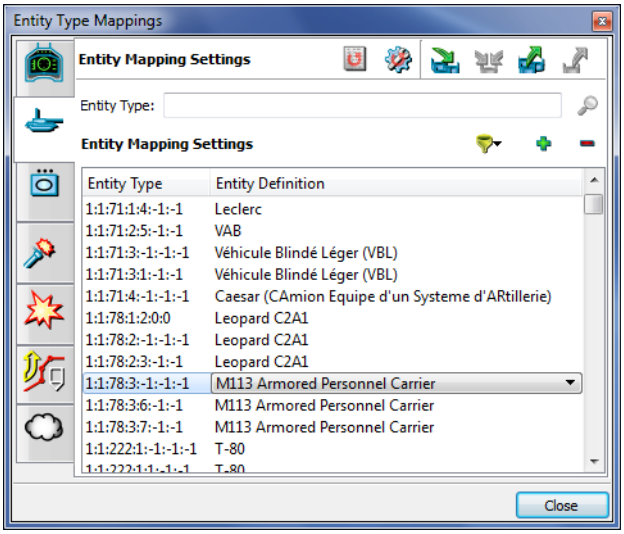


Figure 11-3. Editable entity definition

11.1.3. Filtering the Element Definition List

You can filter the list of element definitions that are available in the Entity Definition drop-down (Figure 11-3) list for mapping to entity types.



Filtering does not change the list of entities in the Entity Mapping Settings window. It just changes the list of entities in the Entity Definition list when you change a specific mapping.

To filter the list of element definitions:

1. On any page of the Entity Type Mappings dialog box, click the Filter button (). A menu is displayed. A check mark indicates the type of element definition that will be displayed when you make a element definition entry editable. (You may have to expand the hierarchy to see which elements are checked.)
2. Select the element definition type that you want to see in the list or select All to see all element definitions.

11.1.4. Deleting an Entity Type Mapping

The procedure for deleting an entity type mapping is the same for any page on the Entity Type Mappings dialog box.

To delete an entity type mapping:

1. Choose **Settings** → **Entity Type Mappings**. The Entity Type Mappings dialog box opens.
2. Select the Entity Mapping Settings page (Figure 11-1).
3. Select the model mapping that you want to delete. If you know the entity enumeration that you want to edit, you can type the enumeration in the Entity Type text box and click the Search button (). VR-Forces highlights the entry for that enumeration if it is present.
4. Click the Delete button ().

11.1.5. How VR-Forces Maps DI-Guy Models

Ordinarily, VR-Forces chooses animations to play for a DI-Guy based on the lifeform's speed, position, and similar attributes. However, VR-Forces can specify the DI-Guy state and appearance with the Set DI-Guy Appearance set data request and the Set DI-Guy Animation task. Once you explicitly set the DI-Guy appearance or animation, VR-Forces will no longer try to choose animations and will expect to be told how to render that lifeform for the remainder of the simulation.

11.2. Clearing the Model Instancing Cache

VR-Forces has a feature called model instancing that lets models share resources, such as geometry and textures. These shared resources are stored in a cache. Use of model instance caching decreases memory use and improves performance.

You can clear the model instancing cache if you need the disk space. You can clear it automatically whenever you create a new scene, or you can clear it manually.

To clear the model instancing cache after each scene change:

1. Choose **Settings** → **Application**. The Application Settings dialog box opens.
2. Select the File Caching Settings page (Figure 11-4).

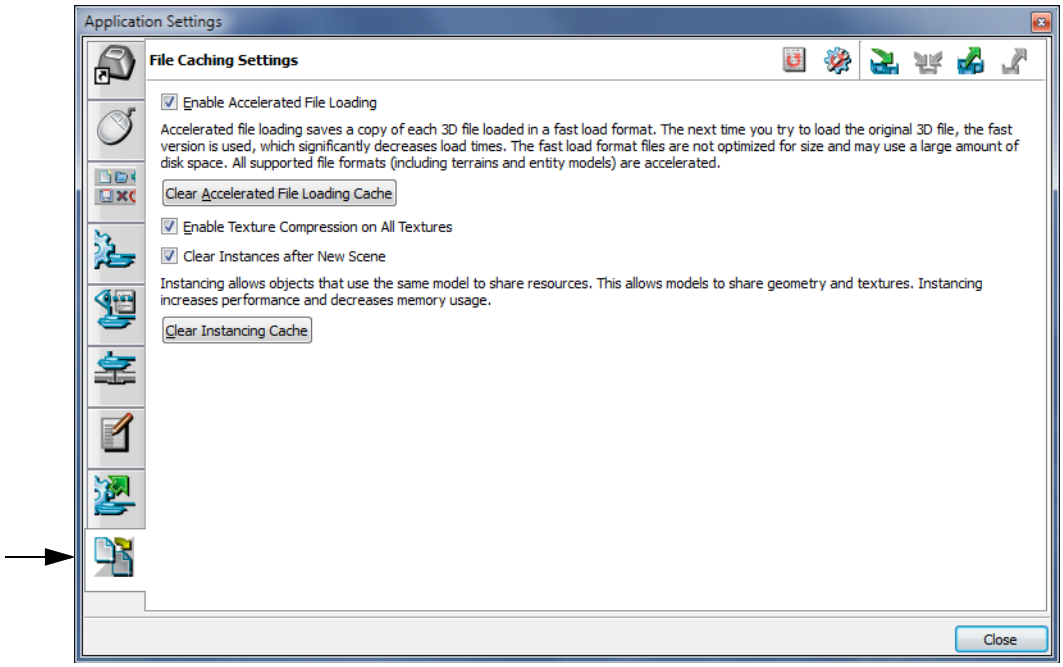


Figure 11-4. File Caching Settings page

3. Select the Clear Instances After New Scene check box.

To clear the model instancing cache manually:

1. Choose **Settings** → **Application**. The Application Settings dialog box opens.
2. Select the File Caching Settings page (Figure 11-4).
3. Click Clear Instancing Cache.

11.3. Compressing Model Files

The models and image files provided with VR-Forces are shipped in compressed formats (MÄK Encrypted Data Format (MEDF) and MÄK Encrypted Image Format (MEIF). You may want to compress your models to save space or protect intellectual property. You can convert supported formats to MEDF and MEIF with *./bin/medfTool.exe*. The compression tool supports the 3D modeling formats supported by VR-Forces, such as OpenFlight, 3DS, and OBJ, and raster formats such as RGB and PNG.



When VR-Forces processes a request to load a a file, such as an external reference in a terrain, it checks the cache and the directory of the requested file for an MEDF version of the file. If it does not exist, it loads the file in the original format.

The syntax for medfTool is as follows:

```
medfTool [-q simple_filename ... -p <integer> -s directory
   ... -z optimization -i -o -m extensions ...
   -x extensions ... --norecurse --directory directory
   -f filename -- -v -h]
```

Table 11-1 describes the arguments.

Table 11-1: medfTool arguments

Argument	Description
`(-- | --ignore_rest)`	Ignore all arguments after this one.
`--directory` *directory*	Specifies the directory to search for image and geometry files to convert into MEDF and MEIF. All subdirectories will be visited unless the `--norecurse` command line option is used.
`(-f | --file)` *filename*	Convert just this file. The extension of the file must be specified using `-x` or `-m` to indicate it is an image or a geometry file.
`(-h | --help)`	Displays usage information.
`(-i | --ignore_errors)`	Ignore errors in the encryption process and continue without exiting.
`(-m | --image_extensions)` *extension*	Specifies the extensions of image formats which will be converted into MEIF format. Use this argument to encrypt a directory. Can be used multiple times.
`--norecurse`	Do not recurse through subdirectories. Default: recurse through subdirectories.
`(-o | --onlyIfNew)`	Only generates an encrypted file if the expected output file does not exist.

Table 11-1: medfTool arguments

Argument	Description
(-p | --threads) *threads*	Specifies the number of threads to run. Specifying zero results in the number of threads equaling the number of logical processors the host machine has.
(-q | --forceOpaque) *simple_filename*	Specifies a filename and extension, but no path, to force polygons with these filenames to be opaque. Accepted multiple times.
(-s | --search) *directory*	Adds a directory to the search path when resolving external references. During processing, any external references not found will be removed from the generated files. Files in the search path are not converted.
(-v | --version)	Display version information and exit.
(-x | --extensions) *extension*	Specifies the extensions of geometry file formats which will be converted into MEDF format. Use this argument to encrypt a directory. Can be used multiple times.
(-z | --optimize) *optimization*	Specifies the optimization level. Maximum optimization may provide better optimization than the default setting, but it is significantly slower. Possible values are: ◆ 0 = None. ◆ 1 = Default. ◆ 2 = Maximum optimization.

The following example recursively compresses all FLT, RGB, RGBA, PNG, and DDS files in *%MAK_DATADIR%/Terrain*:

```
./bin/medfTool.exe
  --directory %MAK_DATADIR%/Terrain --extensions flt
  --image_extensions rgb --image_extensions rgba
  --image_extensions png --image_extensions dds
```

The following example compresses all FLT, RGB, RGBA, PNG, and DDS files in *%MAK_DATADIR%/Lifeforms*. It does not compress files in subdirectories.

```
./bin/medfTool.exe
  --directory %MAK_DATADIR%/Lifeforms --norecurse
  --extensions flt --image_extensions rgb
  --image_extensions rgba --image_extensions png
  --image_extensions dds
```

12

Model and Element Definitions

In Section 4.3, "Introduction to VR-Forces Object Modeling," in *VR-Forces Users Guide*, we describe the interplay of schemas, model definitions, entity definitions, and model mapping. This chapter explains how to create and edit model definitions and model schemas. "Adding a Model to VR-Forces," on page C-2 walks you through the process of adding a model.

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12.1. Managing Model and Element Definitions

This chapter explains how to use the Visual Model Editors dialog box to create and edit schemas, model definitions, and element definitions. This process can be rather complex. If you are customizing the visual characteristics of the entities provided with VR-Forces or adding new entity types that are significantly different from those provided with VR-Forces, you may need to create new model definitions or edit the existing ones. However, if you just need to add new entity types that are similar to existing entity types, it is strongly recommended that you do so in the Entity Editor. When you create an entity in the Entity Editor, it adds new model definitions and entity type mappings automatically. You will not need to do anything in the Visual Model Editor to configure the new entities.

12.2. Creating and Editing Schemas

The elements that make up a scene have parameters that help define them, for example a model filename. The set of parameters for a particular scene element is a schema. VR-Forces uses schemas to validate element definitions. You can create, copy, and delete schemas. For any schema, you can add and delete parameters and edit parameter values.



- Changes to schemas are saved automatically. For more information, please see Section 5.6, "Managing VR-Forces Settings," in *VR-Forces Users Guide*.
- Changes to element definitions do not take effect until you restart VR-Forces.

Model definition schemas define the elements that can be displayed in a scene. The model definition schemas provided with VR-Forces are:

- 3DText
- Animation
- Channel Compass
- Cockpit Display
- ControlLine
- ControlPoint
- ControlPrism
- Cuboid
- Cylinder
- Decal
- DiGuyCharacter
- EllipsoidArc
- Entity
- GreatCircleArc
- GridLines
- Line
- ParticleSystem
- Ribbon
- SpeedTree
- TacticalSmoke
- Terrain
- Tree
- WidgetTheme.

12.2.1. Creating Schemas

To create a schema:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Schema Editor page (Figure 12-1).

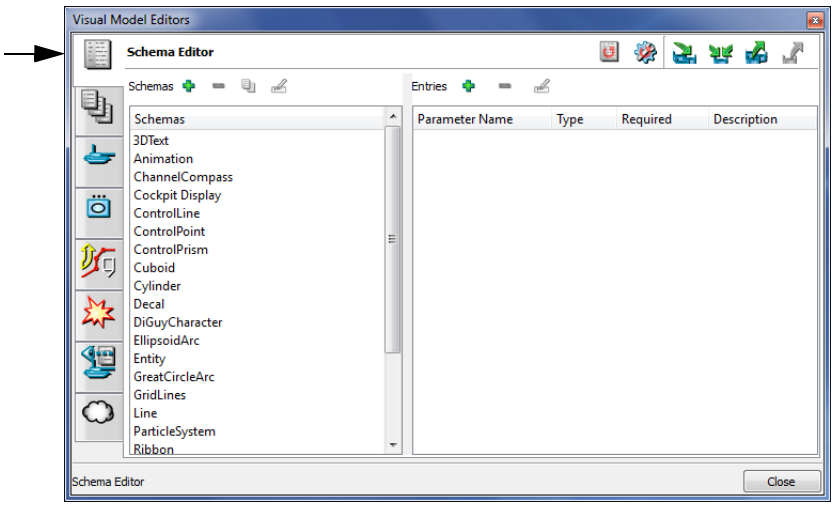


Figure 12-1. Schema Editor page

3. Click the Add button (+) next to the Schemas label. The Create Instance dialog box opens (Figure 12-2).

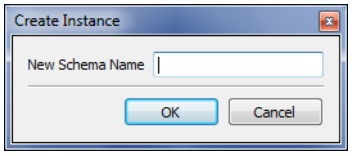


Figure 12-2. Create Instance dialog box

4. Type a name for the new schema.
5. Click OK.
6. Add parameters as described in "Adding a Parameter to a Schema," on page 12-6.

12.2.2. Deleting Schemas



If a schema is used by a model definition, you cannot delete it. The Delete Schema button will be unavailable.

To delete a schema:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Schema Editor page (Figure 12-1).
3. In the Schemas list, select the schema you want to delete.
4. Click the Delete button () next to the Schemas label. You are prompted to confirm the deletion.
5. Click Yes. The schema is removed from the list.

12.2.3. Copying Schemas

If you want a new schema that is a variant of an existing one, it can be easier to copy the existing schema and edit it, than it is to create a new schema and add all of the parameters.

To copy a schema:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Schema Editor page (Figure 12-1).
3. Select the schema that you want to copy.
4. Click the Duplicate button (). The Duplicate Schema dialog box opens.
5. Type a name for the copied version of the schema.
6. Click OK.
7. The new schema is added to the list.
8. Edit the parameters as described in "Editing a Schema Parameter," on page 12-7.

12.2.4. Adding a Parameter to a Schema

To add a parameter to a schema:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Schema Editor page (Figure 12-1).
3. In the Schemas list, select the schema to which you want to add a parameter.
4. Click the Add button (✚) next to the Entries label. A parameter called “key” is added to the parameter list (Figure 12-3).

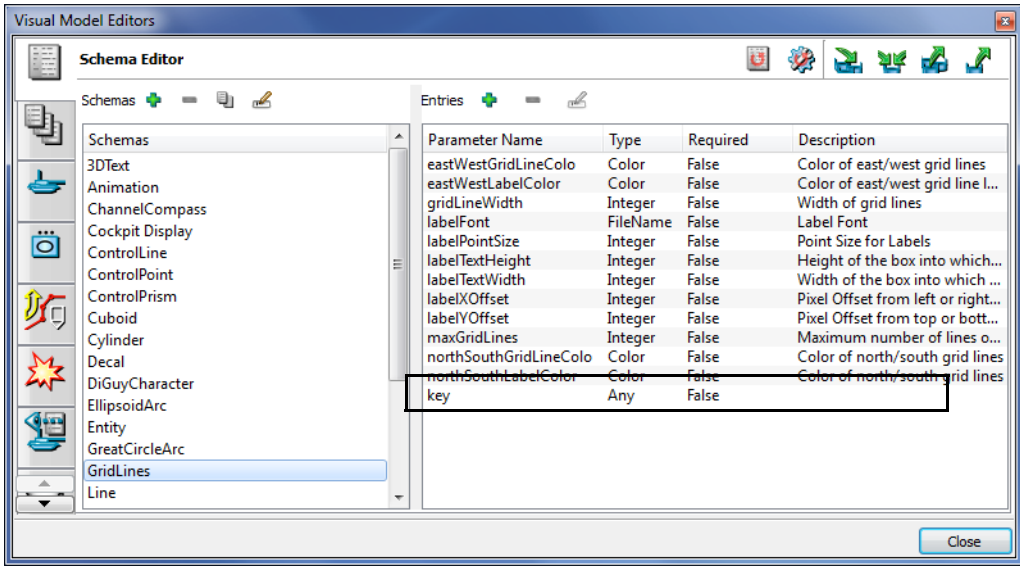


Figure 12-3. New schema parameter

5. Double-click “key”. The Rename Parameter dialog box opens.
6. Type a name for the parameter.
7. If the parameter has a specific type, click the value in the Type column and edit it.
8. If the parameter is required, click the value in the Required column and change it to True.
9. Optionally, add a description. The description provides context sensitive help on the element definition pages. To add a description:
   a. Click the empty field in the Description column. The Edit Text dialog box opens.
   b. Type the descriptive text.
   c. Click OK.

12.2.5. Deleting a Parameter from a Schema

If you delete a parameter from a schema, any element definitions that use the schema may become invalid. Invalid element definitions are shown in red in the list of definitions.

To delete a parameter from a schema:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Schema Editor page (Figure 12-1).
3. In the Schemas list, select the schema from which you want to delete a parameter.
4. Select the parameter that you want to delete.
5. Click the Delete button (−) next to the Entries label.

12.2.6. Editing a Schema Parameter

To edit a parameter for a schema:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Schema Editor page (Figure 12-1).
3. In the Schemas list, select the schema for which you want to edit a parameter.
4. Click the parameter attribute that you want to edit. The attribute becomes editable.
5. Type the new attribute value.

12.3. Creating and Editing Model Definitions

Many of the visual definitions in an element definition have a model definition parameter. A model definition specifies a set of parameters that are appropriate to the object type. (The parameters are determined by the model definition's schema. For information about model schemas, please see "Creating and Editing Schemas," on page 12-3.) For most VR-Forces users, the most important thing to know about model definitions is that for 3D models, the model definition specifies the 3D model, such as an OpenFlight file, that is used to display an entity. If you want to add new models to VR-Forces, you will probably have to create a new model definition for each one.

VR-Forces comes with an extensive set of model definitions that are mapped to the included models. You can edit or delete these model definitions and you can create new ones.

Model definitions are created and edited on the Model Definition Editor page of the Visual Model Editors dialog box (Figure 12-4).

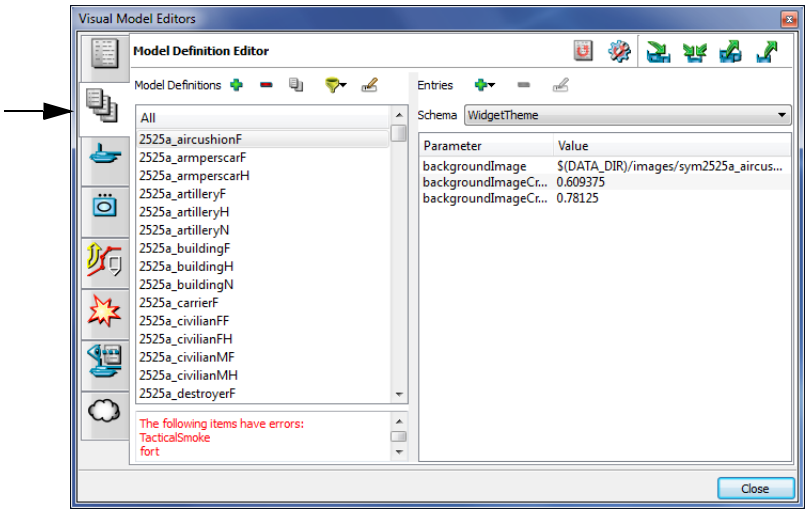


Figure 12-4. Model Definition Editor page

- Any model definition that uses the Entity, Tree, or SpeedTree schema is automatically added to the Prop Palette.
- The model definition for an entity includes the 3D model used to represent it. You can change the model in the Visual Model Editors dialog box. However, you can also quickly and easily change the 3D model for an entity in the Entity Editor. For details, please see "Editing an Entity's Visual Model," on page 5-21.
- Changes to element definitions do not take effect until you restart VR-Forces.

12.3.1. Creating a Model Definition

To create a model definition:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Model Definition Editor page (Figure 12-4).
3. Optionally, filter the model definitions in the list. (For details, please see "Filtering the List of Model Definitions," on page 12-11.)
4. Click the Add button (+) next to the Model Definitions label. The Add Model Definition dialog box opens (Figure 12-5).

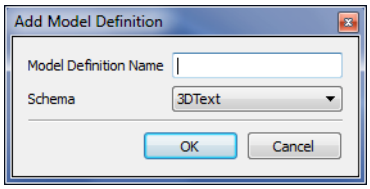


Figure 12-5. Add Model Definition dialog box

5. Type a name for the new model definition.

! Model definitions for DI-Guy characters must end with the letters DIG. Model definitions for SpeedTrees must end in ST.

---

6. In the Schema list, select a schema for the model. (This list matches the list of schemas on the Schemas page.)
7. Add parameters to the model, as described in "Adding Parameters to a Model Definition," on page 12-12.

12.3.2. Deleting a Model Definition



If a model definition is being used, you cannot delete it.

To delete a model definition:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Model Definition Editor page (Figure 12-4).
3. Optionally, filter the model definitions in the list. (For details, please see "Filtering the List of Model Definitions," on page 12-11.)
4. Select the model that you want to delete.
5. Click the Delete button () next to the Model Definitions label. You are prompted to confirm the deletion.
6. Click Yes. The model definition is removed from the list.

12.3.3. Copying a Model Definition

If you want a new model that is a variant of an existing one, it can be easier to copy the existing model and edit it, than to create a new model and add all of the parameters.

To copy a model definition:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Model Definition Editor page (Figure 12-4).
3. Optionally, filter the model definitions in the list. (For details, please see "Filtering the List of Model Definitions," on page 12-11.)
4. Select the model that you want to copy.
5. Click the Duplicate button ( ). The Duplicate Model Definition dialog box opens (Figure 12-6).

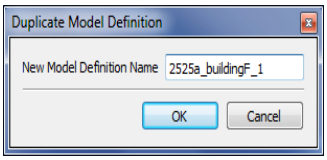


Figure 12-6. Copy model definition

6. Type a name for the copied version of the model.
7. Click OK.
8. The new model definition is added to the list.
9. Edit the parameters as described in "Editing a Model Definition," on page 12-12.

12.3.4. Filtering the List of Model Definitions

By default, the Model Definition Editor page lists all models that VR-Forces knows about. You can filter the list to more easily work with a specific type of model.

➤ To filter the list of model definitions, click the Filter button ( ) and select a schema type from the list.

12.3.5. Editing a Model Definition

You can add parameters to a model definition, you can delete parameters, and you can change their values. You can only add parameters that are appropriate to the schema type for a model.

> If you change the model definition for an entity that is already in the scene, the updated definition is not applied to the entity. To apply an edited model definition to all entities, disconnect from the exercise and then reconnect.

Adding Parameters to a Model Definition

When you create a new model definition, you must specify the parameters required by its schema. You can only add parameters that are permitted by the schema.

To add a parameter to a model:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Model Definition Editor page (Figure 12-4).
3. Optionally, filter the model definitions in the list. (For details, please see "Filtering the List of Model Definitions," on page 12-11.)
4. Select the model for which you want to add a parameter.
5. Click the Add Parameter button (). A list of parameters is displayed (Figure 12-7).

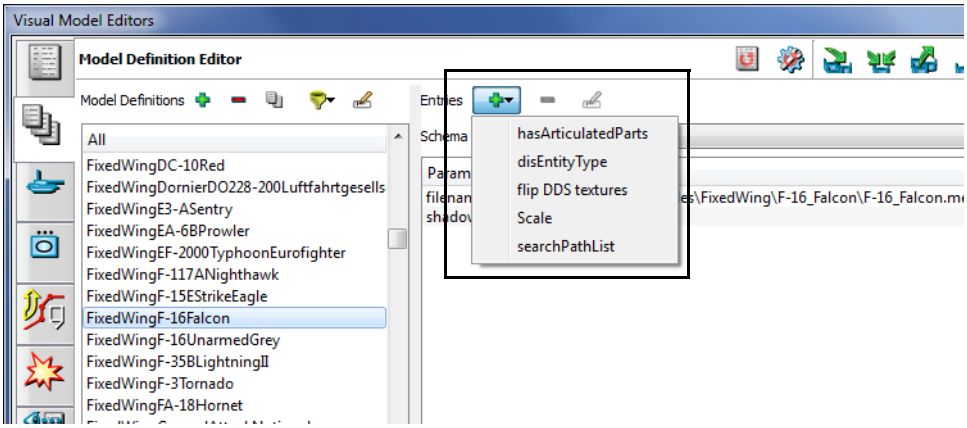


Figure 12-7. Add parameter list

6. Select the parameter you want to add. It is added to the parameter list.
7. Click the value for the parameter. The field becomes editable (Figure 12-8).

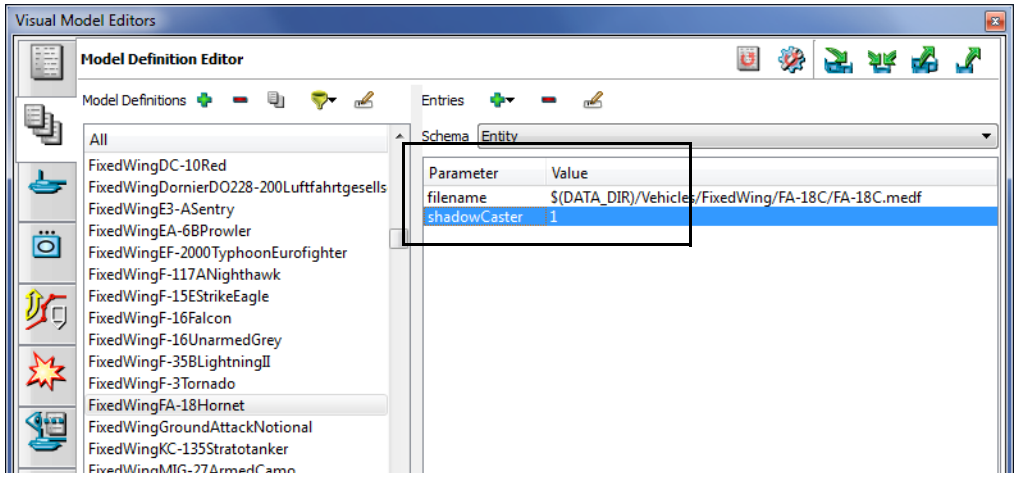


Figure 12-8. Editable parameter

8. Type or select a value for the parameter.
9. Click away from the field.

Editing a Model Definition Parameter

To edit a parameter:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Model Definition Editor page (Figure 12-4).
3. Optionally, filter the model definitions in the list. (For details, please see "Filtering the List of Model Definitions," on page 12-11.)
4. Select the model for which you want to edit a parameter.
5. Click the value for the parameter you want to edit. The field becomes editable (Figure 12-8).
6. Change the value for the parameter.
7. Click away from the field.

Deleting Parameters from a Model Definition

If you delete a parameter from a model definition, the definition may become invalid. Invalid model definitions are shown in red.

To delete a parameter from a model:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Model Definition Editor page (Figure 12-4).
3. Optionally, filter the model definitions in the list. (For details, please see "Filtering the List of Model Definitions," on page 12-11.)
4. Select the model from which you want to delete a parameter.
5. Select the parameter that you want to delete.
6. Click the Delete button (−) next to the Entries label. The parameter is removed.

12.3.6. Saving Model Definitions

Like all VR-Forces settings, when you change a model definition, the change is automatically saved. You can also use the common settings management controls for exporting, loading, and merging settings. For details about the common settings, please see Section 5.6, "Managing VR-Forces Settings," in *VR-Forces Users Guide*.

12.4. Creating and Editing Element Definitions

Element definitions define how VR-Forces renders scene elements (entities, tactical graphics, interactions, aggregates, cultural features, spot reports, and so on).

Element definitions use a tree-style hierarchy to assign visual definitions. At any level of the hierarchy an element definition inherits the visual definitions of its parents. This makes it possible to assign a visual definition to many elements at one time. You can change the inherited parameter values for a specific element at any level of the hierarchy. However, in most cases, you cannot delete an inherited visual definition.

You can create and edit element definitions. The procedures are the same for each element type.



Changes to element definitions do not take effect until you restart VR-Forces.

12.4.1. Creating an Element Definition

To create an element definition:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the page for the type of element definition that you want to create.
3. Expand the element definition hierarchy to the level at which you want to add an element definition and select the parent element (Figure 12-9).

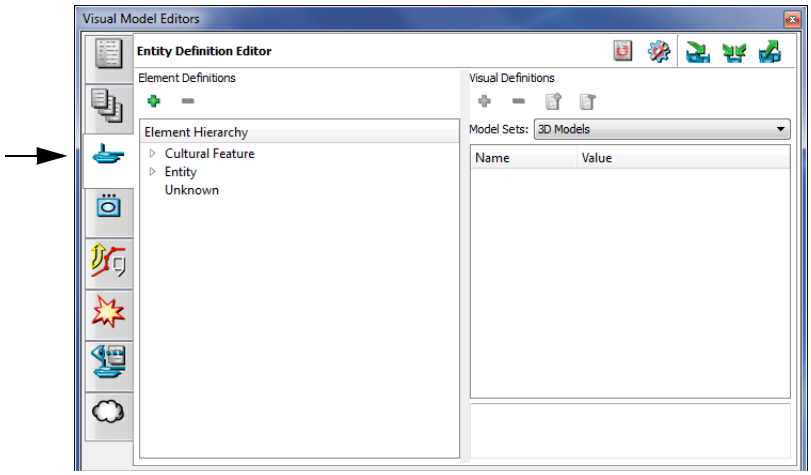


Figure 12-9. Entity Definition Editor page

4. Click the Add button (+). The Create Element Definition dialog box opens.
5. Type a name for the element definition. (You cannot edit the name after you create it, so try to avoid typing errors.)
6. Click OK. The new element is added to the list.
7. Optionally, edit the visual definitions assigned to the element. For details, please see "Editing a Visual Definition," on page 12-17.
8. Optionally, add a visual definition to the element. For details, please see "Adding a Visual Definition," on page 12-16.
9. Optionally, save the element to a file. For details, please see "Saving Element Definitions," on page 12-20.

12.4.2. Editing an Element Definition

An element definition consists of a list of visual definitions for that element. You can add visual definitions and you can edit their parameters. In most cases, you cannot delete an inherited visual definition.

Adding a Visual Definition

To add a visual definition to an element definition:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the page for the type of element definition that you want to edit (Figure 12-9).
3. Select the element definition that you want to edit.
4. Optionally, on the Model Sets list, select the model set you want to use.
5. Click the Add button (+) next to the Visual Definitions label. The Create Visualizer Definition dialog box displays a list of available visual definitions.

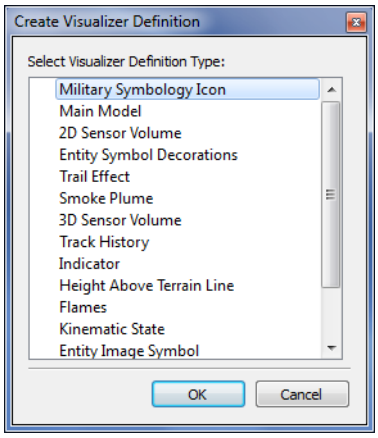


Figure 12-10. Create Visualizer Definition dialog box

6. Select the visual definition that you want to add.
7. Click OK. The visual definition is added to the element.
8. Optionally, edit the parameters for the visual definition. For details, please see "Editing a Visual Definition," on page 12-17.

Editing a Visual Definition

Visual definitions and their attributes are displayed either as grey italicized text or as black text (Figure 12-11). Italicized text indicates that the visual definition or attribute is inherited from a parent element. Visual definitions and attributes that are not italicized are particular to that element. (These entries could be inherited by child elements.)

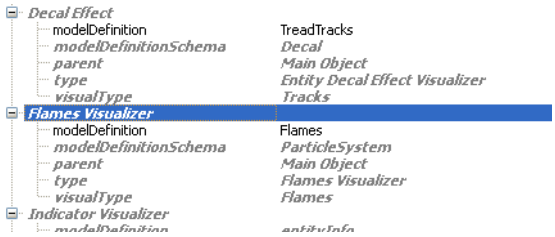


Figure 12-11. Visual definition entry

To edit a visual definition parameter:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the page for the type of element definition that you want to edit (Figure 12-9).
3. Select the element definition that you want to edit.
4. In the Visual Definitions pane, click the value of the attribute that you want to edit. Depending on the attribute, a list of available values is displayed, a dialog box is displayed (Figure 12-12), or the field becomes editable.

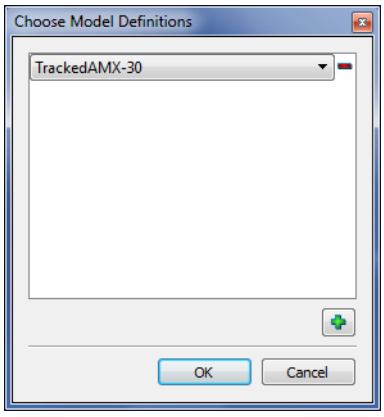


Figure 12-12. Choose Model Definitions dialog box

5. For a list, select the new value. For an editable field, type a new value. For a dialog box:
   a. If the dialog box window does not have a list, click the Add button (+). A list of values is added to the dialog box window.
   b. Select the value that you want.
   c. Click OK.

Mapping to Multiple Model Definitions or Schema

There may be cases where you want to map a visual definition to multiple model definitions or multiple schema. If you do this, VR-Forces randomly assigns the model definition or schema to instances of the object.

To map a visual definition attribute to multiple values:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the page for the type of element definition that you want to edit (Figure 12-9).
3. Select the element definition that you want to edit.
4. In the Visual Definitions pane, click the value of the **modeldefinition** or **modeldefinitionschema** parameter that you want to edit. A dialog box opens. If the attribute already has values, they are listed in the dialog box window as a series of lists (Figure 12-13).

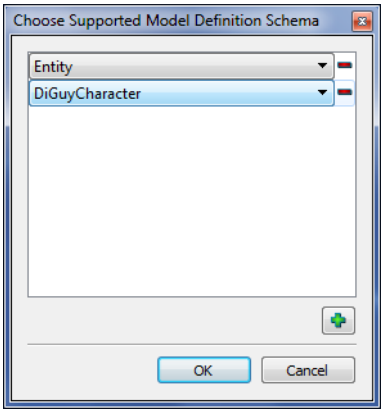


Figure 12-13. Parameter with multiple values

5. To add a value, click the Add button (+). A new list is added to the window.
6. Select a value from the new list.
7. To remove a value, click the Delete button (−) next to the list for that value.
8. Click OK. The visual definitions list does not show all of the values, but clicking it will open the dialog box again and show the selected values.

Adding an Attribute to a Visual Definition

Each visual definition has a set of attributes. Some of them may be optional, so they are not specified as part of the factory definitions. You can add optional attributes to a visual definition.

To add an attribute to a visual definition:

1. Select the visual definition that you want to edit.
2. Click the Add Attribute button ( ). The Add Visualizer Definition Attribute window opens. It lists the attributes that are available for the visual definition (Figure 12-14).

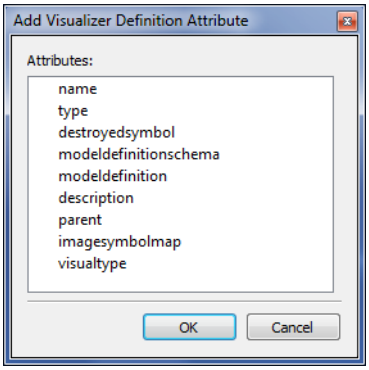


Figure 12-14. Add Visualizer Definition Attribute window

3. Select the attribute that you want to add.
4. Click OK. The attribute is added to the visual definition.
5. Specify a value for the attribute. This might require typing a value, selecting a value from a list, or selecting a value in another window.

Deleting an Attribute from a Visual Definition

You can delete individual attributes from a visual definition.

! The Delete button above the list of visual definitions deletes entire visual definitions. Do not click it thinking it will delete just the selected attribute.

To delete an attribute:

1. Select the visual definition that you want to edit.
2. Select the attribute that you want to delete.
3. Click the Delete Attribute button ( ).

12.4.3. Deleting an Element Definition



You cannot delete an element definition if it is being used.

To delete an element definition:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the page for the type of element definition that you want to delete (Figure 12-9).
3. Select the element definition that you want to delete.
4. Click the Delete button (−) next to the Entity Definitions label.
5. Confirm the deletion.

12.4.4. Saving Element Definitions

Changes to element definitions get saved automatically. You can also save element definitions using the standard VR-Forces options for saving settings. For details, please see Section 5.6, "Managing VR-Forces Settings," in *VR-Forces Users Guide*.

12.5. Configuring 2D Icons

The 2D icons in VR-Forces are configured in visual definitions. Font-based icons are configured in the Military Symbol Icon visual definition. Image-based icons use the Entity Image Symbol visual definition.



You can quickly change the 2D icon for an entity in the Entity Editor. For details, please see "Editing an Entity's Visual Model," on page 5-21.

12.5.1. Editing Font-Based 2D Icons

By default, 2D icons are configured in the Military Symbol Icon visual definition, which is part of an entity's entity definition. This visual definition uses font-based icons. You can change an entity's icon by changing the fillGlyph and outlineGlyph attributes.

To change an entity's icon:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Entity Definition Editor page (Figure 12-9).
3. Select the entity whose icon you want to edit.
4. In the Model Sets list, select 2D Icons.
5. To change the fill glyph:
   a. Under the Military Symbology Icon visual definition, select the fillGlyph attribute (Figure 12-15).

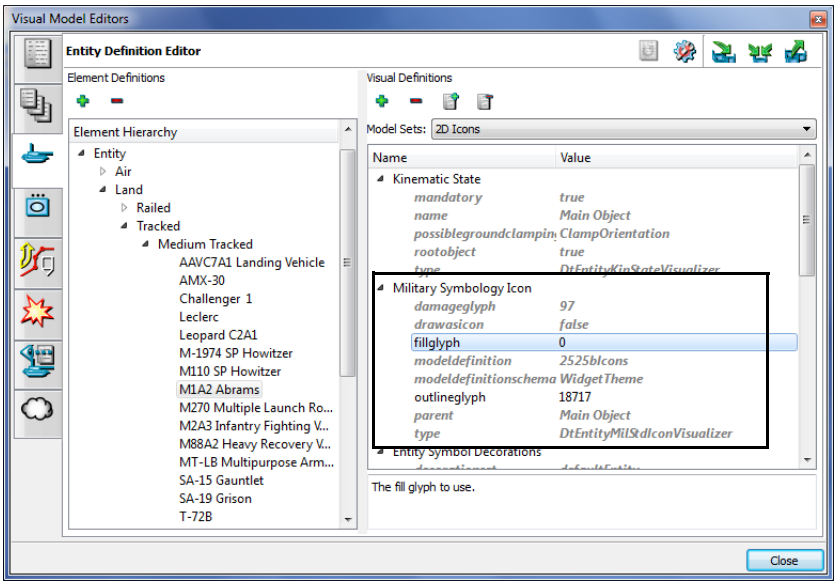


Figure 12-15. Military Symbol Icon visual definition

b. Click the value in the Value column. The Choose Font Glyph dialog box opens (Figure 12-16).

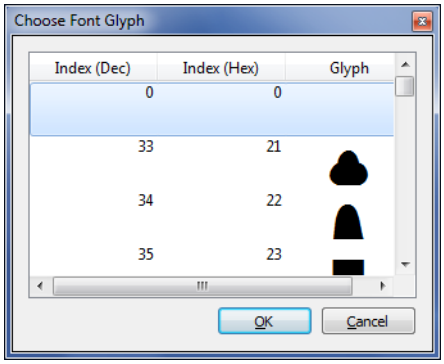


Figure 12-16. Choose Font Glyph dialog box

c. Select the glyph with the fill pattern you want to use. Click OK.

6. To change the outline glyph, follow the same procedure as changing the fill glyph.

12.5.2. Using Images for 2D Icons

By default, VR-Forces uses TrueType fonts for 2D icons. You can replace the font-based icons with images using the Entity Image Symbol visual definition.



If you configure images for icons, be sure to save the entity definitions to a file other than the default settings. If you revert to factory defaults or otherwise switch back to font-based icons and you have not saved the image mappings, you will not be able to recover them without repeating the entire mapping process again.

To use images for entity icons:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Entity Definitions tab (Figure 12-9). (If you want to change the icon for an aggregate, select the Aggregates tab. To change the icon for a waypoint, select the Tactical Graphics tab.)
3. In the Model Sets list, select 2D Icons.
4. In the Element Definitions list, select Entity. (If you are editing aggregate images, in the Element Definitions list select Aggregate. If you are editing tactical graphics images, in the Element Definitions list select Waypoint. For all other tactical graphics, skip to step 8.)
5. In the Visual Definitions list, select Military Symbology Icon (Figure 12-17).

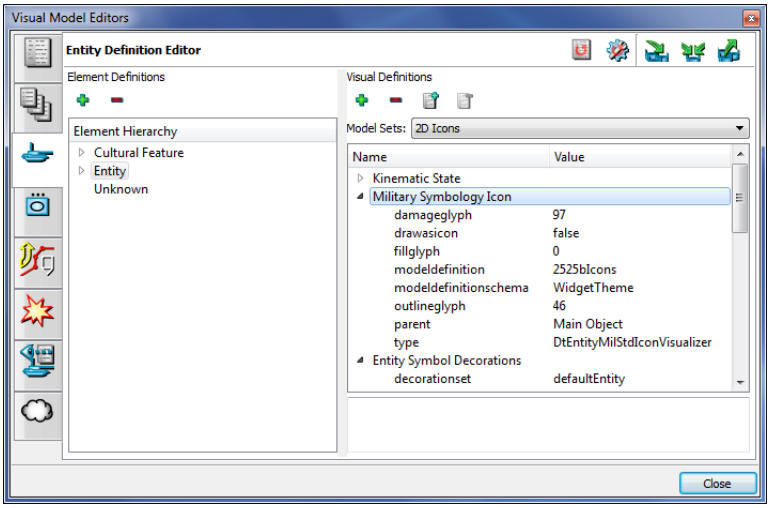


Figure 12-17. Entity element definition with Military Symbology Icon visual definition

6. Click the Delete button (−). The visual definition gets deleted.

7. Click the Add button (). The Create Visualizer Definition window opens. It displays a list of visual definitions (Figure 12-18).

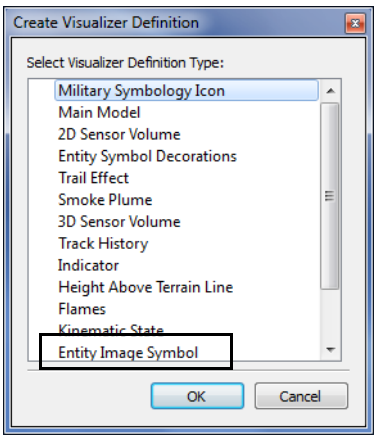


Figure 12-18. Create Visualizer Definition window

8. Select Entity Image Symbol. (If you are configuring images for aggregate entities, select Aggregate Image Symbol; for tactical graphics, select Tactical Graphic Image Symbol.)
9. Click OK.
10. In the Visual Definitions list, select Entity Image Symbol (Figure 12-19).

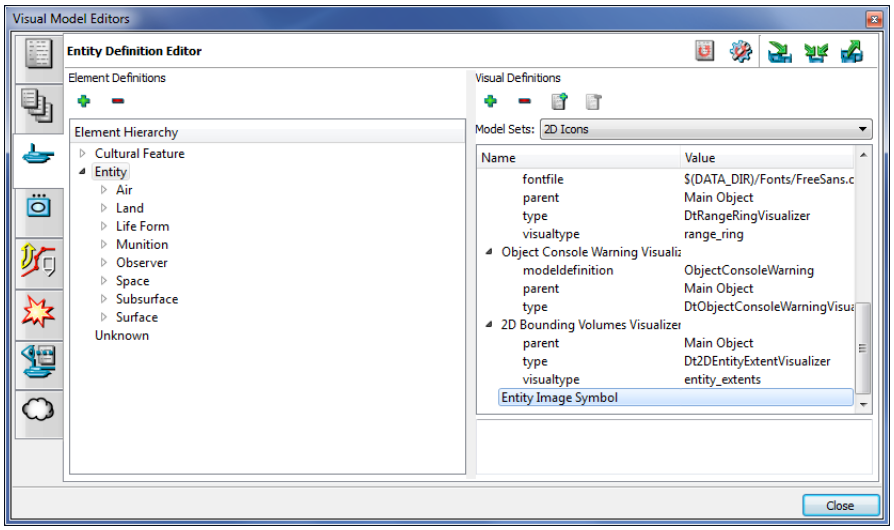


Figure 12-19. Entity element definition with Entity Image Symbol visual definition

11. Click the Add Attribute button (). The Add Visualizer Definition Attribute window is displayed (Figure 12-20).

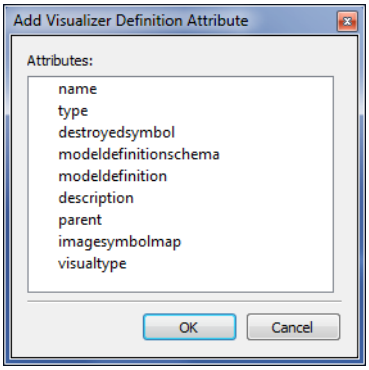


Figure 12-20. Add Visualizer Definition Attribute window

12. In the attribute list, select **parent**.
13. Click OK. The **parent** attribute is added to the visual definition.
14. Click the value field to make it editable.
15. Type Main Model and press **Enter**.
16. Click the Add Attribute button.
17. In the attribute list, select **type**. The value is filled in automatically.
18. Click the Add Attribute button.
19. In the attribute list, select **modeldefinitionschema**. The Choose Supported Model Definition Schema dialog box opens (Figure 12-21).

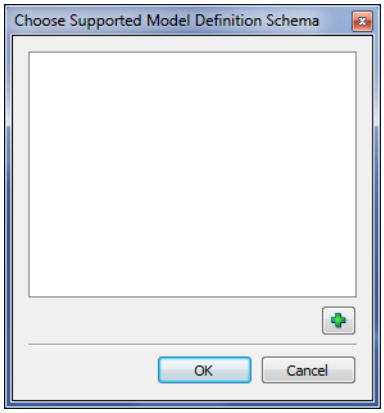


Figure 12-21. Choose Supported Model Definition Schema dialog box

20. Click the Add button. A list is added to the dialog box.
21. In the list, select **WidgetTheme** (Figure 12-22).

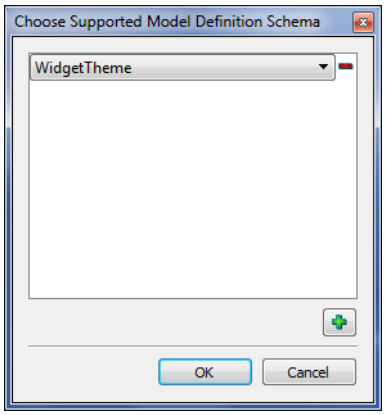


Figure 12-22. Completed Choose Supported Model Definition Schema dialog box

22. Click OK.
23. Click the Add Attribute button.
24. In the attribute list, select **imagesymbolmap**. The 2D Symbol Image Mapper dialog box opens (Figure 12-23).

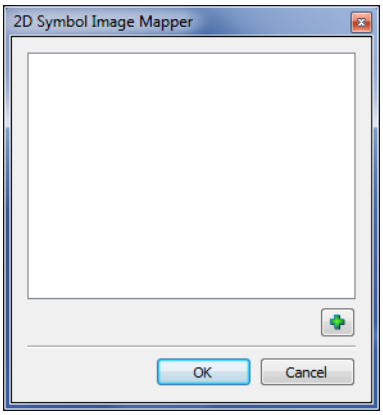


Figure 12-23. 2D Symbol Image Mapper dialog box

25. Click the Add button. A list is added to the dialog box. It lists the forces for which you can map images. and the images that you can apply to a particular force
26. Select a force and an image from the lists (Figure 12-24).

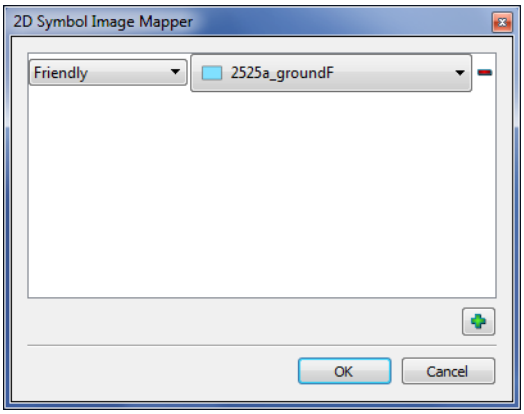


Figure 12-24. 2D Symbol Image Mapper dialog box with force chosen

27. Add an entry for each force that you want to represent with an image.
28. Click OK.
29. Click the Add Attribute button.
30. In the attribute list, select **destroyedsymbol**. The **destroyedsymbol** attribute is added to the visual definition.
31. In the **destroyedsymbol** list, select Destroyed. The completed visual definition should look similar to Figure 12-25.

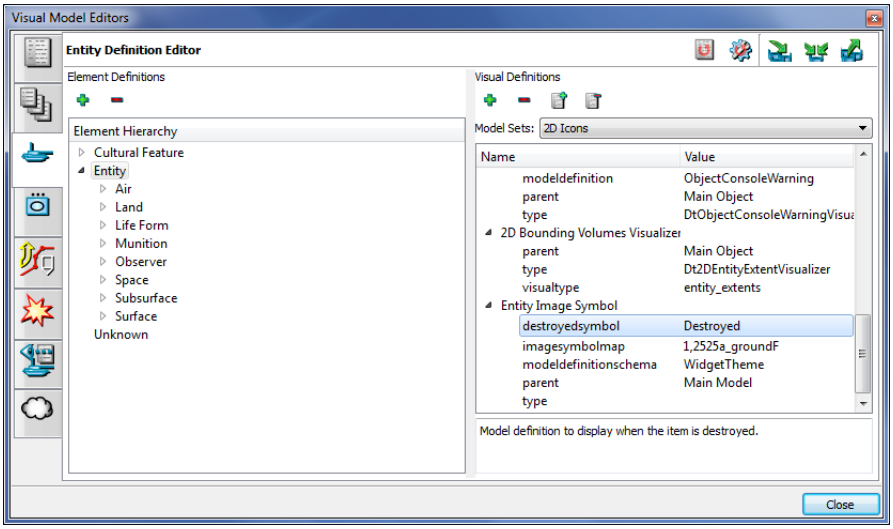


Figure 12-25. Entity Image Symbol visual definition

The settings for the Entity Image Symbol visual definition are inherited by each entity in the hierarchy from the base Entity definition. Unless you configure the various entity categories, all entities use the images you configured for the Entity category. Therefore, at a minimum, change the **imagesymbolmap** values for each force at each generic entity type, such as Fixed Wing and Life Form, to use the proper image for that entity type. Optionally, you can specify an image for each entity definition at the leaf level.



When you edit the Entity Image Symbol visual definition attributes, be sure that you select the 2D Icons model set.

12.5.3. Adding Images for Entities

VR-Forces includes a representative set of MIL-STD 2525a images. They are in *./data/images*. If you want to add your own images, you can do so by adding a new model definition or changing the image mapping for an existing model definition. The new images are automatically added to the list of images for the **imagesymbolmap** in the Entity Image Symbol visual definition.

To add images for entities:

1. Copy the new images to *./data/images*.
2. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
3. Select the Model Definition Editor page (Figure 12-4).
4. In the Schema list, select WidgetTheme.
5. If you want to change the image used for an existing model definition:
   a. Select the model definition that you want to change, for example, 2525a_groundF.
   b. Change the file specified for the **backgroundImage** attribute.

   If you want to specify an image for a new model definition:
   a. Create a new model definition, as described in "Creating and Editing Model Definitions," on page 12-8. It is recommended that you copy an existing model definition for a 2525a symbol.
   b. Specify the image that you want to use for the new model definition.

12.6. Adding New Cockpit Display Models

VR-Forces supports cockpit displays created with GL Studio. A cockpit is implemented through a Reusable Software Object (RSO) DLL. A cockpit's values are changed through updaters. An updater is associated with a cockpit attribute through the cockpit model definition. Figure 12-26 shows the model definition for a cockpit.

Cockpit updaters are associated with an attribute name that is known to the RSO. The value you provide for a cockpit-specific attribute is the name of an updater for dynamically changing values or a constant value. Constant values are commonly used to configure a cockpit when it is loaded. VR-Forces provides a set of commonly used updaters. You can add additional updaters or override existing updaters through a plug-in.



The GL Studio license included with VR-Forces only covers the cockpits delivered with the product. If you add your own cockpits, you will need GL Studio run-time licenses.

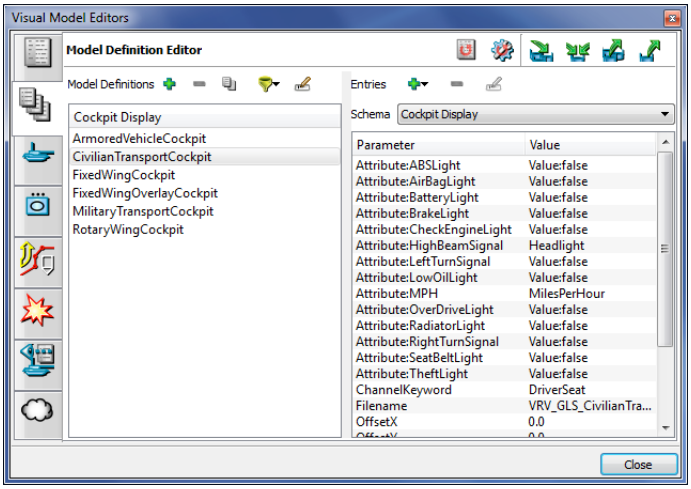


Figure 12-26. Cockpit model definition

The general procedure for adding a new cockpit model is:

1. Install the cockpit's DLL.
2. Create a model definition for the cockpit.
3. Map entity types to the model definition, as described in "Adding an Entity Type Mapping," on page 11-2.

12.6.1. Installing a Cockpit DLL

If you create your own cockpit, it is implemented as an RSO DLL that you must add to the VR-Forces file structure.

➤ To install a new cockpit, place the DLL for the cockpit in *./data/Huds* and create a model definition for it.

12.6.2. Creating a Model Definition for a Cockpit

Cockpit models are configured using schemas and model definitions, just like any other model in VR-Forces. This section provides additional details specific to cockpits.

To create a model definition for a cockpit:

1. Add a new model definition, as described in "Creating a Model Definition," on page 12-9. Be sure to select Cockpit Display as the schema. A new model definition is added to the display (Figure 12-27). The message window lists the parameters that you must add. These are the parameters defined by the schema.

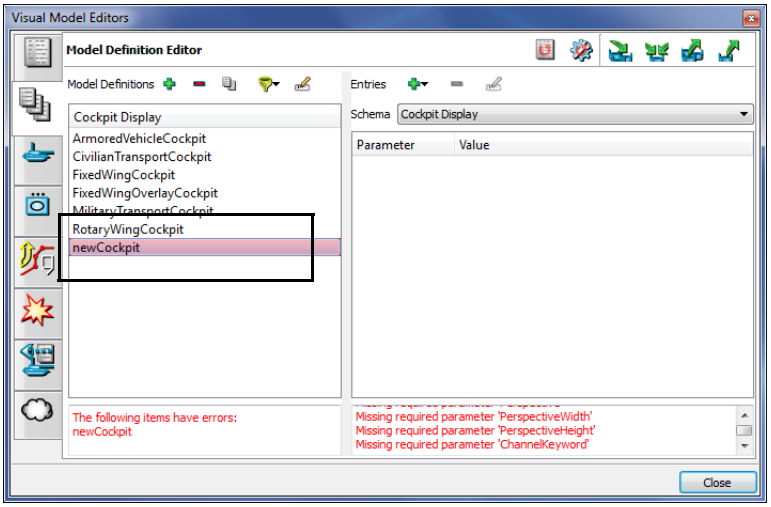


Figure 12-27. New cockpit model definition

2. Add the required parameters, as described in "Adding Parameters to a Model Definition," on page 12-12. Table 12-1 describes the required parameters.

Table 12-1: Required parameters for cockpit models

Parameter	Description
Filename	The name of the DLL without the file extension.
RSOName	The name of the class to be loaded from the DLL. Default: *filename*Class.

Table 12-1: Required parameters for cockpit models

Parameter	Description
Perspective	2D or 3D. This parameter refers to the perspective of the cockpit display, not the terrain. Currently, only 2D cockpit displays are provided with VR-Forces.
PerspectiveWidth PerspectiveHeight	Adjusts the orthogonal projection for a 2D cockpit. Adjusts the perspective projection for a true 3D cockpit.
ChannelKeyword	A keyword that tells a channel to display any object that has the keyword in its definition. Default: showCockpits. (This keyword means that any channel that has the showCockpits keyword will show cockpits.)
Offset X Offset Y Offset Z	Moves the cockpit offset around the screen. The OffsetX value shifts the cockpit left or right. The OffsetY value shifts it up or down. OffsetZ shifts a 3D cockpit forward and back. It has no effect on 2D cockpits.

3. Add the parameters required by the cockpit RSO. To do this, add an Attribute parameter, as follows:
   a. Add an Attribute parameter, as described in "Adding Parameters to a Model Definition," on page 12-12.
   b. Double-click the parameter to make its name editable.
   c. Add a colon and the name of an RSO attribute that you need to map. For example, Attribute:Heading.
   d. In the Value column, click the value to make it editable. Type the name of an updater or specify a constant value in the format Value:*value*. You can specify an updater that you have added through a plug-in or one of the updaters provided with VR-Forces, as described in Table 12-2.
4. Map an entity type to your definition, as described in "Adding an Entity Type Mapping," on page 11-2.

Table 12-2: Updaters provided

Updater	Description
AOA	Angle of Attack. Returns the pitch of the entity clamped (5 to 30 degrees).
FeetAGL	Feet Above Ground Level. Returns the feet above the terrain (or buildings below).
FeetMSL	Feet Above Mean Sea Level. Returns the altitude above the sea level.
FeetPerMinute	Feet Per Minute. Returns the climb rate.
KilometersPerHour	Speed of the entity in kilometers per hour.
MilesPerHour	Speed of the entity in miles per hour.

Table 12-2: Updaters provided

Updater	Description
KnotsPerHour	Speed of the entity in nautical miles per hour.
Pitch	Returns the pitch of the entity clamped (-180 to 180 degrees).
Roll	Returns the roll of the entity clamped (-180 to 180 degrees).
Yaw	Returns the yaw of the entity clamped (0 to 360 degrees).
Headlight	Returns the headlight state of the entity as true or false.
Value	This updater sends any value to the cockpit once and then never again. It is used to configure initial setup and to turn display components on or off.

12.7. Adding Object Models as Props

Props are terrain objects that you can select independently of the terrain. Section 10.12.1, "Extracting Props from a Terrain Patch," explains how to create them by extracting them from a terrain or a feature layer. You can also add props by creating model definitions for them. These props are added to the Prop Palette and are then available to add to a terrain.

To add an object model as a prop:

1. Add a new model definition, as described in "Creating a Model Definition," on page 12-9. Use the Entity, Tree, or SpeedTree schema, as appropriate. When you name the model definition, if you preface it with one of the categories on the Prop Palette, such as Buildings, it will automatically be placed in that category on the palette. For example, BuildingsMyBuilding will put MyBuilding in the Buildings category.
2. Add the filename parameter.
3. Set the value for the filename to the location of your object model file. You can select any supported format. (Some formats, such as Collada (DAE) are not included in the file filter. To select such a format, choose All Files in the filters list.)

12.7.1. Adding a Category to the Prop Palette

The list of categories on the Prop Palette is controlled by the configuration file *./appData/settings/vrfGui/VRF3DTerrainPropCategories.xml*. To add a new category, edit the file. The format should be obvious from examining the existing XML elements.

12.8. Configuring Wakes

When dynamic ocean is enabled, VR-Forces simulates wakes on surface entities. Wakes are configured in the Ship Wake visual definition of an entity's element definition. If you add your own model, you may want to change the default configuration values for its wake so that it more closely matches the dimensions and velocity of the entity type being modeled.

To configure a ship wake:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Entity Definition Editor page (Figure 12-28).

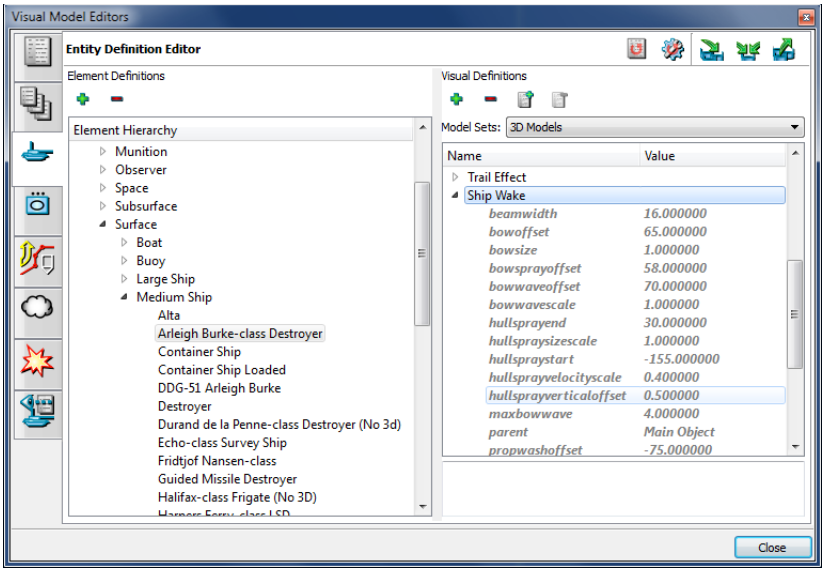


Figure 12-28. Ship Wake visual definition

3. In the Element Hierarchy, expand the Entity list to the Surface level and select the entity that you want to configure.
4. In the Visual Definitions list, select and expand the Ship Wake visual definition.
5. Edit the parameters. Table 12-3 describes each parameter.

Table 12-3: Ship Wake visual definition attributes

Parameter	Description
beamwidth	The width of the ship at its widest point.
bowsize	The size of the bow in world units. This affects the wavelength of the bow wave and the initial spread of spray particles at the bow. Use 0 for a pointy bow.
bowsprayoffset	An offset from the ship position from which to emit spray particles.
bowwaveoffset	An offset from the ship position, along the direction of travel, at which bow waves will originate.
bowwavescale	A scaling factor for the bow wave's amplitude at the bow of the ship.
draft	The depth of the hull underwater.
hullsprayend	The offset from the ship at which hull spray effects end.
hullspraysizescale	A scaling factor applied to the hull spray particles.
hullspraystart	The offset from the ship at which hull spray effects begin.
hullsprayvelocityscale	The initial velocity of hull spray particles as a percent of the ship velocity (0-1).
hullsprayverticaloffset	A vertical offset to the starting point of new hull spray particles.
maxbowwave	The maximum amplitude of the bow wave, or -1.0 for unbounded.
numhullsprays	The number of spray particles emitted periodically along the hull of the ship.
parent	The visualizer's parent.
propwashenabled	Enable or disable propeller backwash effects.
propwashoffset	An offset from the ship position from which to generate propeller backwash effects.
shiplength	The length of the object generating the wake.
sprayenabled	If enabled, the wake emits spray particles.
spraysizescale	A scaling factor applied to the size of the bow spray particles and their random spread.
sprayvelocityscale	A scaling factor for spray effects at the bow of the ship. This is applied to the initial velocity of the spray particles.
sternwaveoffset	An offset for the stern wakes.
type	The type of visualizer.
wakeoffset	An offset to the model's origin that all other offsets are relative to. Changing this offset lets you move all of the wake effects in tandem if the entity model changes.

12.9. Flipping DDS Textures for a Model

If a model is displayed upside down because its DDS textures are not what VR-Forces expects, you can specify that the model be flipped. (For more information about DDS textures, please see "Displaying DDS Textures Correctly," on page 10-38.)

To flip DDS textures for a model:

1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Model Definition Editor page (Figure 12-4).
3. Optionally, filter the model definitions in the list.
4. Select the model for which you want to change the DDS parameter.
5. If the model has the **flip DDS textures** parameter in its parameters list, set it to 1.

   If the model does not have the **flip DDS textures** parameter in its parameters list, click the Add Parameter button () to see if this is a valid parameter for this model. If it is, you can add the parameter and set it to 1.

12.10. Configuring SpeedTree Trees

SpeedTree trees are high resolution models of trees. To improve performance, you can set clipping plane and level-of-detail (LOD) values to vary the resolution of the trees placed in the scene based on their distance from the observer. For details about clipping planes, please see "Setting the Clipping Planes," on page 9-10.

To configure SpeedTree trees:

1. Choose **Settings** → **Display**. The Display Settings dialog box opens.
2. Select the SpeedTree Settings page (Figure 12-29).

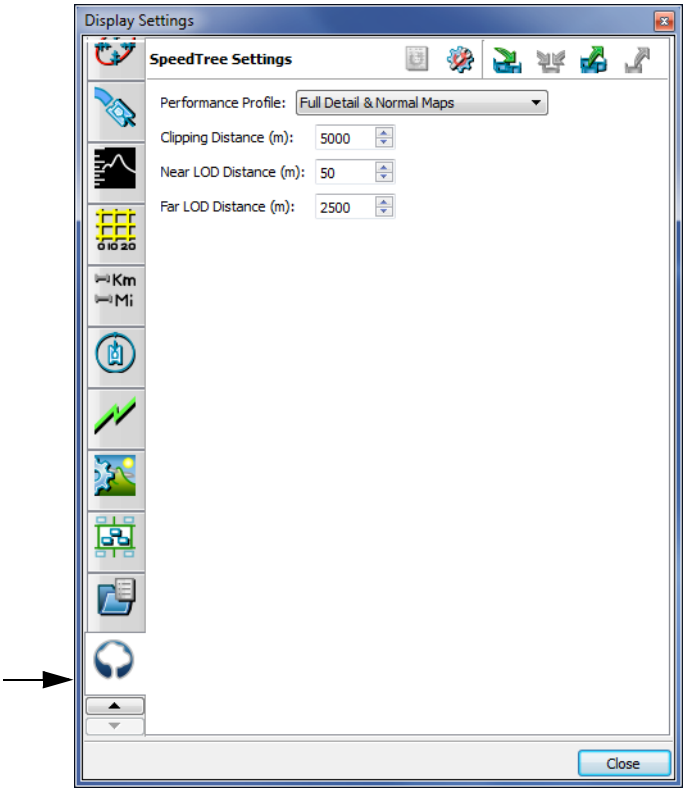


Figure 12-29. SpeedTree Settings page

3. In the Performance Profile list, select a performance profile. (For details, please see "Specifying the SpeedTree Performance Profile," on page 12-37.)
4. Specify the clipping distance, and the near and far LOD distance.
5. Click Close.

12.10.1. Specifying the SpeedTree Performance Profile

The number of SpeedTree objects in a scene can affect performance. Therefore, VR-Forces provides several profiles for display of SpeedTrees so that you can balance performance against visual quality. You specify the performance profile on the SpeedTree Settings page of the Display Settings dialog box. Table 12-4 describes the profiles.

Table 12-4: SpeedTree Performance Profiles

Profile	Branch Texture	Frond Texture	Vertical Billboards	Horizontal Billboards
Disabled				
Single Color Map	Color	Color	Low LOD	
Partial Detail & Normal Maps	Color Detail Normal map	Color	Low LOD	
Full Detail & Normal Maps	Color Detail Normal map	Color Normal map	Low LOD	
Full Detail & Normal & Shadow Maps	Color Detail Normal map Shadow	Color Detail Normal map	Low LOD	Low LOD

12.11. Best Practices for Creating Models for VR-Forces

If you build your own models for use in VR-Forces, following these guidelines will result in models that work efficiently:

- Keep all textures to powers of two, for example 256x256, 128x512, or 2048x2048:
  - Make sure textures use as many of the pixels as possible and that there are no large black areas in the texture.
  - Keep alpha (transparency) to a minimum.
- Minimize the number of textures:
  - Create a texture atlas that uses multiple textures combined into one.
  - Group polygons together that use the same texture.
  - Use the same textures for all LOD nodes.
- Minimize the number of nodes:
  - Keep the hierarchy as flat as possible.
  - Move all LOD nodes to the top of the hierarchy.
  - Minimize unnecessary transforms.
  - When you reuse geometry in the model, use instancing.
- Minimize the number of polygons that have different attributes:
  - Use the same material on polygons whenever possible.
  - Use two polygons with flipped normals instead of using the double sided attribute.
  - Use the same color on polygons whenever possible.
  - Group polygons with similar attributes.
- Consider using a more aggressive LOD structure:
  - Reduce the switchout distance to be smaller so that the LODs switch sooner.
  - Minimize the number of LODs.
  - Make sure that models switch out completely at a reasonable distance.
- Reduce the number of external references:
  - Merge external reference files.
  - Create instances from external merged reference files.

A

Object Parameters

This appendix describes the high-level parameters in the object parameter database. The OPD Editor has context-sensitive help for most parameters and also describes them in the online help system. It also has reference material for local and remote subcomponents and object type enumerations.

The Structure of an Entity Parameter A-2
The Parameter Type Hierarchy A-3
Vrf Base Object Parameters A-3
Vrf Object Parameters A-7
Moving Object Parameters A-8
Parameter Types for Entity Platforms A-8
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LinearObjectCategory A-12
Interaction A-12

A.1. The Structure of an Entity Parameter

The object parameter database uses MÄK Technologies LISP (MTL). (For details about MTL, please see "MÄK Technologies Lisp (MTL) Files," on page 2-13.) A parameter block has the form:

```
(block_name
  ( parameter_name value)
  ...
  (parameter_name
    (sub-parameter value)
  )
  and so on
)
```

Entries have the following requirements:

- The block_name can be anything that you like.
- The parameter_name must be exactly as documented (except that in some cases, a parameter may contain an arbitrary length list of sub-parameters, for which the parameter names are not used – these will be noted). Parameter names must not contain spaces, and must not start with a digit (or a dash followed by a digit, for example, -1).
- The first parameter in any parameter block must be **parameter-type**.
- You can include comments in the file. A comment begins with a semicolon(;) and continues to the end of the line.
- All numerical parameters use standard MKS values: meters, kilograms, seconds, radians, liters, and so on.
- Real constants must begin with a digit and contain a decimal point. For example, 0.5 and 0. are acceptable, but .5 and 0 are not.

A.2. The Parameter Type Hierarchy

Figure 4-4, in "Parameter Types," on page 4-8, illustrates the hierarchy of parameter types. In this section, we describe the parameters associated with each **parameter-type**.

A.2.1. Vrf Base Object Parameters

All object parameters inherit from the parameter type **vrf-base-object-param**. The parameters associated with vrf-base-object-param are potentially applicable to any type of object (ground, rotary-wing, control object, and so on). Please see the General Parameters topic in the OPD Editor online help for parameter descriptions. In addition to parameters, each object has an object type and parameter type, as described in Table A-1.

Table A-1: Object and parameter type

Parameter	Description
object-type	(Required) 8-digit object type. Not actually a parameter. Specifies the key used to look up the entry. For more information, please see "Object Types," on page 4-4.
parameter-type	(Required) One of the following (string): ◆ "vrf-base-object-param" ◆ "vrf-object-param" ◆ "moving-object-param" ◆ "fixed-wing-param" ◆ "ground-vehicle-param" ◆ "rotary-wing-entity-param" ◆ "missile-param" ◆ "surface-entity-param" ◆ "subsurface-entity-param" ◆ "human-param" ◆ "cultural-feature-param". The value must be in quotation marks.

Local Objects Subcomponent Parameters

The **local-objects** parameter specifies the types of subcomponents to create for locally simulated objects. You can omit optional items, or set them with an empty string "". Table A-2 lists the subcomponent parameters and their possible values.

Table A-2: Local-objects subcomponent parameters (Sheet 1 of 2)

Subcomponent parameter	Description
state-repository	(Required) Maintains the state information for the object. An object that has components (sensors, controllers, and actuators) for simulation sets and retrieves information in the repository. Some simulation components expect a specific kind of state repository. In general, you will want to specify the state repository type that most closely matches the kind of entity you expect to simulate. May be one of the following types: ◆ "vrf-object-base-state-repository": Used for the base object in the object parameter database. ◆ "vrf-object-state-repository": Derived from vrf-object-base-state-repository, it adds the concepts of resources, sector of responsibility, engagement rules, and targeting. Because there are more entity-specific state repository types that are derived from this type, this kind of repository is not typically specified. ◆ "vrf-overlay-object-state-repository": For tactical graphics. ◆ "vrf-moving-object-state-repository": For any object that you expect to simulate movement. Pseudo-aggregate entities have this kind of state repository. The more entity-specific repository types that follow inherit this kind of state repository, so choose one of those when simulating a specific type of individual entity. ◆ "ground-entity-state-repository": For ground vehicles, such as tanks, trucks, dismounted infantry. ◆ "rotary-wing-entity-state-repository": For rotary-wing aircraft. ◆ "fixed-wing-entity-state-repository": For fixed-wing aircraft. ◆ "missile-entity-state-repository": For missile and rocket entities. ◆ "surface-entity-state-repository": For surface entities. ◆ "subsurface-entity-state-repository": For subsurface entities. ◆ "human-state-repository": For lifeform entities. ◆ "cultural-feature-state-repository": For cultural features that are created as entities.

Table A-2: Local-objects subcomponent parameters (Sheet 2 of 2)

Subcomponent parameter	Description
network-interface	(Optional) The network interface handles the publication of the object over the network. It acts as an interface between an entity's state repository and its network (VR-Link) representation. Choose one that most closely matches the kind of entity you are simulating. May be one of the following types: ◆ "aggregate-local-entity-net-interface": For aggregate entities. ◆ "pseudo-aggregate-local-entity-net-interface": For aggregate entities that have subordinate entities that are separately simulated. ◆ "individual-local-entity-net-interface": For individual platform entities, such as tanks, aircraft, dismounted infantry. ◆ "local-environmental-net-interface": For entities that are best represented as an environmental process. Non-entity objects such as control objects (waypoints, routes, areas) use this type of network interface.
net-interface-min-tick-period	(Optional) Specifies the shortest period of time, in seconds, that can elapse between ticks of an entity's network interface.
net-interface-min-tick-period-variance	(Optional) Specifies an amount within which the net-interface-min-tick-period can vary. Defined as: plus or minus rand(net-interface-min-tick-period/2)
component-manager	(Optional) A component manager contains the lists of sensor, controller, and actuator components used to simulate the behavior of a given object (typically entities). Expected value: "component-manager"
plan-manager	(Optional) The entity plan manager. If you want an entity to be able to execute a plan, it must have a plan manager.
task-manager	(Optional) If a component manager is specified for an object, then you must specify a task manager. The task manager works in conjunction with the component manager to manage the processing and message handling associated with execution of a task. Expected value For individual entities or true aggregates: "local-task-manager".

Remote Object Subcomponent Parameters

The **remote-objects** parameter specifies the types of sub-components to create for remote objects. Remote objects are those objects simulated by other applications on the network (including other VR-Forces applications). You can omit optional items, or set them with an empty string "". Table A-3 lists the subcomponent parameters and their possible values.

Table A-3: Remote object subcomponent parameters (Sheet 1 of 2)

Subcomponent parameter	Description
state-repository	(Required) Maintains the state information for the object. Unlike the local-object entry, it is not as important to specify the closest match based on type. For entities, the "vrf-moving-object-state-repository" is sufficient. A more specific state repository may be specified. However, some of the entity-specific data may not be set. May be one of the following types: ◆ "vrf-object-state-repository": Derived from vrf-object-base-state-repository, it adds the concepts of resources, sector of responsibility, engagement rules, and targeting. Because there are more entity-specific state repository types that are derived from this type, this kind of repository is not typically specified. ◆ "vrf-overlay-object-state-repository": For tactical graphics. ◆ "vrf-moving-object-state-repository": For any object that you expect to simulate movement, including individual and aggregate entities. ◆ "ground-entity-state-repository": For ground vehicles, such as tanks, trucks, dismounted infantry. ◆ "rotary-wing-entity-state-repository": For rotary-wing aircraft. ◆ "fixed-wing-entity-state-repository": For fixed-wing aircraft. ◆ "missile-entity-state-repository": For missile and rocket entities. ◆ “human-state-repository”: For lifeform entities. ◆ “cultural-feature-state-repository”: For cultural features that are created as entities. ◆ "surface-entity-state-repository": For surface entities. ◆ "subsurface-entity-state-repository": For subsurface entities.

Table A-3: Remote object subcomponent parameters (Sheet 2 of 2)

Subcomponent parameter	Description
network-interface	(Optional) The network interface is the interface between the remote network (VR-Link) representation of the object and its state repository. It acts as an interface between an entities state repository and its network (VR-Link) representation. Choose one that most closely matches the kind of entity you are simulating. May be one of the following types: ◆ "vrf- aggregate -remote-entity-net-interface": For remote aggregate entities. ◆ "vrf-individual-remote-entity-net-interface": For individual platform entities, such as tanks, aircraft, dismounted infantry. ◆ "vrf-remote-environmental-net-interface": For entities that are best represented as an environmental process. Non-entity objects such as control objects (waypoints, routes, areas) use this type of network interface.
net-interface-min-tick-period	(Optional) Specifies the shortest period of time, in seconds, that can elapse between ticks of an entity's network interface.
net-interface-min-tick-period-variance	(Optional) Specifies an amount within which the net-interface-min-tick-period can vary. Defined as: plus or minus rand(net-interface-min-tick-period/2)
plan-manager	Do not specify a plan manager for remote objects. (Give it the value "" (empty string). If you specify a plan manager, it is ignored.)
component-manager	Do not specify a component manager for remote objects. (Give it the value "" (empty string). If you specify a component manager, it is ignored.)
task-manager	(Optional) Do not specify a task manager for remote objects. (Give it the value "" (empty string). If you specify a task manager, it is ignored.)

A.2.2. Vrf Object Parameters

The parameter type **vrf-object-param** inherits from **vrf-base-object-param** and is the parent of the moving object parameter type. Vrf object parameters include resources, engagement rules, and target acquisition time. The **vrf-object-param** parameter type represents an intermediate class in the parameter hierarchy. It is not usually used to represent objects in VR-Forces. You will probably want to instantiate a derived type, (for aggregates and entities) or you will want to specify vrf base object parameters (for case of control objects.)

Control objects have the parameter type **vrf-base-object-param**.

A.2.3. Moving Object Parameters

Moving objects have the parameter type **moving-object-param**. Moving objects inherit parameters from vrf objects and vrf base objects. The **moving-object-param** parameter type is used for objects that are capable of movement, such as individual entities and aggregates. Parameters include support points, maximum speed, maximum reverse speed, turning radius, maximum slope, ordered speed, maximum acceleration, maximum deceleration, and fuel efficiency. Aggregates are moving objects and have this parameter type. All of the platform-specific parameter types derive from this one.

A.2.4. Parameter Types for Entity Platforms

Table A-4 lists the parameter types used by each entity type.

Table A-4: Parameter types for entities

Platform	Parameter Type	Inherits from
Ground vehicle	ground-vehicle-param	moving-object-param
Fixed-wing	fixed-wing-entity-param	moving-object-param
Human	human-param	moving-object-param
Rotary-wing	rotary-wing-entity-param	moving-object-param
Surface	surface-entity-param	moving-object-param
Subsurface	subsurface-entity-param	moving-object-param
Cultural feature	cultural-feature-param	moving-object-param
Missile	missile-param	moving-object-param
Pseudo-aggregate	moving-object-param	vrf-object-param

A.3. Entity Parameters

For descriptions of entity parameters, please see the descriptions of individual components in the OPD Editor online help.

A.4. Object Type Enumerations

This section lists the object type enumerations as listed in the header file *objType-Enums.h*. It is presented here primarily for customers who have purchased VR-Forces, but not the toolkit. Therefore we have departed from the typical header file format for readability.

A.4.1. Object Super-type

The header file *objTypeEnums.h* contains the VR-Forces extensions to the DIS/RPR FOM enumerations. The enumerations specify individual, aggregate, and non-entity object types. The sim object super-type is an enumeration used in the *DtObjectType* class (an extension of the *DtEntityType* class). It extends the DIS/RPR FOM entity type enumeration by specifying the sort of object associated with the *DtEntityType*. Because entity types are not guaranteed to be unique across all of the possible individual and aggregate types, the extra enumerated field provides a way to uniquely identify all objects in a VR-Forces simulation.

VR-Forces uses the value 3 in the object super-type for all of the aggregates that it simulates.

Other	0
Individual	1
Aggregate	2
PseudoAggregate	3
TrueAggregate	4
Interaction	5

A.4.2. AggregateKind

The enumeration for *DtAggregateKind* should start with 0, but VR-Forces starts with 10, to ensure that entity types will be unique.

Other	10
MilitaryHierarchy	11
CommonType	12
CommonMission	13
SimilarCapabilities	14
CommonLocation	15
DtSimArtPartKind	20

A.4.3. ObjectKind

Extension of entity kind to represent non-entity objects, such as control objects (control points, routes, phase lines, obstacles, etc.)

DtPointObjectKind	16
DtLinearObjectKind	17
DtArealObjectKind	18
DtCircleObjectKind	19
DtTextObjectKind	20

A.4.4. Aggregate Category

VR-Forces extends the enumeration to include *DtAggregateCategoryForce*, which represents the force level. All of the entries from Force through the end of the list, are extensions to the standard.

Other	0
IndividualVehicle	1
Element	2
Platoon	3
Battery	4
Company	5
Battalion	6
Regiment	7
Brigade	8
Division	9
Corps	10
Force	11
Team	12
Squad	13
Section	14

Aggregate Subcategory

The Subcategory field enumerations for Kind field = Military Hierarchy specify the Echelon Type of the aggregate. Not all of the echelon types are applicable to each of the categories.

In the following list, ForceFriendly, ForceOpposing, ForceNeutral, and ForceOther are extensions to the DIS/RPR FOM enumerations.

Other	0	ArmyAviationFixedWing	13
CavalryTroop	1	ArmyAviationRotaryWing	14
Armor	2	ArmyAttackHelicopter	15
Infantry	3	AirCavalry	16
MechanizedInfantry	4	ArmorHeavyTaskForce	17
Cavalry	5	MotorizedRifle	18
ArmoredCavalry	6	MechanizedHeavyTaskForce	19
Artillery	7	CommandPost	20
SelfPropelledArtillery	8	CEWI	21
CloseAirSupport	9	TankOnly	22
Engineer	10	ForceFriendly	23
AirDefenseArtillery	11	ForceOpposing	24
AntiTank	12		

A.4.5. Aggregate Specific

The Specific field enumerations for Kind field = Military Hierarchy specify whether the aggregate unit contains a headquarters, and is enumerated as follows.

Noheadquarters	0
ContainsHeadquarters	1

A.4.6. Point Object Category

Subcategories for use with the Kind field = *DtPointObjectKind*.

Other	0
ControlPoint	1
TargetPoint	2
Marker	3

A.4.7. LinearObjectKind

Subcategories for use with the Kind field = *DtLinearObjectKind*.

Other	0
PhaseLine	1
Route	2

A.4.8. LinearObjectCategory

Subcategories for use with the Kind field = *DtArealObjectKind*.

Other	0
ControlArea	1
Obstacle	2

ArealObjectCategory

A.4.9. Interaction

Kinds for Supertype interaction.

Other	0
Fire	1
Detonate	2

B

Terrain Tutorials

Although the individual procedures for managing terrain are fairly straightforward, understanding how they fit together to help you achieve your visualization goals is not always obvious. This appendix contains tutorials that demonstrate how to combine various procedures to create terrains and how to create a local terrain server.

Composing a Terrain B-2
- Add Elevation Data (Add a Terrain Patch) B-3
- Add Imagery B-5
- Add a Feature Layer B-8
- Add Props B-9

Adding a Terrain Server B-13
- Connect to the SanLuisObispo Terrain Server B-16

Extracting Props from a Terrain B-18
- Create a New Terrain and Add a Terrain Patch B-18
- Extract the Props B-19
- Change the Model Definition for a Prop B-21

Adding Feature Data to a GDB Terrain B-23
- Create a New GDB Terrain in the TDB Tool B-24
- Add a Point Feature to the Terrain B-26
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B.1. Composing a Terrain

This tutorial shows how to compose a terrain by combining elevation data, imagery, and feature data. It recreates a portion of the LittlePond terrain that is included with VR-Forces. Little Pond is a small detailed area in a suburb of Boston, Massachusetts, U.S.A.



This tutorial shows you how to add props to the LittlePond elevation and image data. However, the tutorial does not ask you to add every type of prop that the complete LittlePond terrain contains. Therefore, at the completion of the tutorial, your terrain will not look exactly like the LittlePond terrain provided with VR-Forces. If you want to completely recreate the LittlePond terrain, you will have to continue to add props on your own.

The basic steps for composing a terrain are:

1. Add elevation data (a terrain patch) ("Add Elevation Data (Add a Terrain Patch)," on page B-3).
2. Add imagery ("Add Imagery," on page B-5).
3. Add a feature layer ("Add a Feature Layer," on page B-8).
4. Add props ("Add Props," on page B-9).

B.1.1. Add Elevation Data (Add a Terrain Patch)

The first step in building a terrain is to add elevation data. Elevation data is added using terrain patches. The terrain patch in this tutorial is DTED data that covers about 1° east of Boston, Massachusetts, U.S.A.

To add the terrain patch:



1. If you are joined to a session, choose **File** → **Resign from Session**.
2. Choose **Observer** → **Set Observer Mode** → **Stealth**.
3. Choose **File** → **New Terrain**. This results in an empty window (Figure B-1).



Figure B-1. No terrain loaded

4. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
5. Select the Terrain Contents page.
6. Click Add Terrain Patch. The Add Terrain Patch dialog box opens and an Open dialog box opens on top of it.
7. In the Open dialog box, navigate to *./data/Terrain/LittlePond/elevation*.
8. Select *w072n042.dt1*.
9. Click Open. Information about this terrain patch is displayed in the Add Terrain Patch dialog box (Figure B-2).

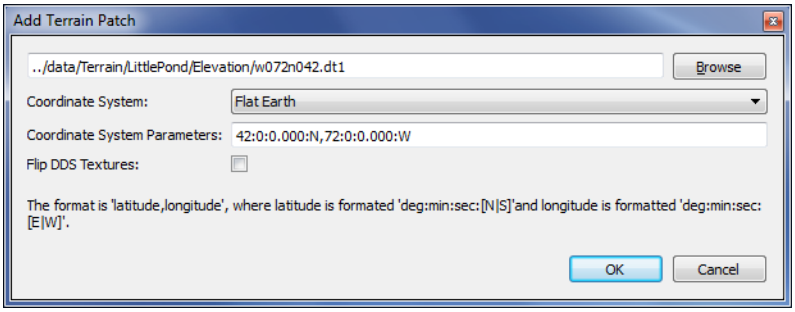


Figure B-2. Add Terrain Patch

10. Click OK. The terrain is added to the scene (Figure B-3).

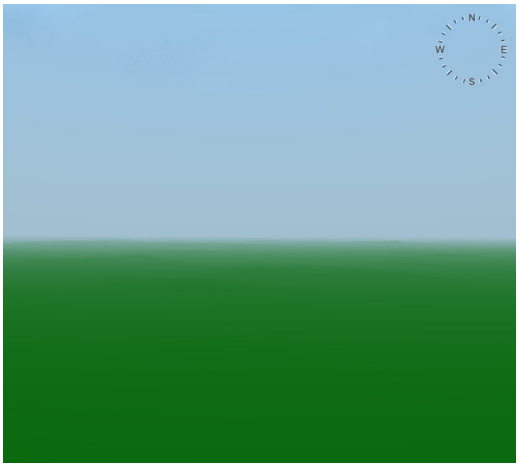


Figure B-3. Terrain patch added

B.1.2. Add Imagery

The terrain patch you added in the first step of this tutorial is just elevation data. It has no texture and no features. You can get some sense of its contours by enabling elevation coloring (Figure B-4). However, this still does not provide the rich 3D environment you expect to see in a product like VR-Forces. Now we will add image data.

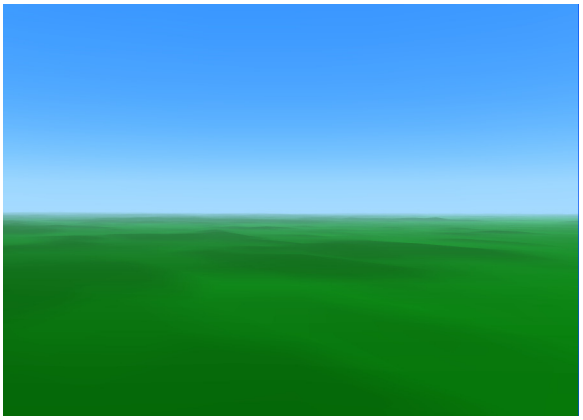


Figure B-4. Elevation coloring

To add image data:



1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Raster Maps page (Figure B-5).

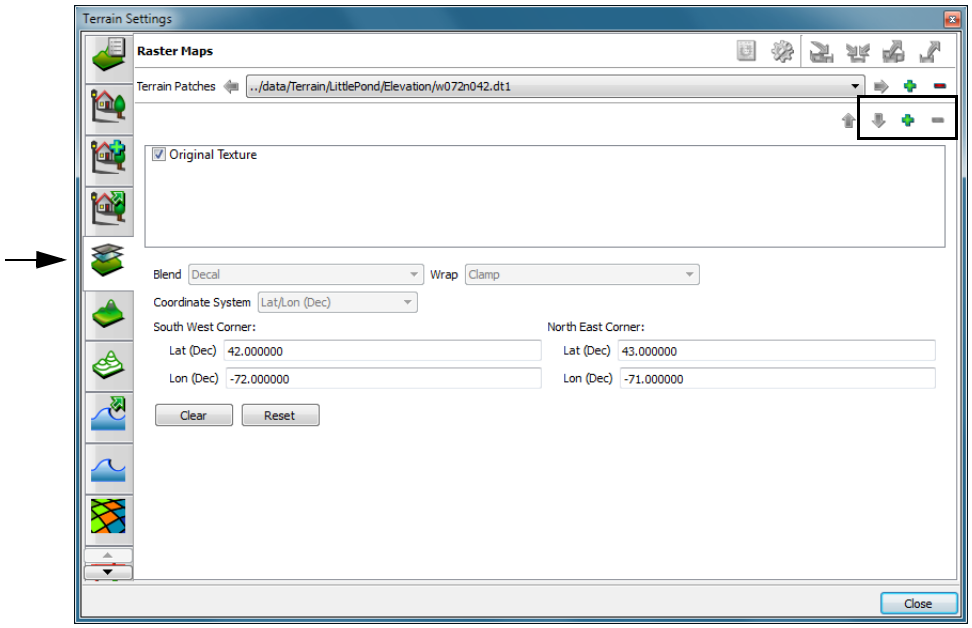


Figure B-5. Raster Maps page

3. Click the Add button (+) that is at the upper right of the list window (Figure B-5). A line labeled Image 1 is added to the list in the window (Figure B-6).

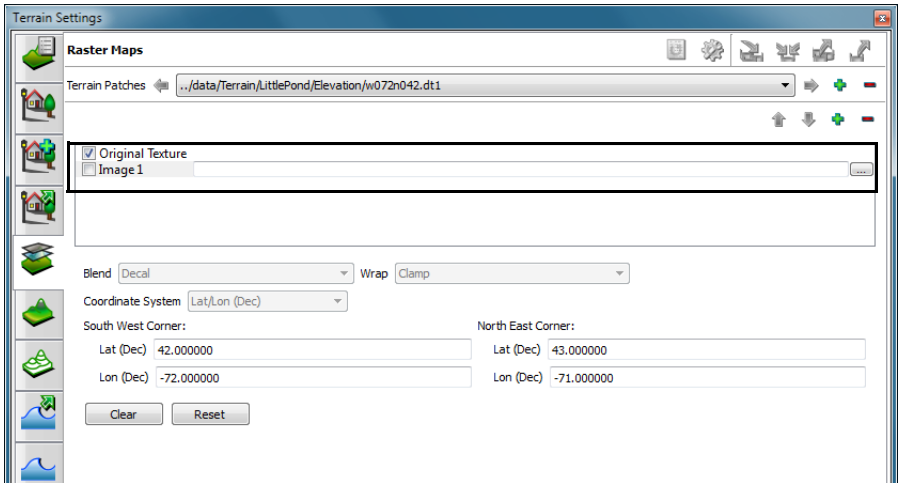


Figure B-6. New image

4. Click the Browse button at the right end of the image entry. The Image File dialog box opens.
5. In the Image File dialog box, navigate to *./data/Terrain/LittlePond/imagery*.
6. Select *W72N42.tif*.
7. Click Open. The image is listed in the Raster Maps window. To view it, select the check box at the left end of the entry. This image adds low resolution imagery over the entire terrain (Figure B-7).

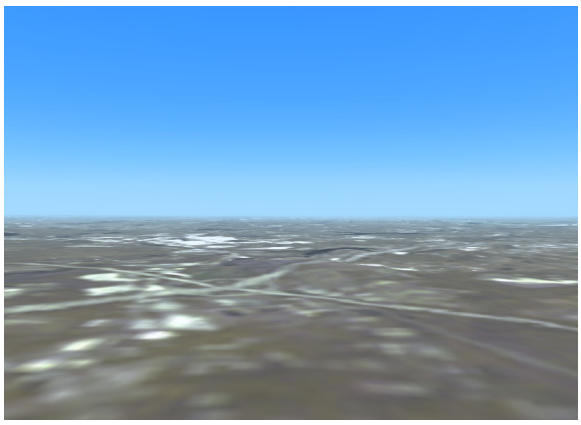


Figure B-7. Low resolution image

8. Add another image. This time, select *LittlePond.tif*.

9. Select the check box for the *LittlePond.tif* image (Figure B-8). A high resolution image is added to the Little Pond Area of the terrain (Figure B-9). (The high resolution image might be hard to find. The next section explains how to find it quickly.)

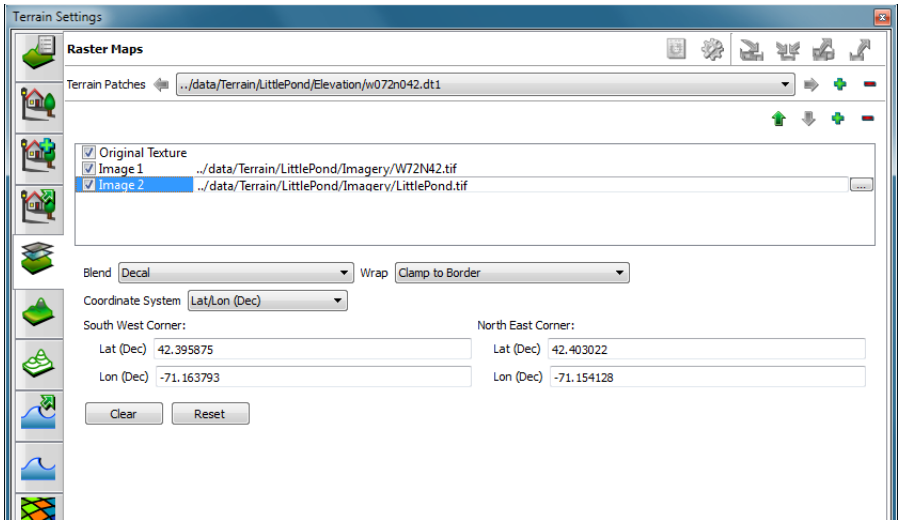


Figure B-8. Raster Maps page with both images added

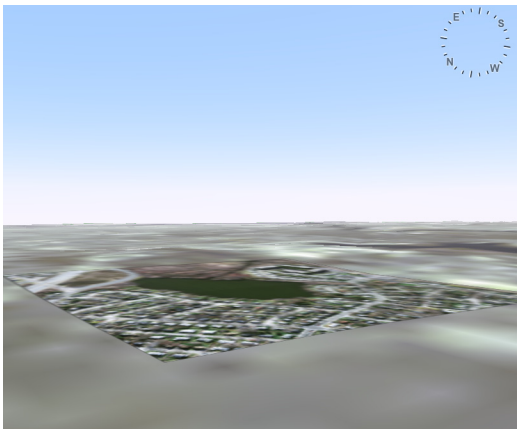


Figure B-9. Little Pond image

Finding the High Resolution Image

It is not easy to find the Little Pond image unless you know where to look. To make things easier, we have saved an observer view of the Little Pond image. It will be the starting point for the rest of the tutorial.

To view the Little Pond image:

1. If the Observer Views Panel is not already displayed, choose **View** → **Observer Views Panel**.
2. On the Observer Views Panel, click the Load View button ( ). The Load and Set Observers dialog box opens.
3. Select *LittlePondTutorial.osrx*.
4. Click Open. The view should jump to an image similar to Figure B-9.



As an alternative to this procedure, you could hide the low resolution image by clearing its selection on the Raster Maps page. Then you could scroll through the terrain until you find the high resolution image.

B.1.3. Add a Feature Layer

The image of Little Pond shows lots of buildings and greenery, but these are just images, not 3D objects. Now we want to add props to the terrain. To do that, we need to add a feature layer that has objects that we can extract.

To add the feature layer:



1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Add Props page (Figure B-10).

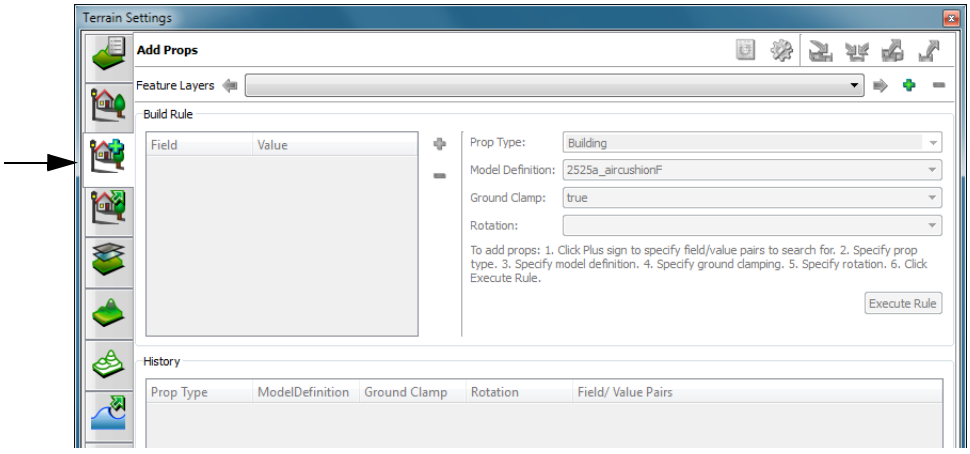


Figure B-10. Add Props page

3. Click the Add button (+) next to the Feature Layers list. The Select Source File for Feature Layer dialog box opens.
4. Navigate to *./data/Terrain/LittlePond/Features*.
5. Select *BuildingsP.shp*.
6. Click Open. The layer is added to the Add Props page.

B.1.4. Add Props

When you add a prop, VR-Forces extracts data from a feature layer and maps it to a model definition. You have to tell VR-Forces what to extract and what to map it to. You do this by building a rule.

To build a rule and extract feature data:

1. In the Terrain Settings dialog box, on the Add Props page, in the Build Rule group box, click the Add button (+) (Figure B-11). The Build Field/Value Pair dialog box opens.

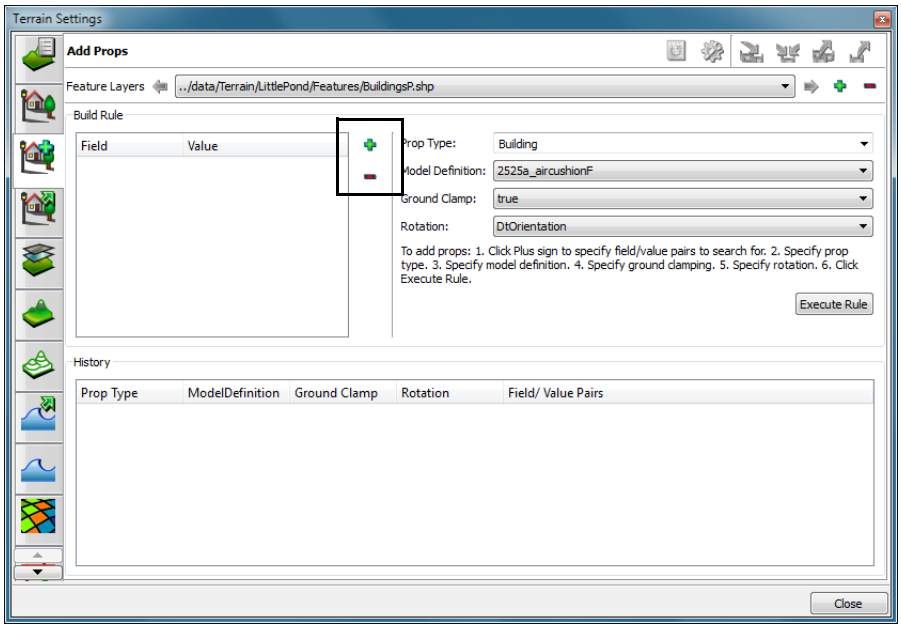


Figure B-11. Add build rule

2. In the Field list, select TYPE.
3. In the Value list, select HousesColonialGarrison (Figure B-12).

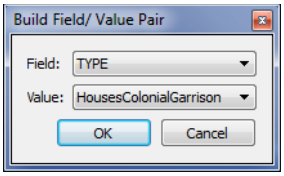


Figure B-12. Build Field/Value Pair dialog box

4. Click OK.
5. On the Add Props page, in the Prop Type list, select the prop type for the rule. In this case, select Building.
6. In the Model Definition list, select HousesColonialGarrisonClapboardWhite.
7. In the Ground Clamp box, specify whether or not you want the prop to be ground-clamped.
8. In the Rotation list, select the orientation of your model. By default, if the GDB or Shapefile has a field called Rotation or DtOrientation, it is automatically selected. The completed rule is illustrated in Figure B-13.

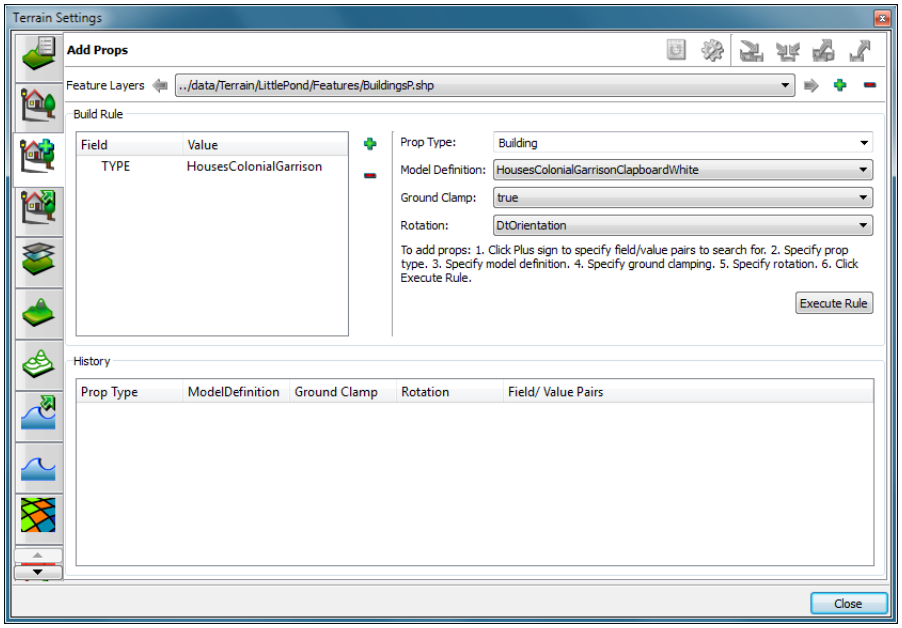


Figure B-13. Completed rule

9. Click Execute Rule. The rule is executed. The Add Props page is updated (Figure B-14) and houses are added to the terrain. Zoom in for a better look at them (Figure B-15). (You might need to close the Terrain Settings dialog box or move it out of the way to see the terrain.)

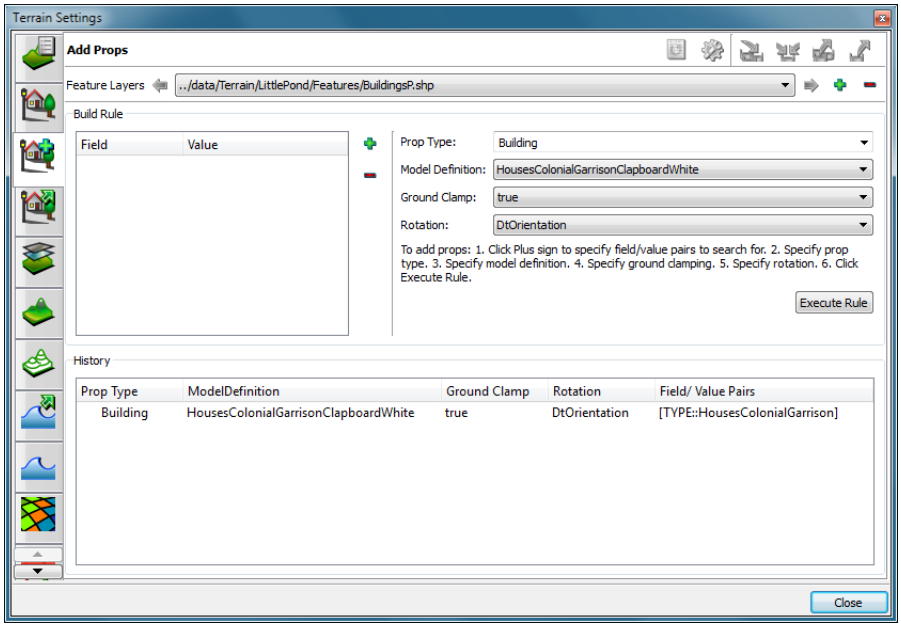


Figure B-14. Build rule implemented

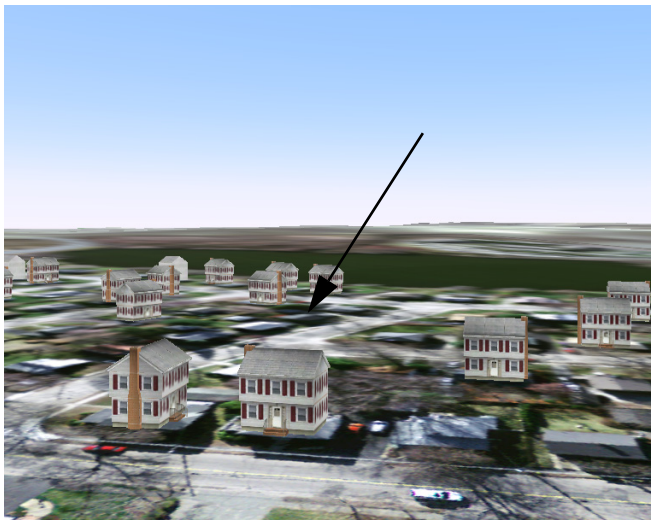


Figure B-15. Props added to terrain

If you want to, you can add more buildings by creating rules for some of the other building types available.

Add Vegetation

We will continue the tutorial by adding another feature type.

To add vegetation to the terrain:

1. If the Terrain Settings dialog box is not open, choose **Settings** → **Terrain**.
2. Select the Add Props page.
3. Click the Add button (✚) next to the Feature Layers list. The Select Source File for Feature Layer dialog box opens.
4. Select *./data/Terrain/LittlePond/features/VegetationP.shp*.
5. Click Open. A new feature layer is added to the list.
6. In the Build Rule group box, click the Add button (✚). The Build Field/Value Pair dialog box opens.
7. In the field list, select VEG.
8. In the Value list, select TreesBigLeafMaple.
9. Click OK.
10. In the Prop Type list, select Tree.
11. In the Model Definition list, select TreesBigLeafMapleST. The build rule should look like Figure B-16.

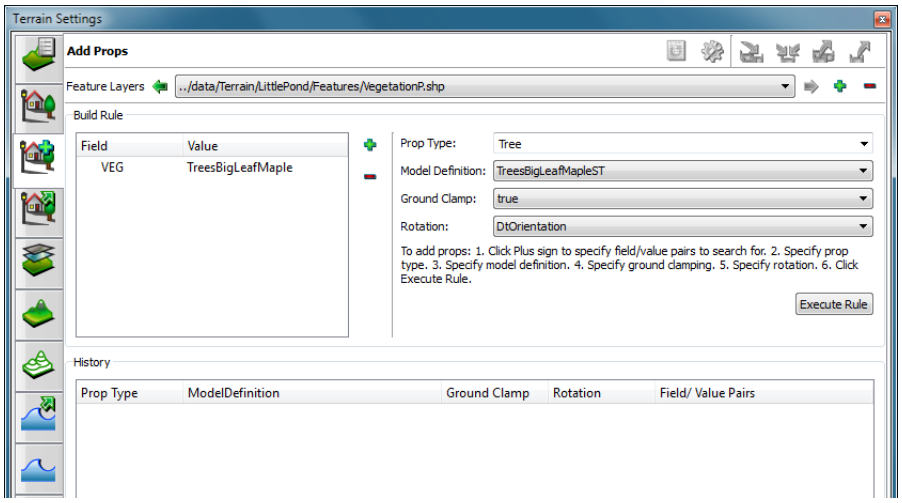


Figure B-16. Rule for big leaf maples

12. Click Execute Rule. The page is updated and trees are added to the terrain (Figure B-17).



Figure B-17. Little Pond with maples

You can build additional rules to add other types of vegetation to the terrain. When you are done, you can create another feature layer with the architecture shapefile (*InfrastructureP.shp*) and add light posts, fire hydrants, and street signs to the terrain.

B.2. Adding a Terrain Server

This tutorial explains how to add a terrain server that streams data from directories on your local network. It uses the San Luis Obispo terrain data, which is provided with VR-Forces. In the tutorial, we copy an existing *.earth* file. Then we change the elevation and imagery data paths to point to the correct files and directories in *./data/Terrain/SanLuisObispo*.

.earth files are text files in XML format. You should have a basic understanding of XML and XML elements before you edit them. For more information about *.earth* files, please see Chapter 8, *Editing Earth Files*.

To add a terrain server:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Server Settings page (Figure B-18).

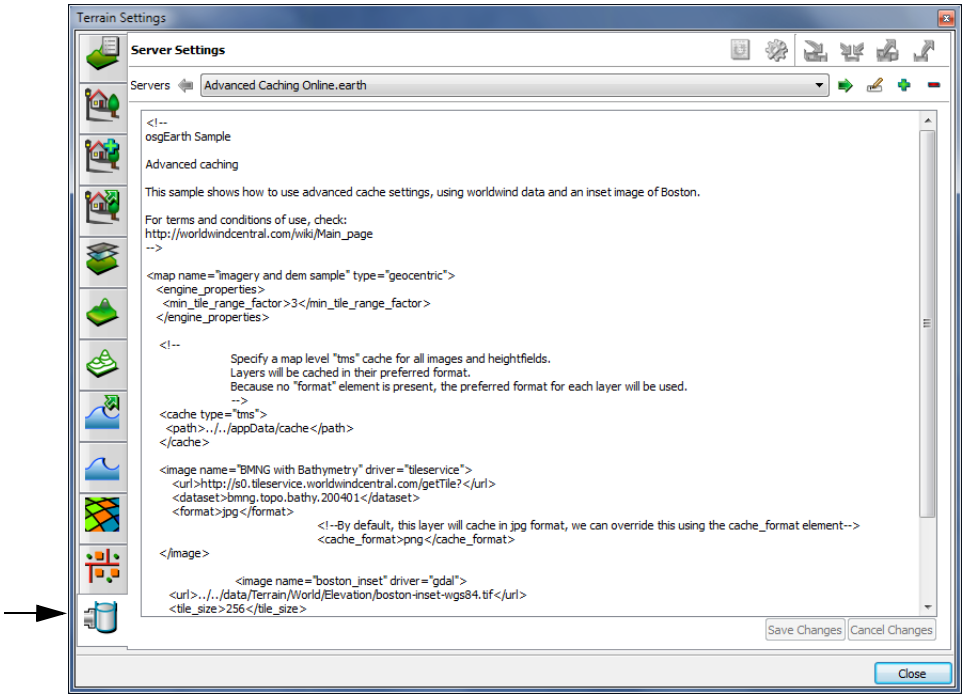


Figure B-18. Server settings page

3. In the Servers list, select *Local World.earth*.
4. Click the Add button (+). A new configuration file is added to the list. It copies the contents of *Local World.earth* and names it *Local World_1.earth*.
5. The image element reads as follows:

```
<image name="World Imagery" driver="gdal">
      <url>../../data/Terrain/World/Imagery/World4km.tif</url>
  </image>
```

   The SanLuisObispo/Imagery directory has multiple files, so we want to point the imagery URL to the directory, not to a specific file. VR-Forces will use all of the files as needed.

   Change the image element name and URL to:

```
<image name="SanLuisObispo Imagery" driver="gdal">
  <url>../../data/Terrain/SanLuisObispo/Imagery</url>
</image>
```

6. Change the heightfield element's name value from:

```
<heightfield name="World Elevation" driver = "gdal">
```

   to:

```
<heightfield name="SanLuisObispo Elevation" driver = "gdal">
```

7. The elevation section of the file reads as follows:

```
<url>../../data/Terrain/World/Elevation/earthnew/w001001.adf</url>
```

If there is only one elevation file, the URL must specify the file. If there are multiple elevation files, the URL must specify the directory.

Change the elevation URL line to:

```
<url>../../data/Terrain/SanLuisObispo/Elevation</url>
```

8. Delete the lines from:

   ```
   <model name="countries" driver="feature_geom" overlay="true">
   ```

   to:

   ```
   </model>
   ```

   (There are two <model> blocks. Delete both of them.)

9. Click the Rename button (). (If you are prompted to save changes, click Save.) The Rename Server dialog box opens.

10. Change the name to *mySanLuisObispo.earth*. (If you are prompted to save changes, click Save.) The completed server should look like Figure B-19.

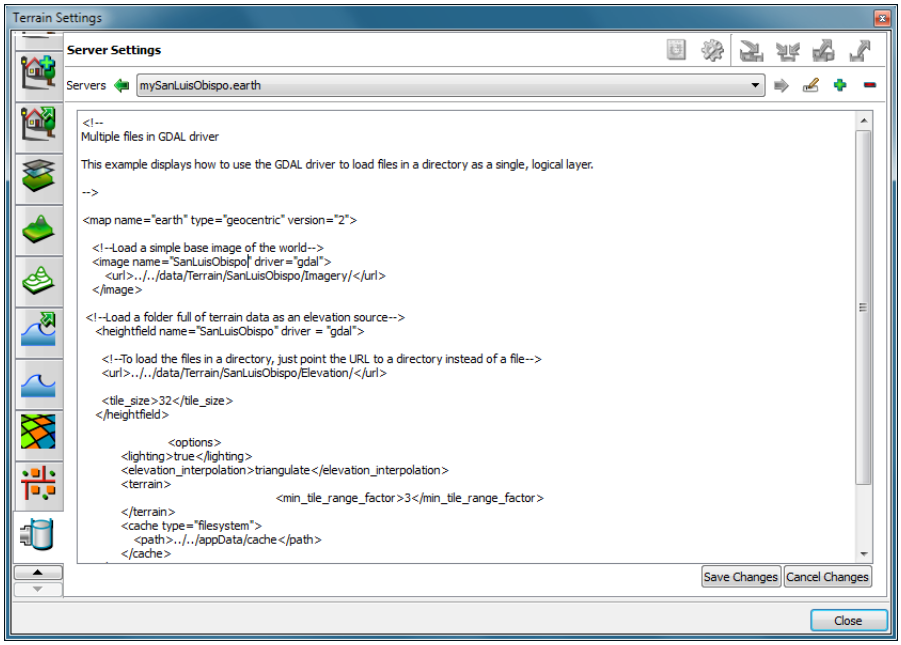


Figure B-19. *mySanLuisObispo.earth* server

11. Click Save Changes. The new server file is saved to *./userData/servers*.

12. Close the Terrain Settings dialog box.

B.2.1. Connect to the SanLuisObispo Terrain Server

Now we will connect to the new server. We can also compare it to the San Luis Obispo terrain that ships with VR-Forces, which was created using the composable terrain method.

To connect to the server:

1. Choose **New** → **Scene**.
2. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
3. Select the Terrain Contents page.
4. Click Add Terrain Server. The Add Terrain Server dialog box opens.
5. In the Servers list, select *mySanLuisObispo.earth*.
6. Click Connect. The server is loaded. It will be visible as a small area of terrain on a featureless globe (Figure B-20), so you will have to move the observer closer to it (Figure B-21). Notice how as you move the observer closer, the terrain imagery gets paged in at greater levels of detail.

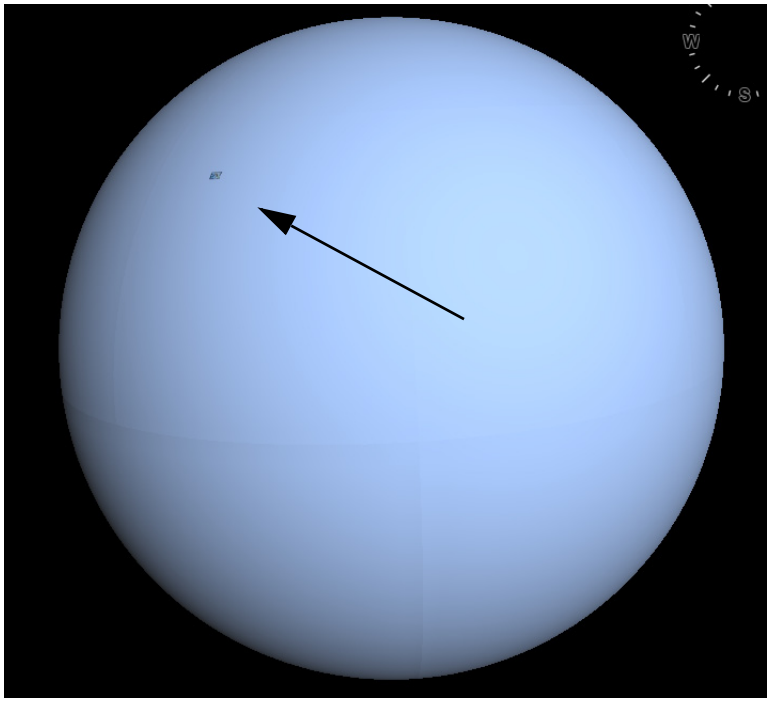


Figure B-20. *mySanLuisObispo.earth* initial view

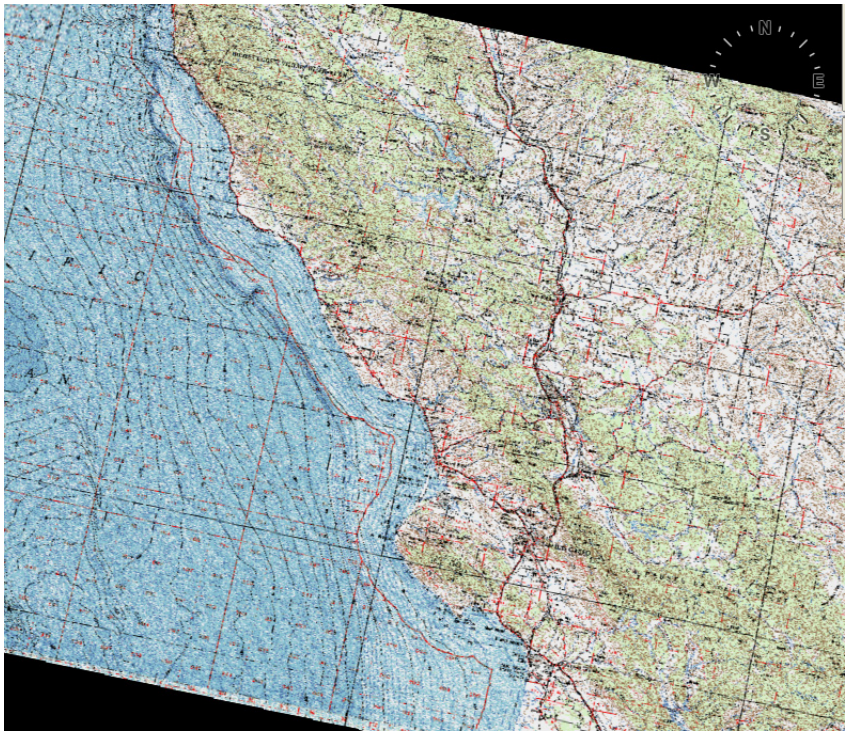


Figure B-21. *mySanLuisObispo.earth* zoomed in view

7. Choose **File** → **Save Terrain**. The Save Terrain dialog box opens.
8. Type a name, such as *mySanLuisObispoEarth*. (Do not name it SanLuisObispo or you will overwrite the terrain shipped with VR-Forces.)
9. Click Save.
10. Choose **File** → **Close Terrain**.
11. Open the *SanLuisObispo.mtf* terrain. Then open the *SanLuisObispoTopoGdal.mtf* terrain. Compare these terrains to each other and the one you just built.

B.3. Extracting Props from a Terrain

In the tutorial "Composing a Terrain," on page B-2, we extract props from a feature layer by building a rule in the Add Props page. In this tutorial, we demonstrate the other way to create a prop – by extracting information from a terrain.

The general steps for extracting props from a terrain are:

1. Create a new terrain with a terrain patch ("Create a New Terrain and Add a Terrain Patch," on page B-18).
2. Select the external references that you want to extract as props and extract them ("Extract the Props," on page B-19).
3. Optionally, change the model definitions ("Change the Model Definition for a Prop," on page B-21).

B.3.1. Create a New Terrain and Add a Terrain Patch

To create the new terrain and add a terrain database:

1. Choose **File** → **New Terrain**. If any terrain data is loaded, it is removed.
2. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
3. Select the Terrain Contents page.
4. Click Add Terrain Patch. The Add Terrain Patch dialog box opens.
5. Navigate to the *./data/Terrain/Makland/Geometry/OpenFlight* directory.
6. Select *Makland.flt*.
7. In the Add Terrain Patch dialog box, click OK. The terrain is loaded.

B.3.2. Extract the Props

To extract the props:

1. Move the observer so that you have a view of the plateau in Makland similar to Figure B-22.



Figure B-22. Makland

2. Click on the trees or buildings in the scene. Notice that you cannot select them. They are part of the terrain; they do not exist as props.
3. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
4. Select the Extract Props page (Figure B-23). On the Extract References tab, the External References window lists all of the objects in the terrain that are incorporated into the terrain by reference. These are the objects that you can extract as props. You can extract them individually. For this tutorial, we will extract all of them.

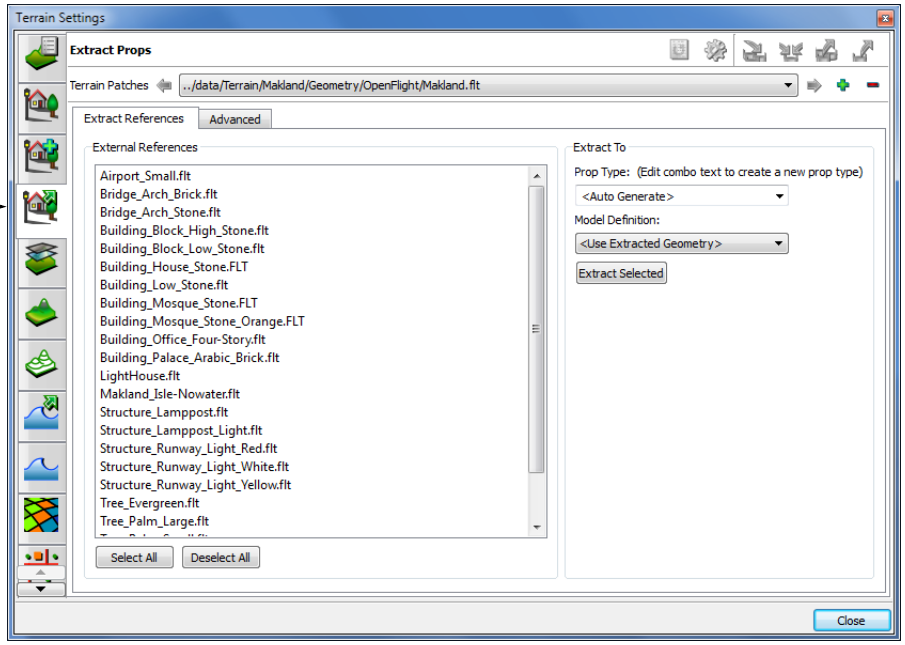


Figure B-23. Extract props page

5. Click Select All. All of the references are selected.
6. In the Extract To group box, click Extract Selected. The objects are extracted as props. The list of external references is cleared.
7. Click the trees and buildings on the plateau. You can now select them because they are props, not part of the terrain (Figure B-24). They are displayed using the geometry in the OpenFlight files from which they were referenced. You can change the models that the props use if you want to. For example, you might want to change the trees to SpeedTrees.



Figure B-24. Selected props

B.3.3. Change the Model Definition for a Prop

To change the model definition for a prop:

1. Select one of the trees.
2. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
3. Select the Edit Existing Props page. The selected prop is highlighted in the list of props (Figure B-25).

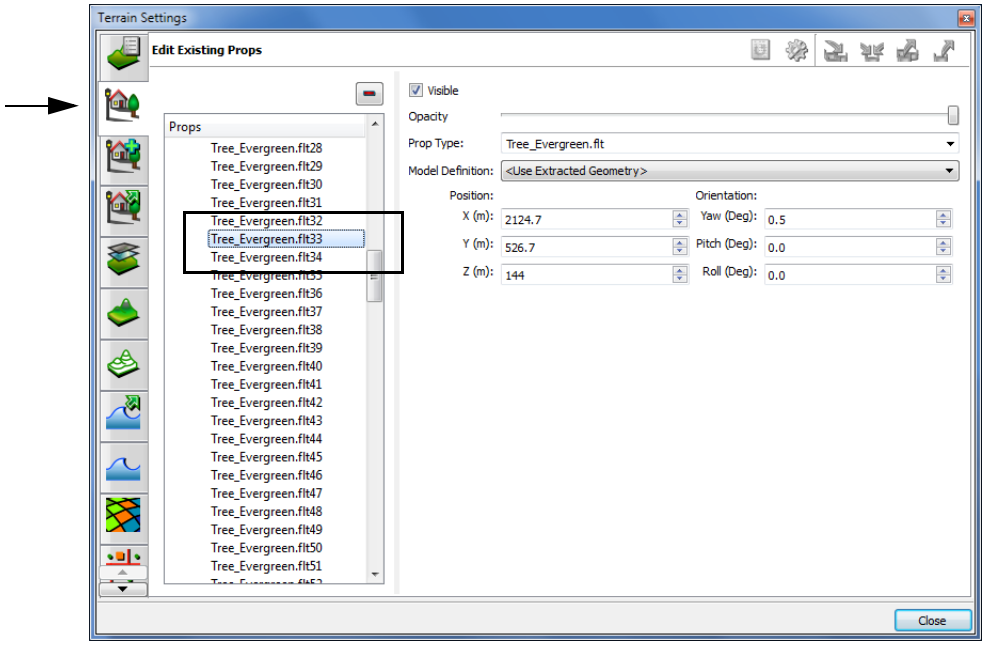


Figure B-25. Edit Existing Props page

4. In the Model Definition box, select a model definition from the list, such as Trees-GiantRedwoodST. The tree changes to the new model definition (Figure B-26).



Figure B-26. New model definition for tree

5. To restore the tree to its original model, on the Edit Existing Props page, change the model definition to Use Extracted Geometry.

B.4. Adding Feature Data to a GDB Terrain

The documentation for creating props focuses on adding props from terrain data files that already contain feature data. However, what if you do not have shapefiles or other feature data for your terrain? How would you add a SpeedTree or a building? The MÄK Terrain Database Tool, which is included with VR-Forces, lets you add feature data to a GDB terrain. You can then extract these features and map them to models as described in this manual.

This tutorial shows you how to add a tree point feature to a terrain and then add it as a feature layer. A companion tutorial explains how to extract the feature and map it to a Speed Tree model. (For that portion of the tutorial, please see "Extracting a Point Feature as a Prop (Adding a SpeedTree)," on page C-13.) The process for adding a building or some other object would be similar.

To see a set of brief videos that illustrate this tutorial, open *./doc/vrforces_tutorialvideos.htm*.

The general process is as follows:

1. Create a new GDB terrain in the TDB Tool or open an existing terrain ("Create a New GDB Terrain in the TDB Tool," on page B-24).
2. Add point features in the locations where you want them ("Add a Point Feature to the Terrain," on page B-26).
3. Save the GDB file.
4. In VR-Forces, add the GDB file as a feature layer ("Add the GDB Terrain to VR-Forces as a Feature Layer," on page B-30).

B.4.1. Create a New GDB Terrain in the TDB Tool

This step of the tutorial minimally describes the process for creating a new terrain in the TDB Tool. Please refer to *MAK Terrain Database Tool Users Guide* for details about creating projects, GDB files, and MTD files. This tutorial uses the Little Pond terrain.

To create a Little Pond GDB file and add feature data:



1. Start the TDB Tool. (Choose **All Programs** → **MÄK Technologies** → **VR-Forces 4.2** → **Tools** → **TDB Tool**. The TDB Tool opens (Figure B-27).)

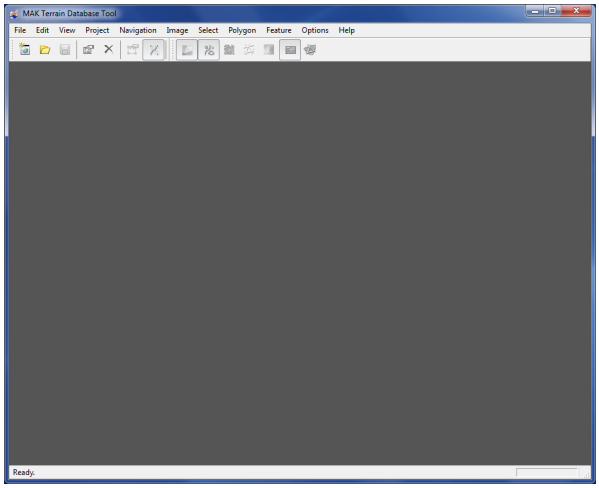


Figure B-27. TDB Tool window

2. Choose **File** → **New** → **Terrain Project**. The Utility Bar is added to the window (Figure B-28).

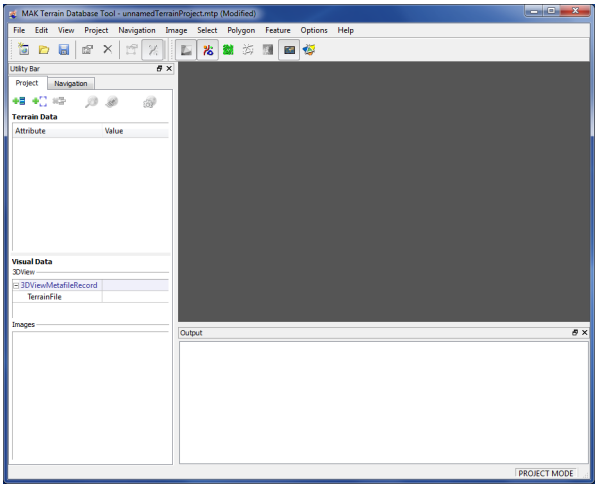


Figure B-28. New project

3. Choose **Project** → **Add Data From File**. The Add Data dialog box opens.
4. Navigate to *./data/terrain/LittlePond/Elevation* and choose *w072n042.dt1*.
5. Click Open. The data is added to the project. By default, the TDB Tool sets the projection for DTED files to UTM. However, the default for DTED in VR-Forces is Flat Earth, so you must change the projection.
6. In the Terrain Data panel on the Project tab, scroll through the Attribute list until you see the Projection attribute.
7. Click on the value (UTM). The value becomes editable (as a list).
8. In the list, select FlatEarth (Figure B-29).

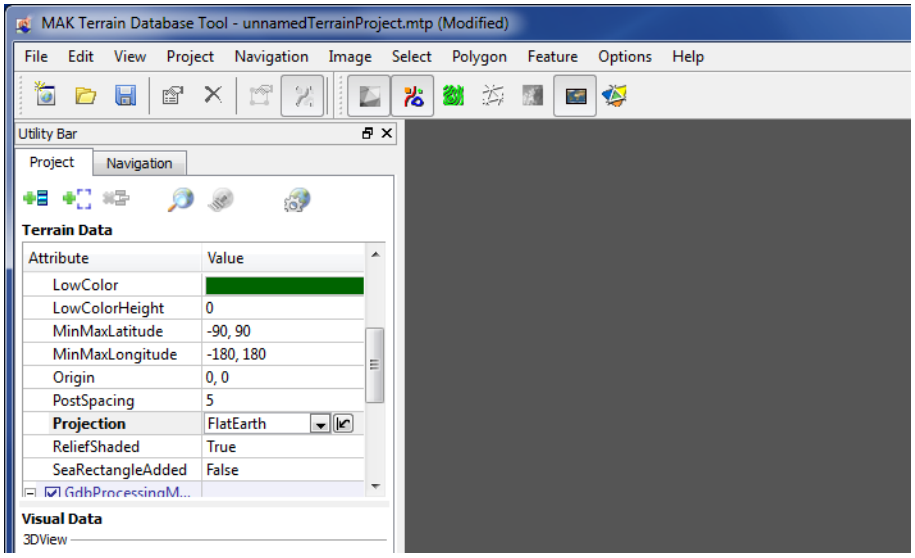


Figure B-29. Change the projection to FlatEarth

9. Choose **Project** → **Build Terrain**. The Build Terrain dialog box opens.
10. Type a name for your project, such as *myLittlePondFeatures*.
11. Click Save. The terrain is built and the TDB Tool asks you if you want to open the *myLittlePondFeatures.mtd* and *myLittlePondFeatures.gdb* files.



The files get saved to *./userData/terrains/myLittlePondFeatures.gdb*.

12. Click Yes.
13. Optionally, save the project when prompted. The terrain is displayed (Figure B-30).

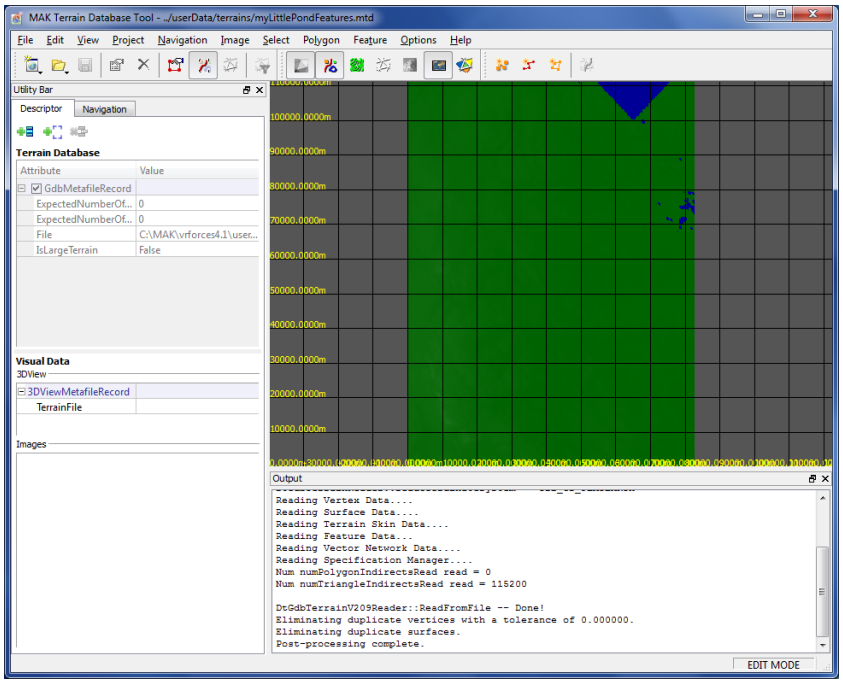


Figure B-30. New terrain

B.4.2. Add a Point Feature to the Terrain

This step of the tutorial minimally describes the process for adding point features in the TDB Tool. It uses the terrain created in the previous section. Please refer to *MAK Terrain Database Tool Users Guide* for details about creating projects, GDB files, and MTD files.

To add a point feature to the terrain:



1. On the Descriptor tab of the Utility bar, click Add Data. The Add Image Data dialog box opens.
2. Navigate to *./data/Terrain/LittlePond/Imagery* and choose *LittlePond.tif*.
3. Click Open. The image is added to the terrain (Figure B-31). Its purpose is to give us an easily identified location on which to place our point features.

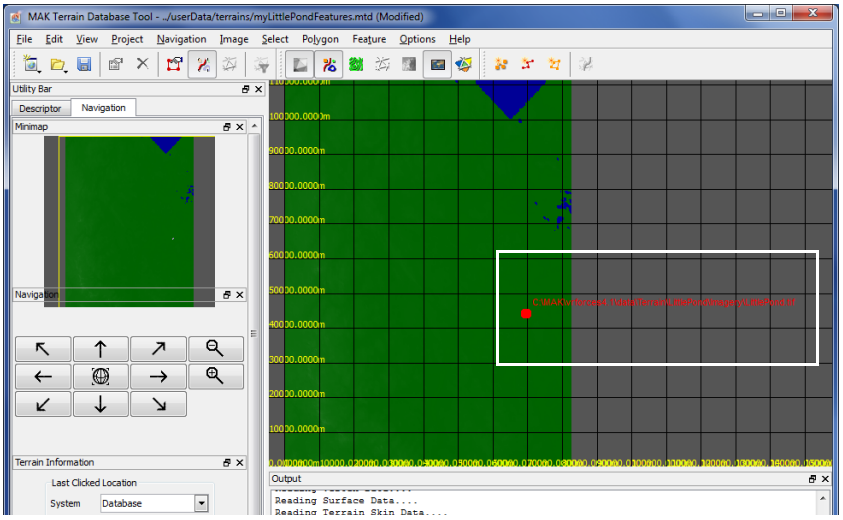


Figure B-31. Terrain with image added

4. Use the controls on the Navigation tab to zoom in on the image. Get close enough to see the roads easily, as in (Figure B-32).



Figure B-32. Zoomed-in view of image

5. Choose **Feature** → **Add Point Feature**. The cursor changes to a point and the Add Point Feature dialog box opens (Figure B-33).

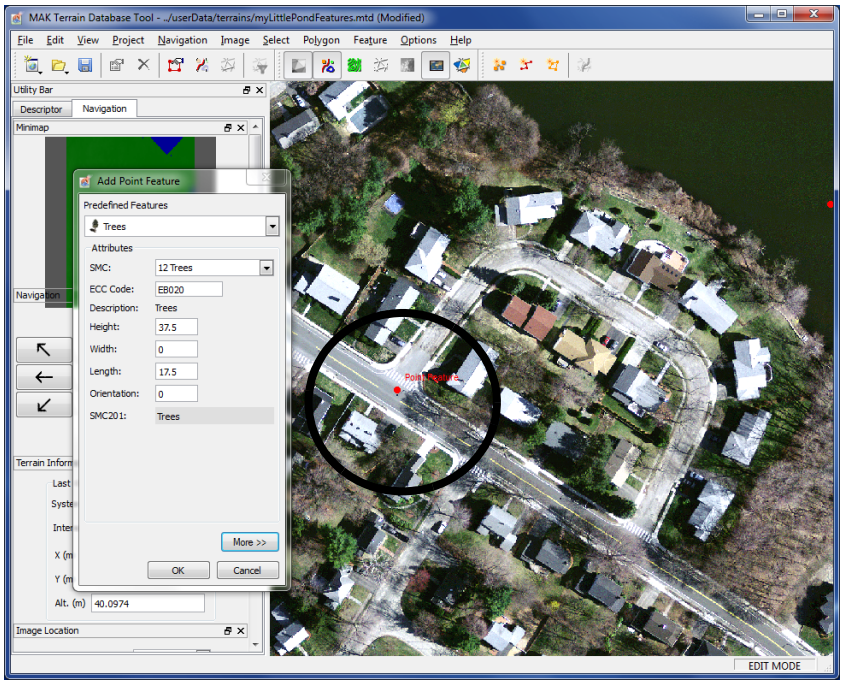


Figure B-33. Add Point Feature dialog box and new point

6. In the Predefined Features List, select Trees.
7. Click on the image in a place where your feature will be obvious, such as in the middle of the road (Figure B-33).
8. Click OK. The feature is added to the terrain (Figure B-34).

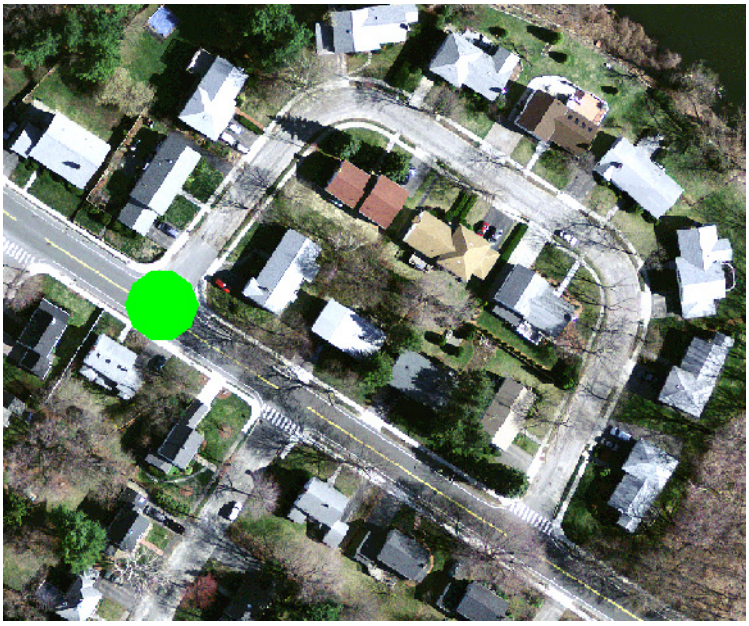


Figure B-34. Point feature added

9. Choose **File** → **Save**.
10. Close the TDB Tool.

B.4.3. Add the GDB Terrain to VR-Forces as a Feature Layer

In this step, we take the GDB terrain that we created in the previous steps and add it as a feature layer in VR-Forces.

To add a feature layer:



1. Start VR-Forces.
2. Change the observer mode to Stealth mode.
3. Open the *LittlePond.mtf* terrain.
4. Orient your view of the terrain so that you are viewing the area in which you created the point feature in the GDB file (Figure B-35). (If you open the Observer Views Panel and load the *LittlePond.osrx* saved views file, you can select the saved view and jump right to the inset.)



Figure B-35. 3D view of Little Pond

5. Open the Terrain Settings dialog box.
6. Select the Terrain Contents page.
7. Click Add Feature Layer. The Select Source File for Feature Layer dialog box opens on top of the Feature Layer Settings dialog box.
8. Select the file *./userData/terrains/myLittlePondFeatures.gdb*.
9. Click Open. The file is added to the list of feature layers.

To complete the tutorial by extracting the new point feature as a prop, please see "Extracting a Point Feature as a Prop (Adding a SpeedTree)," on page C-13.

C

Model Tutorials

Although the individual procedures for managing model definitions and model mappings are fairly straightforward, understanding how they fit together to help you achieve your visualization goals is not always obvious. This appendix contains several tutorials that demonstrate how to combine various procedures to add models.

Adding a Model to VR-Forces C-2
- Create a Model Definition C-2
- Add an Element Definition C-5
- Add a Model Mapping C-8
- Test the Model Mapping C-10

Extracting a Point Feature as a Prop (Adding a SpeedTree) C-13

C.1. Adding a Model to VR-Forces

This tutorial shows how to add a new model to VR-Forces. To help you with the tutorial, VR-Forces includes a model of an F/A-18 Hornet that is not mapped to any entities.

The basic steps are:

1. Create a model definition ("Create a Model Definition," on page C-2).
2. Add an element definition ("Add an Element Definition," on page C-5).
3. Map the new model to an entity or object type enumeration ("Add a Model Mapping," on page C-8).
4. Test the new model ("Test the Model Mapping," on page C-10).

C.1.1. Create a Model Definition

A model definition is an instance of a schema. It specifies values for the parameters required by the schema.

To create the model definition:



1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Model Definition Editor page (Figure C-1).

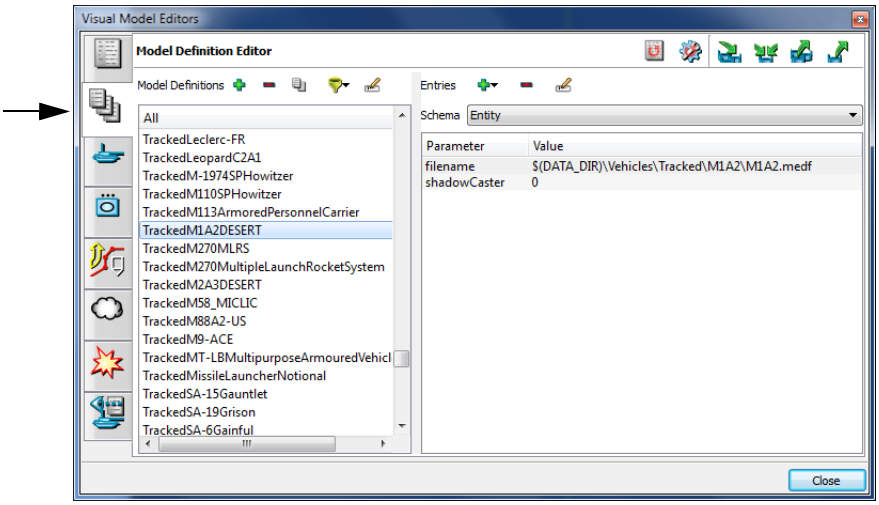


Figure C-1. Model Definition Editor page

3. Optionally, filter the model definitions in the list to just show entity model definitions. (For details, please see "Filtering the List of Model Definitions," on page 12-11.)

4. Click the Add button (+) next to the Model Definitions label. The Add Model Definition dialog box opens (Figure C-2).

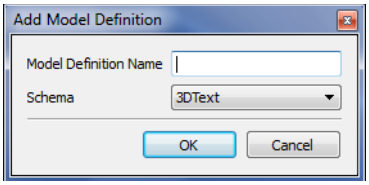


Figure C-2. Add Model Definition dialog box

5. Type a name for the new model definition, for example, myF18.
6. If you filtered the model definition list, the Schema box says Entity. If not, in the Schema list, select Entity. The dialog box now looks like Figure C-3.

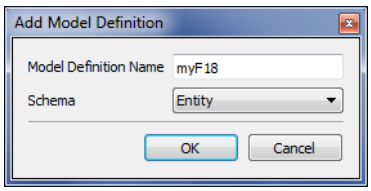


Figure C-3. New model definition

7. Click OK. The new definition is added to the list (Figure C-4). It does not have any parameters specified yet, so VR-Forces prints an error message. Now you must specify the model file for this model definition.

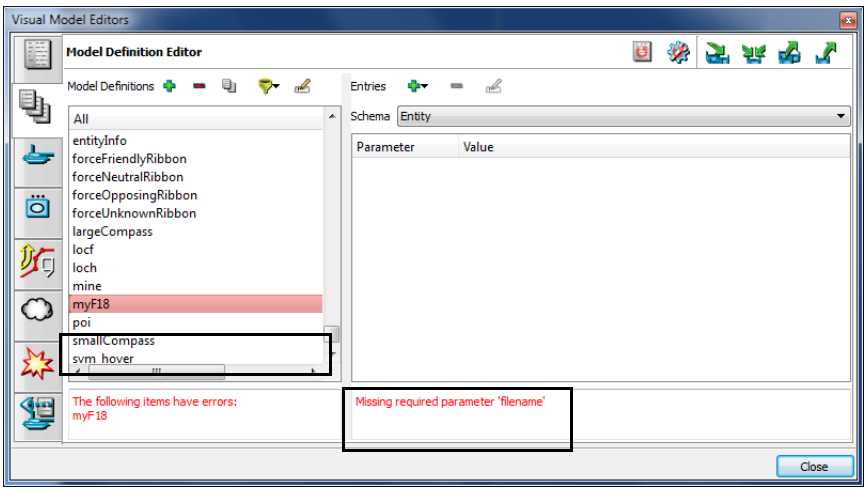


Figure C-4. New model definition in list

8. Select the new model definition.

9. Click the Add Parameter button (). A list of parameters is displayed (Figure C-5).

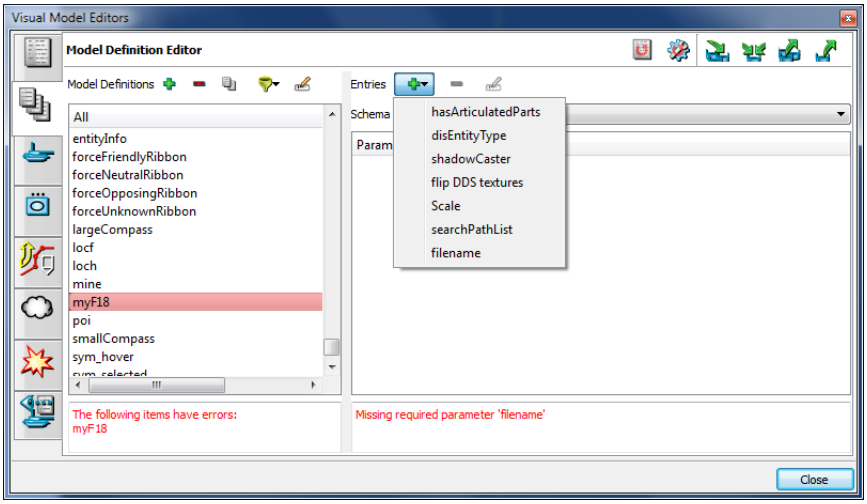


Figure C-5. List of parameters

10. Select filename. It is added to the parameter list.
11. Click the value for the parameter. A file selection dialog box opens.
12. Navigate to *./data/Vehicles/FixedWing/FA-18_Hornet* and select *FA-18_Hornet.flt*.
13. Click OK. The value is updated (Figure C-6).

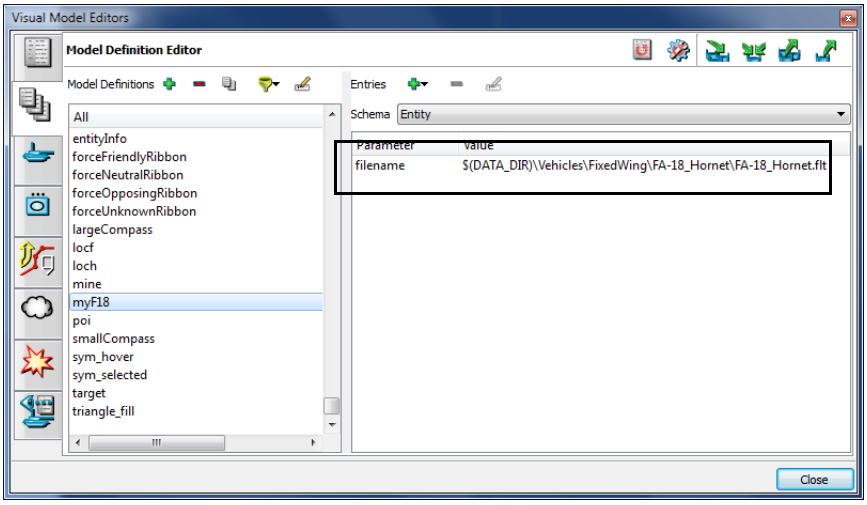


Figure C-6. Model definition parameter

C.1.2. Add an Element Definition

An element definition configures the visualizers used to display an element and its effects. You must specify the model definition to use for the Model Visualizer.

To add an element definition:



1. Choose **Settings** → **Visual Model Editors**. The Visual Model Editors dialog box opens.
2. Select the Entity Definition Editor page (Figure C-1).

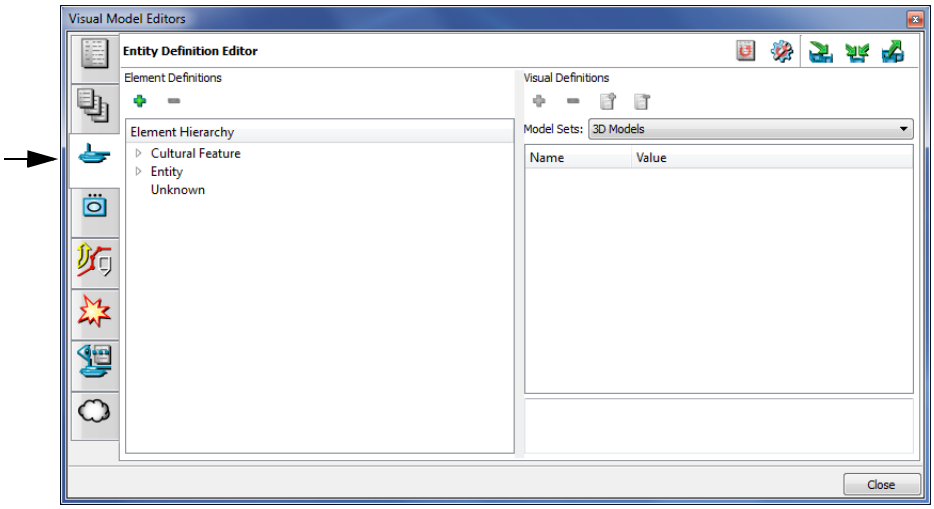


Figure C-7. Entity Definition Editor page

3. Expand the Entity section of the hierarchy and then expand the Air section.
4. Select Fixed Wing.
5. Select Medium Fixed Wing.
6. Click the Add button (+) next to the Entity Definitions label. The Create Element Definition dialog box opens.
7. Type a name for the new entity, for example, myF18.
8. Click OK. An entry called myF18 is added to the list of fixed wing entities (Figure C-8). It has the same list of visualizers as the fixed wing parent level.

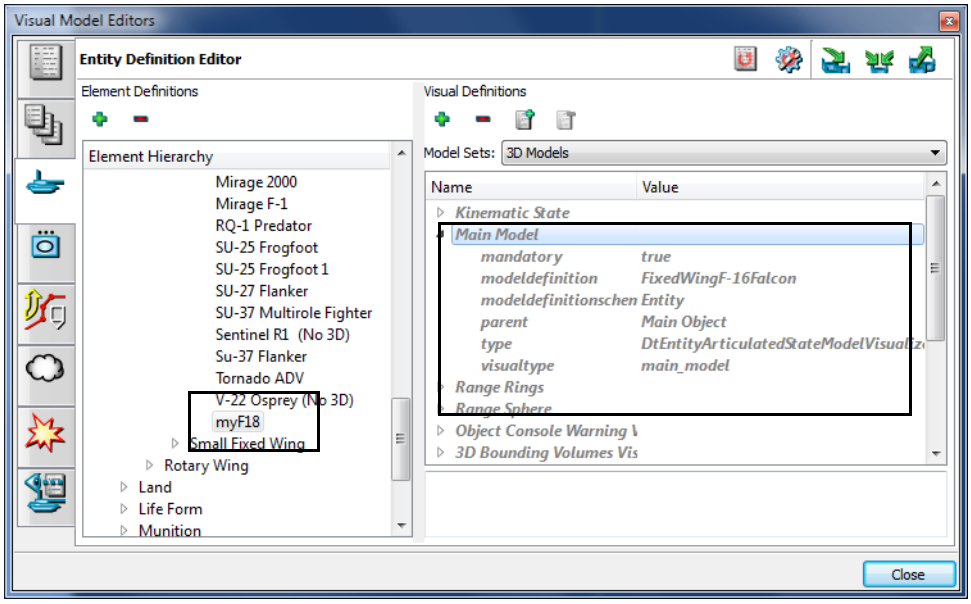


Figure C-8. New entity definition

9. Scroll through the Visual Definitions list until you find the Main Model visualizer. This visualizer specifies the model definition that this element should use. It has the model definition of the parent element. We need to change it to use the myF18 model definition.

10. Click the Value column for the **modelDefinition** attribute to make it editable. The Choose Model Definitions dialog box opens (Figure C-9). It shows the current model definition as a selection in a list.

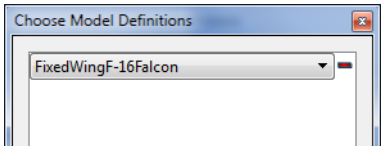


Figure C-9. Choose Model Definitions dialog box with list of definitions

11. Click the Down Arrow to expand the model definition list and select the new model definition (myF18).

12. Click OK. The model definition is now specified (Figure C-10).

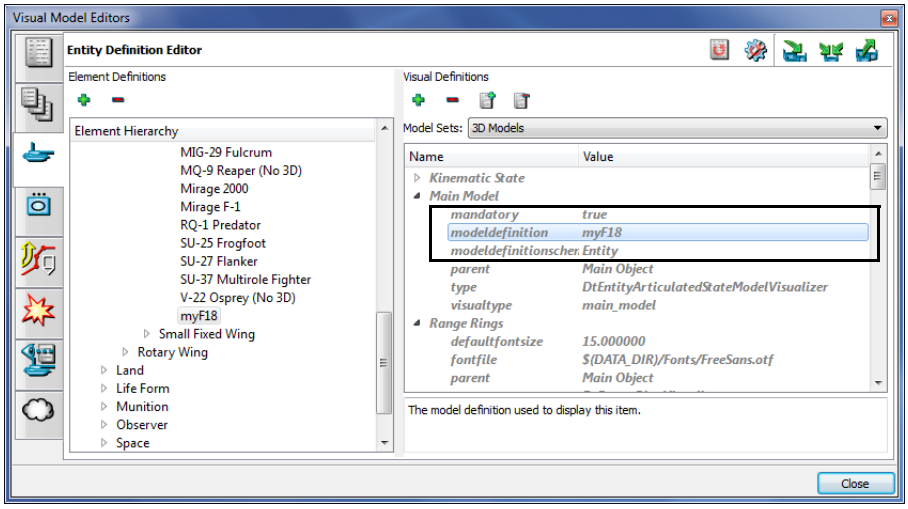


Figure C-10. Model Definition for Model Visualizer

13. Close the Visual Model Editors dialog box.

C.1.3. Add a Model Mapping

Now, you have to map the new model definition to an entity type enumeration.

To add a model mapping:

1. Choose **Settings** → **Entity Type Mappings**. The Entity Type Mappings dialog box opens.
2. Select the Entity Mapping Settings page (Figure C-11).

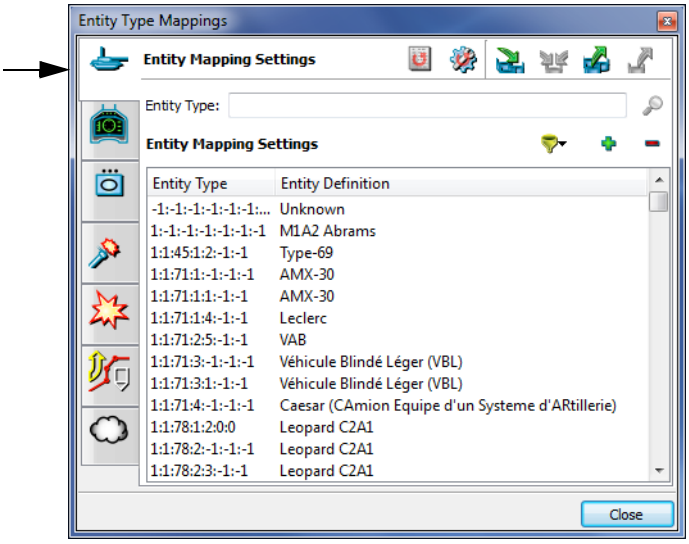


Figure C-11. Entity Mapping Settings page

3. Click the Filter button ( ).
4. In the list, select **Entity** → **Air** → **Fixed Wing** → **Medium Fixed Wing**. (This does not change the Entity Mapping Settings list; it filters the list in the Create New Entity Type Model Mapping dialog box.)
5. Click the Add button ( ). The Create New Entity Type Model Mapping dialog box opens (Figure C-12). It lists a default entity type enumeration.

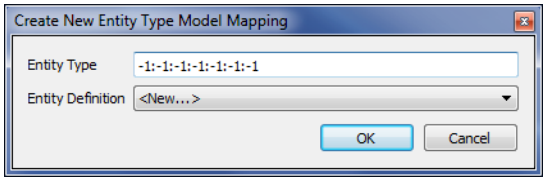


Figure C-12. Create New Entity Type Model Mapping dialog box

6. In the Entity Type text box, type the enumeration you want to map to the new model mapping. (The enumeration for an F/A18 is 1:2:225:1:9:1:-1.)



VR-Forces already has an F/A18 mapped to this enumeration. However you can map multiple model definitions to an enumeration. When an entity type that has multiple model definitions mapped to it is discovered in a simulation, VR-Forces randomly assigns a model definition from among those mapped to the entity type.

7. In the Entity Definition list, select the model definition that you added in the previous procedure (myF18) (Figure C-13).

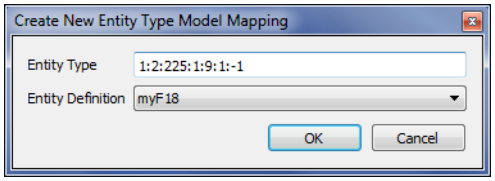


Figure C-13. Create new model mapping

8. Click OK.
9. The new model mapping is added to the list.

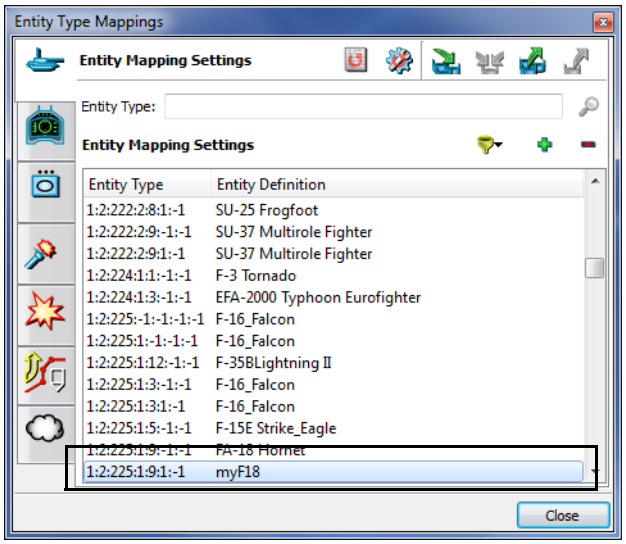


Figure C-14. New model mapping

10. Restart VR-Forces. Changes to model definitions and mappings do not take effect until you restart.

C.1.4. Test the Model Mapping

It is a good idea to test the new model mapping to see if the correct model is being displayed. You can test a model by running a simulation that has the entity or object type, or you can perform the simple test described here.

To test a model:



1. Open a terrain database that has easily identifiable props. For the purposes of this tutorial, open the Makland terrain.
2. In the VR-Forces window, move the observer so that you are viewing the palace on top of the hill near the town in Makland.
3. Click the palace to select it (Figure C-15).

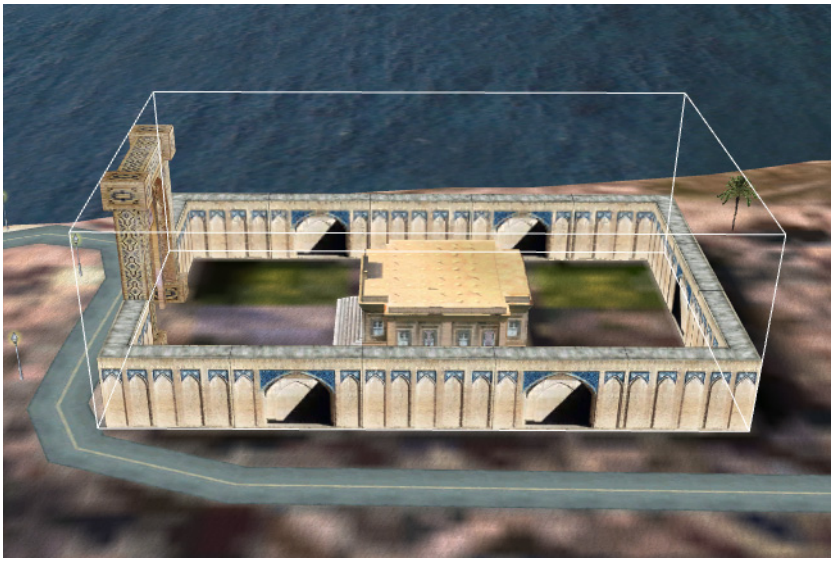


Figure C-15. Palace

4. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
5. Select the Edit Existing Props page. The list of props shows that Building26, the palace, is selected (Figure C-16).

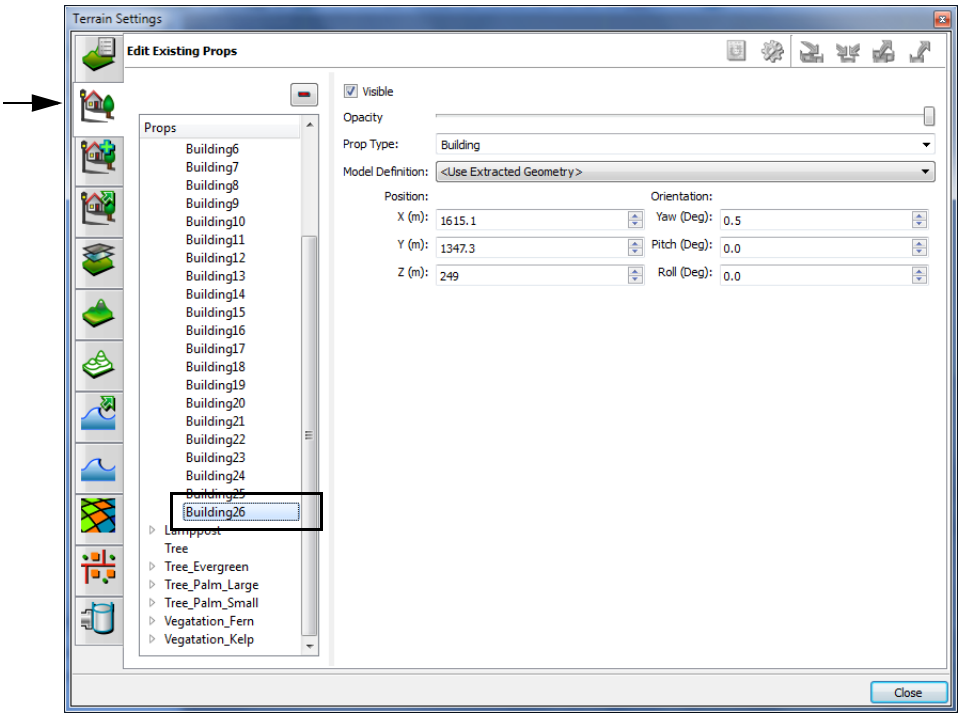


Figure C-16. Edit Existing Props page

6. In the Model Definition list, select the model definition that you added earlier in this tutorial (Figure C-17). The model of the palace is replaced with the model for the F/A-18 (Figure C-18). If this is the model that you wanted to add, then you know that you completed the procedure correctly. If this is not the model, you expected, check the filename you specified for the model definition.

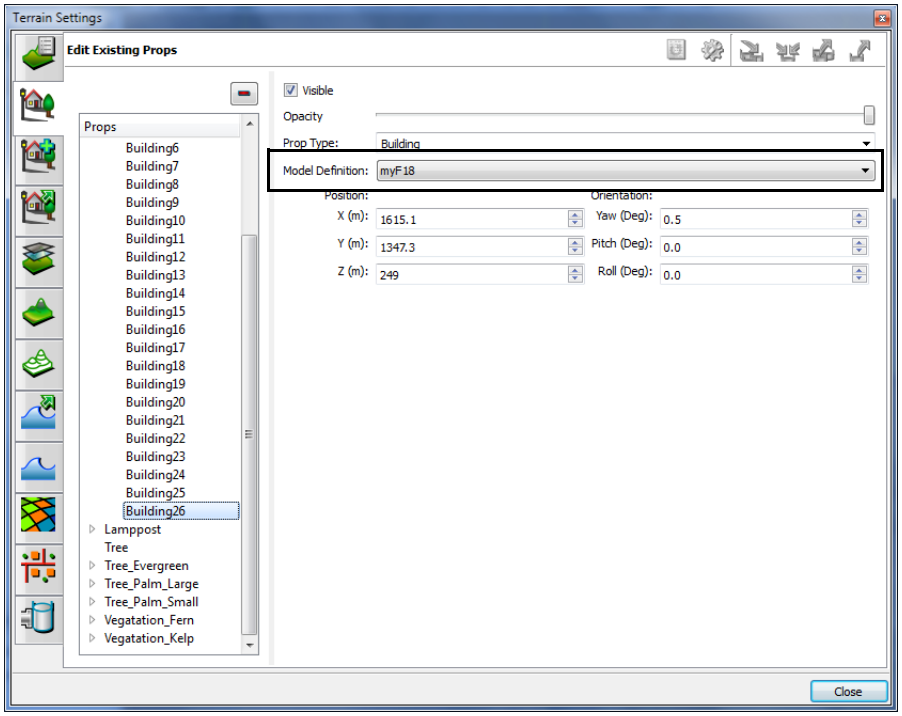


Figure C-17. Changed model definition

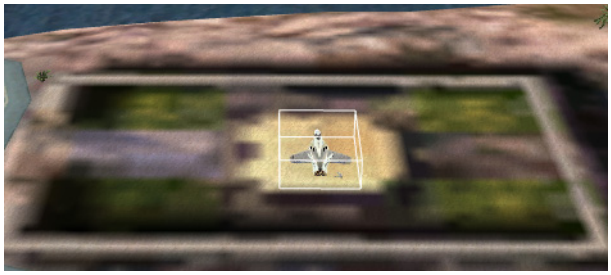


Figure C-18. F/A-18 replaces the palace

7. If you are going to use this terrain for simulations, change the model definition back to Use Extended Geometry.

C.2. Extracting a Point Feature as a Prop (Adding a SpeedTree)

In the tutorial "Adding Feature Data to a GDB Terrain," on page B-23, we explain how to add a point feature to a GDB terrain and add the terrain as a feature layer. In this tutorial, we extract the point feature and map it to a SpeedTree model. This tutorial assumes that you have completed the companion tutorial. Once the GDB file is added as a feature layer, you can extract the feature as a prop and map it to a model.

To see a brief video that demonstrates this tutorial, run *./doc/vrforces_tutorialvideos.htm*.

To extract a feature as a prop:

1. Load the LittlePond terrain.
2. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
3. Select the Add Props page.
4. Click the Add button (+) next to the list of Feature Layers.
5. Select *./userData/terrains/myLittlePondFeatures.gdb*.
6. In the Build Rule group box, click the Add button (+). The Build Field/Value Pair dialog box opens.
7. In the Field list, select DtFeatureName. The Value should be automatically set to Trees (Figure C-19).

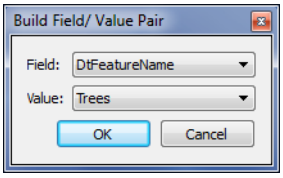


Figure C-19. Build Field/Value Pair dialog box

8. Click OK.
9. In the Prop Type list, select Tree.
10. In the Model Definition list, select the type of tree that you want to add, such as TreesGiantRedwoodSt (Figure C-20).

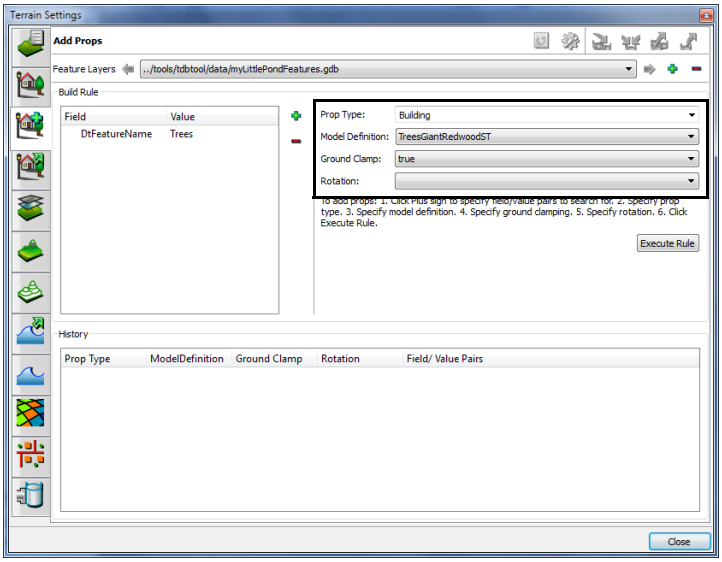


Figure C-20. Full build rule specified

11. Click Execute Rule. The tree is added to the scene where the point feature was located in the GDB file (Figure C-21).



Figure C-21. New tree in Little Pond

D

Creating and Editing Key Mappings

This appendix explains how to edit key mappings and create new key mappings.

Introduction D-2
The Key Mapping Editor D-2
Binary Key Mappings D-3
Editing a Key Map D-3
Adding a Key Mapping D-4
Changing a Key Mapping D-5
Deleting a Key Mapping D-6
Using Combined Key Mappings D-6
Filtering the Function List D-7
Creating a Key Map D-7
Deleting a Key Map D-7

D.1. Introduction

When you move the observer, you are actually executing functions that control the observer's movement. For example, the Move Observer Forward function moves the observer forward in observer coordinates. The Move Level Observer Forward function moves the observer forward in level observer coordinates.

The various movement functions are mapped to the keys on the keyboard and to mouse buttons and the mouse wheel.

VR-Forces comes with key mappings that we think will meet the needs of most VR-Forces users. However, you can edit the default keyboard mappings and create new mappings of your own with the Key Mapping Editor.

D.2. The Key Mapping Editor

The Key Mapping Editor (Figure D-1) lists all of the functions that you can control from the keyboard and the keys to which they are mapped. Some functions are mapped to more than one key or key combination. A key can be mapped to more than one function (combined mappings). You can:

- Edit a function's key mappings.
- Add new mappings.
- Delete mappings.

Changes are saved automatically.

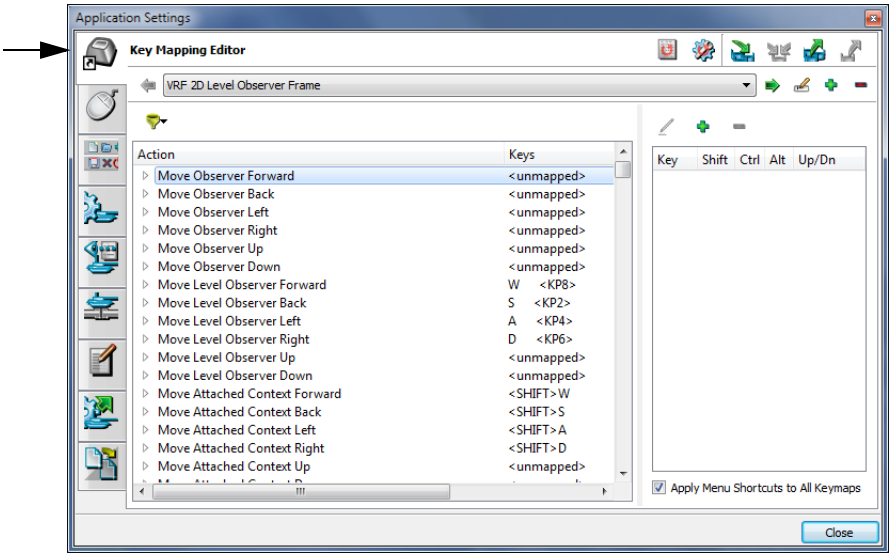


Figure D-1. Key Mapping Editor

D.2.1. Binary Key Mappings

Many navigation functions require you to press and hold a key. For example, you press and hold **w** to move the observer forward. (By contrast some keyboard actions are toggles or unary functions, such as pressing period to attach to the next entity.) For these actions, VR-Forces needs to keep track of when the key is pressed down (start the action) and when it is released (stop the action). To a human user, a function like Move Observer Forward is experienced as one action. But the computer experiences it as two actions. Therefore, key mappings must take this into account. The Key Mapping Editor shows the key mappings for these functions as paired functions that are subordinate (children) to the primary function (the parent), as shown in the Move Observer Up entry in Figure D-1.

D.3. Editing a Key Map

The Key Mapping Editor lists all of the VR-Forces functions that you can control from the keyboard.

To edit a key map:

1. Choose **Settings** → **Application**. The Application Settings dialog box opens.
2. Select the Key Mapping Editor page (Figure D-1).
3. Select the function whose key mappings you want to edit.
4. Edit the key mappings as described in:
   - "Adding a Key Mapping," on page D-4.
   - "Changing a Key Mapping," on page D-5.
   - "Deleting a Key Mapping," on page D-6.
5. Optionally, export the key map to a file.
6. Click OK.

D.3.1. Adding a Key Mapping

If a function is not mapped to a key, it is marked <unmapped>. You can add a mapping to unmapped functions and you can add additional key mappings to functions that are already mapped. If you add a key mapping to a binary function, the Key Mapping Editor automatically applies it to the child (UP and DN) functions. You can add key mappings to the child functions of binary mappings. When you add a key mapping to a child function, it is not applied to its paired function or the parent function.



In most cases, an unmapped function is unmapped because it is not meaningful in the observer frame for the key mapping. For example, the level observer movement functions are not meaningful in the observer frame key mappings.

To add a key mapping:

1. Optionally, filter the function list. For details, please see "Filtering the Function List," on page D-7.
2. Select the function to which you want to add a key mapping.
3. Click the Add button (+) above the Key Map window (Figure D-2). The Key Entry dialog box opens (Figure D-3).

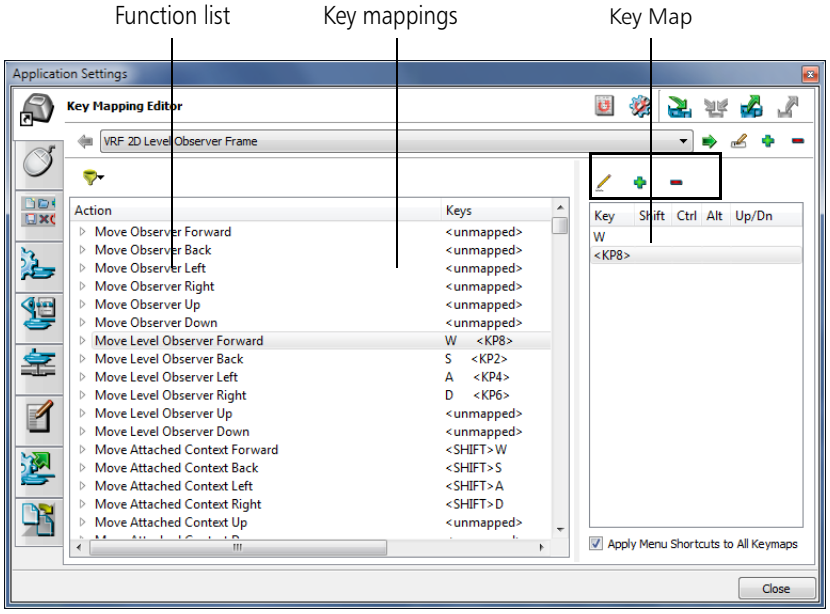


Figure D-2. Key Mapping Editor

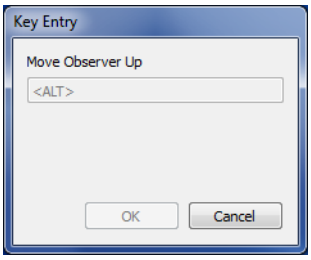


Figure D-3. Key Entry dialog box

4. On the keyboard, press the key or key combination (such as **`Ctrl`**+key or **`Shift`**+key) that you want to map to this function.
5. Click OK. (If you choose a key combination that is already in use, VR-Forces notifies you and asks how to proceed. For details about duplicate key mappings, please see "Using Combined Key Mappings," on page D-6.) The mapping is added to the function and is listed in the Keys column of the function list and in the Key Map window.

D.3.2. Changing a Key Mapping

If a key mapping is assigned to a binary function, the key is automatically assigned to the child functions. You cannot edit the key mappings for the child functions. You can only change the parent's key mapping. However, if you add a key mapping to a child function, you can edit it.

To change a key mapping:

1. Select the function whose key mapping you want to change. Its key mappings get listed in the Key Map window (Figure D-2).
2. In the Key Map window, select the key mapping that you want to change.
3. Click the Edit Key Mapping button (). The Key Entry dialog box opens (Figure D-4). It shows the current key mapping.

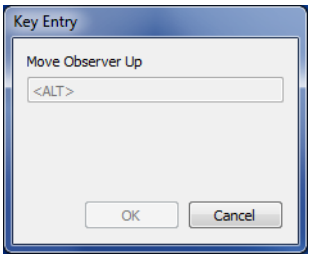


Figure D-4. Key Entry dialog box

4. On the keyboard, press the key or key combination (such as **`Ctrl`**+key or **`Shift`**+key) that you want to map to this function.

5. Click OK. The mapping is changed.

D.3.3. Deleting a Key Mapping

To delete a key mapping:

1. Select the function whose key mapping you want to delete. Its key mappings get listed in the Key Map window (Figure D-2).
2. In the Key Map window, select the key mapping that you want to delete.
3. Click the Delete button (−) above the Key Map window. The mapping is deleted. The function list is updated.

D.4. Using Combined Key Mappings

You can assign a key combination to more than one function. This allows you to combine the behaviors of two or more functions into one key combination. For example, the **`z`** key detaches the observer from the attached entity. The **`Space Bar`** resets the observer view to the default view. Suppose that whenever you detach from an entity, you want the observer to return to the default view. You could map the Reset function to **`z`**. **`z`** is now mapped to two functions. When you press **`z`**, VR-Forces detaches from the attached entity and moves the observer to the default view.

To manage combined key mappings:

1. Add the appropriate key mapping to a function.
2. Click OK. The Key Already Mapped dialog box opens (Figure D-5). It lists the functions that already use this key mapping.

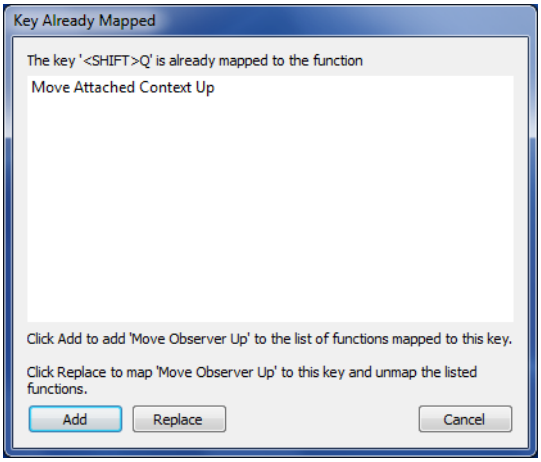


Figure D-5. Key Already Mapped dialog box

3. If the functions listed are the ones with which you want to share this key mapping, click Add. The key mapping is added to the function.

4. If you do not want to share this key mapping with other functions and want to use it for the function that you are editing, click Replace. The key mapping is applied to the function you are editing and removed from the functions listed in the dialog box.
5. If you do not want to remove the key mapping from existing functions and do not want to share it with the other functions, click Cancel. Presumably you wanted a unique key mapping for the function you are editing and did not realize you chose one that was already in use. Choose a different key mapping for this function.

D.5. Filtering the Function List

You can filter the function list in the Key Mapping Editor. Functions are grouped thematically.

➤ To filter the function list, click the Filter button (▾) and select an option on the list.

D.6. Creating a Key Map

To create a key map:

1. Choose **Settings** → **Application**.The Application Settings dialog box opens.
2. Select the Keyboard Mappings page (Figure D-1).
3. Click the Add button (+). The Create New Key Map dialog box opens.
4. Type a name for the new key map.
5. Click OK.
6. Add key mappings for the movement actions as described in "Adding a Key Mapping," on page D-4.

D.7. Deleting a Key Map

To delete a key map

1. Choose **Settings** → **Application**.The Application Settings dialog box opens.
2. Select the Keyboard Mappings page (Figure D-1).
3. In the key mapping list, select the key mapping that you want to delete.
4. Click the Delete button (−).
5. Confirm that you want to delete the selected key map.

E

Configuring the GUI

This appendix explains how to specify which menus, menu options, toolbars, and dialog box pages get displayed in the graphical user interface (GUI).

Introduction E-2
Configuring Menus and Menu Commands E-2
Configuring Dialog Box Pages E-3
Configuring Context-Sensitive Menus E-4
Configuring Toolbars E-5
    Creating Toolbars E-5
    Specifying an Icon for a Toolbar Item E-6
Locking Main GUI Elements E-6

E.1. Introduction

VR-Forces displays menus, menu commands, toolbars, dialog box pages, and right-click menus based on the information in an XML configuration file. The default file is *./appData/settings/vrfGui/default_guiConfiguration.gui*. You can edit this file or create alternative GUI configuration files. VR-Forces includes an example of a simple GUI configuration file, *./appData/settings/vrfGui/default_guiSimpleScenarioPlayer.gui*, that shows how you might create a highly modified GUI. You can specify an alternative GUI configuration file with the `--gui` command-line option when you start VR-Forces.

The elements in the configuration file are fairly self-explanatory. This chapter provides a brief description of the file.



For those GUI elements that can be rearranged, such as toolbars, the *.gui* file provides the initial organization of GUI elements. If a user rearranges toolbars, the new layout is saved in the settings file and overrides the *.gui* file.

E.2. Configuring Menus and Menu Commands

Menus are configured in the `<mainmenuconfiguration>` element. Each menu is configured in a `<mainmenu>` element. Menu commands are configured in `<menuitem>` elements. The following example configures a menu bar with one menu that has two items, which are separated by a separator line.

```
<mainmenuconfiguration name="main_menu_configuration">
  <mainmenu menuname="DtFileMenu">
    <menuitem itemname="DtNewScenarioMenuItem"/>
    <separator separatorname="1"/>
    <menuitem itemname="DtExitItem"/>
  </mainmenu>
</mainmenuconfiguration>
```

The values for the `menuname` and `itemname` attributes must be valid IDs registered in VR-Forces code. *default_guiConfiguration.gui* has all of the valid IDs for menus and menu commands.

To remove a menu or menu command from the GUI, delete the applicable element from *default_guiConfiguration.gui* or create an alternative file that does not have the elements. To add menus or menu items, you must know the ID.

E.3. Configuring Dialog Box Pages

Dialog boxes such as Display Settings and Terrain Settings have multiple pages for configuring different features. The GUI configuration file lets you disable or enable the pages on dialog boxes. The dialog boxes are configured as `<pagecollection>` elements inside the `<pagecollections>` element. The following example configures the Application Settings dialog box:

```
<pagecollections name="page_collections">
  <pagecollection pagecollectionname="DtApplicationSettings"
  title="Application Settings" location="8" visible="True" index="-1"
  show="DtKeyMappingEditorPage" closable="True" floatable="True"
  movable="True">
    <pageitem pageitemname="DtKeyMappingEditorPage"/>
    <pageitem pageitemname="DtMouseMappingEditorPage"/>
    <pageitem pageitemname="DtInterfaceLayoutEditorPage"/>
    <pageitem pageitemname="DtPerformanceOptionsPage"/>
    <pageitem pageitemname="DtSpotReportOptionsPage"/>
    <pageitem pageitemname="DtSessionOptionsPage"/>
    <pageitem pageitemname="DtScriptedTaskOptionsPage"/>
    <pageitem pageitemname="DtEntityBehaviorOptionsPage"/>
  </pagecollection>
</pagecollections>
```

In addition to settings dialog boxes, you can configure the pages on information dialog boxes, such as the Entity Information dialog box, and the specific data on the pages. These are configured in `<informationpagecollection>` elements. The following example is part of the Entity Information dialog box:

```
<informationpagecollections name="information_page_collections">
  <pagecollection pagecollectionname="DtEntityInformation" title="Entity
  Information" location="9" visible="True" index="-1"
  show="DtEntityStatePage" closable="True" floatable="True"
  movable="True">
    <pageitem pageitemname="DtTaskStatePage"/>
    <pageitem pageitemname="DtEntityStatePage">
      <informationitem informationitemname="DtEntityLocation"/>
      <informationitem informationitemname="DtEntitySpeed"/>
      <informationitem informationitemname="DtEntityVelocity"/>
      <informationitem informationitemname="DtEntityAcceleration"/>
      <informationitem informationitemname="DtEntityHeadingPitchRoll"/>
      <informationitem
        informationitemname="DtEntityRotationalVelocity"/>
      <informationitem informationitemname="DtEntityBoundingVolume"/>
      <informationitem
        informationitemname="DtEntityBoundingVolumeOffset"/>
    </pageitem>
    <pageitem pageitemname="DtEntityInformationPage">
      <informationitem informationitemname="DtEntityStateEntityId"/>
      ...
      <informationitem informationitemname="DtEntityStateGuise"/>
      <informationitem
        informationitemname="DtEntityStateIndependentlyTasked"/>
      <informationitem informationitemname="DtEntityStateUnderFire"/>
      <informationitem informationitemname="DtEntityStateHasPlan"/>
      <informationitem
        informationitemname="DtEntityStateRulesOfEngagement"/>
```

```
        <informationitem
          informationitemname="DtEntityStateDIGuyCharacter"/>
        <informationitem
          informationitemname="DtEntityStateDIGuyAppearance"/>
        <informationitem informationitemname="DtEntityStateFrozen"/>
        <informationitem informationitemname="DtEntityStateDRAlgorithm"/>
      </pageitem>
      ....
    </pagecollection>
  </informationpagecollections>
```

Notice that by default, the DtTaskStatePage does not have any `<informationitem>` elements. The information on that page is generated dynamically. There are no static fields.

E.4. Configuring Context-Sensitive Menus

The Entities menu on the main menu bar and the context-sensitive, or right-click, menus vary depending on which entities and objects are selected. These menus are configured as a set of `<rightclickmenu>` elements. There are multiple versions of these elements to account for the different contexts in which a menu might be displayed, for example, one aggregate, multiple single entities, a mix of entities and control objects. The following example is part of the context-sensitive menu for multiple entities:

```
<rightclickmenus name="right_click_menus">
  <rightclickmenu rightclickmenuname="Multiple_Entity">
    <popupmenu menuname="DtVrfRightClickContextMenu">
      <menu menuname="DtRightClickTaskMenu"/>
      <menu menuname="DtRightClickSetMenu"/>
      <separator separatorname="2"/>
      <menuitem itemname="DtVrfEntityAbandonPlanAction"/>
      <menuitem itemname="DtVrfEntityRestartPlanAction"/>
      <menuitem itemname="DtVrfEntityPlanAction"/>
      <menuitem itemname="DtVrfManageReactiveTasksActionId"/>
      <menuitem itemname="DtVrfEntitySkipTaskAction"/>
      <separator separatorname="110"/>
      <menuitem itemname="DtVrfAggregateAsAction"/>
      <menuitem itemname="DtExpandAggregateMenuItem"/>
      <menuitem itemname="DtExpandAllAggregateMenuItem"/>
      <menuitem itemname="DtCollapseAggregateMenuItem"/>
      <menuitem itemname="DtCollapseAllAggregateMenuItem"/>
      <menuitem itemname="DtObjectSettingsAction"/>
      ...
      <menuitem itemname="DtZoomToExtentsAction"/>
      <separator separatorname="DtInformationItemSeparator"/>
      <menuitem itemname="DtVrfVrlinkObjectInformationItem"/>
    </popupmenu>
  </rightclickmenu>
<rightclickmenus name="right_click_menus">
```

Notice that the entries for the Task menu (DtRightClickTaskMenu) and the Set menu (DtRightClickSetMenu) do not have any `<menuitem>` elements. That is because these menus are themselves context-sensitive and get built dynamically.

E.5. Configuring Toolbars

You can configure use of the various toolbars provided with VR-Forces. For each displayed toolbar, you can configure which row it is in and which command icons are used. The following example shows that the Scenario toolbar is in the top row:

```
<toolbarconfiguration name="toolbar_configuration">
  <toolbarrow toolbarname="Top_Row">
    <toolbar toolbarname="DtScenarioToolbar" visible="True"
      floating="False">
      <item itemname="DtNewScenarioMenuItem"/>
      <separator separatorname="DtScenarioToolbar_1"/>
      <item itemname="DtLoadScenarioMenuItem"/>
      <item itemname="DtLoadBatchScenarioMenuItem"/>
      <separator separatorname="DtScenarioToolbar_2"/>
      <item itemname="DtSaveScenarioMenuItem"/>
      <separator separatorname="DtScenarioToolbar_3"/>
      <item itemname="DtCloseScenarioMenuItem"/>
    </toolbar>
  </toolbarrow>
</toolbarconfiguration>
```

E.5.1. Creating Toolbars

Since toolbars are just buttons that reference existing menu options, you can create your own toolbars as easily as you add, delete, or edit the toolbars provided with VR-Forces. Simply add a `toolbar` element in one of the `toolbarrow` elements.

If you want to add tasks or sets to the Task or Set toolbars, or create a new toolbar, specify the `itemname` using the task or set ID as listed in *./include/vrfGuiConstants/vrfMenuIds.h*. If you want to add a scripted task to a toolbar, the `itemname` is its script ID plus "ToolbarItem". For example, if you add the Place IED scripted task to the Task toolbar, it would look like this:

```
<toolbar toolbarname="DtTaskToolbar" visible="True" floating="False">
  <item itemname="DtVrfTaskMoveToActionToolbarItem"/>
  <item itemname="DtVrfTaskMoveToLocationActionToolbarItem"/>
  <item itemname="DtVrfTaskMoveAlongRouteActionToolbarItem"/>
  <item itemname="DtVrfTaskMoveToAltitudeActionToolbarItem"/>
  <item itemname="DtVrfTaskPatrolObjectsActionToolbarItem"/>
  <item itemname="DtVrfTaskPatrolRouteActionToolbarItem"/>
  <item itemname="DtVrfTaskEmbarkActionToolbarItem"/>
  <item itemname="DtVrfTaskDisembarkActionToolbarItem"/>
  <item itemname="Place_IEDToolbarItem"/>
</toolbar>
```

E.5.2. Specifying an Icon for a Toolbar Item

If you add an item to a toolbar, you can associate an icon with the toolbar button. To associate an icon with a scripted task, specify it in the Scripted Tasks dialog box. For details, please see Section 13.2.2, "Specifying the Task Menu Icon," in *VR-Forces Scenario Management Guide*. For tasks or sets, create an SVG file and put it in *./data/Icons*. The file should use the menu ID of the task or set (from *./include/vrfGuiConstants/vrfMenuIds.h*) with the DtVrf text and Action text stripped from it. For example, the icon for DtVrfTaskMoveToAltitudeAction is *TaskMoveToAltitude.svg*. The icon for DtVrfSetHeadingAction is *SetHeading.svg*.

E.6. Locking Main GUI Elements

VR-Forces plug-ins can modify menus, dialog boxes, and other GUI features. You can lock GUI settings for first level elements (elements under the root element). This feature is used in *./appData/settings/vrfGui/default_guiSimpleScenarioPlayer.gui*. The syntax would be as follows:

```
<mainmenuconfiguration name="main_menu_configuration" locked="True">
  ...
</mainmenuconfiguration>
```

Given this configuration, none of the menus on the main menu could be modified.

F

The WRM Specification

Some OpenFlight files contain information specified by the *WRM Entity Model Specification for DIS Interoperability*. This information makes it possible for VR-Forces to depict the state of an entity's articulated and attached parts correctly and to switch among different entity appearances.

This appendix contains information that can help you build entity models that comply with the WRM specification, or add that compliance to existing models.

The WRM specification was developed by MÄK Technologies (now VT MÄK), Paradigm Simulation Inc., MultiGen Inc., and SAIC, for the ARPA War Breaker project. (Paradigm Simulation and MultiGen merged and were later acquired by Presagis.)



Although the WRM specification was developed for DIS, it is used in the HLA RPR FOM.

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F.1. Introduction

In order for visualization applications such as VR-Forces to change the state of a model in response to network messages, they must have certain information about the model. For example, which piece of the model's geometry is associated with which articulated part, and which piece of a model is associated with a particular entity appearance attribute.

This appendix describes a method of encoding information in an OpenFlight format model so that applications can make these associations. For the most part, information is associated with a MultiGen node by including it as a comment associated with the node. Comments that contain this information begin with the token, `@dis`.

VR-Forces depicts the movement of articulated parts and changes in entity appearances only when using models constructed to this specification.

This appendix represents a subset of the Model Specification for DIS Interoperability (version 001). For more details, please refer to that document. You can obtain the Model Specification at http://local.wasp.uwa.edu.au/~pbourke/dataformats/wrm/.

Although VR-Forces implements only a subset of the functionality enabled by the WRM Model Specification, we recommend that models conform to as much of the specification as is appropriate for the model, to promote compatibility with future versions of VR-Forces, and with visualization applications from other vendors.

F.2. The OpenFlight File Format

The OpenFlight file format organizes geometry into the following types of nodes:

- Face nodes represent individual polygons.
- Object nodes represent face nodes that are logically or geographically related. Object nodes can have only face nodes (polygons) as children.
- Level of detail (LOD) nodes provide a means to select alternate geometries based on a user-definable range. Using lower resolution geometry for objects that are far from the observer saves memory and improves performance.
- Degree of Freedom (DOF) nodes specify translational or rotational freedom, or both, for portions of a model. They can be used for DIS articulated parts or animated special effects. They specify a type of transformation and its limits, such as "rotate about the x axis between 45 and 135 degrees". The OpenFlight approach to degrees of freedom is hierarchical.
- Group nodes represent logically-related or geographically-related object nodes. Group nodes are the most general, and may have any type of nodes, except face nodes, as children.

F.2.1. Node Name and Comment Fields

Each node contains a comment field for user-definable data. The WRM Specification defines keywords that, when placed in a comment field, provide the information that DIS applications need to properly render a model.

F.2.2. External References and Instancing

The following OpenFlight constructs provide a means to avoid duplicating massive amounts of geometry:

- An external reference (or xref) is a pointer to another OpenFlight file that contains additional geometry.
- A transformation matrix is usually attached to an xref to locate the position and orientation of the referenced object's coordinate system geometry. Each instance may have a transformation matrix controlling the position and orientation of the child's coordinate system.

F.3. Modeling for DIS Interoperability

The WRM Specification provides uniform standards for locating and orienting the model coordinate system and a way to map DIS codes to associated models and parts. By conforming to these standards, applications that support the WRM Specification do not need customized software to interpret the multiple potential model formats that might otherwise exist.

F.3.1. The DIS Attribute Lexicon (DAL)

DIS attributes are specified using the following syntax:

```
@dis keyword values # comment
```

where:

- `@dis` must precede the keyword.
- *`keyword`* is one of the DAL keywords.
- values can be a number or string. Depending on the requirements of the keyword, the values specified can be an individual value, a comma separated list, or a range.
- `#` indicates the start of a comment. Comments are case sensitive. A comment continues until the next `@dis` entry.

Remember that all comments will be parsed by VR-Forces, so spelling counts.

F.3.2. DAL Keywords

The WRM Spec supports the following keywords:

- `articulated_part` *`part`*. Identifies the moveable parts of a model with a unique DIS Articulated Part code. This keyword is placed in a Group node that is a child to the DOF node that identifies an articulated part, and above the geometry that is going to be articulated. This keyword is always followed by the motion keyword. The articulated part codes are specified in DIS Standard SISO-REF-010-2006 Enumerations and Bit Encoded Values Articulated Parts. They are listed in Table F-3.

  This keyword is always followed by the switch keyword.

- `switch` *`appearance`*. Identifies a model appearance attribute with a DIS keyword. This keyword is placed in a Switch node in the model above the geometry that is going to be switched.

  The switch keyword takes the name value in DIS Standard SISO-REF-010-2006 Enumerations and Bit Encoded Values Entity Appearance (General and Specific), joined by the underscore character (_) if the name is multiple words, as its value. Note that frozen_status, power_plant_status, and state are preceded by an abbreviation for their domain, as follows: gm_ for guided munitions and lf_ for life forms. For a list of supported values, please see Table F-2.

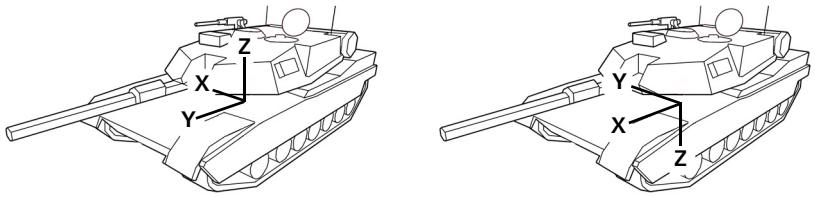
- `state` *`state`*,*`state`*... . Specifies the state of the appearance attribute with a DIS appearance state code. This keyword is placed in a Group node just below the switch node. For a list of supported values, please see Table F-2.

F.3.3. Model Coordinate Systems

OpenSceneGraph (OSG) and the DIS Standard use different right-hand coordinate systems. Table F-1 describes the two systems. Figure F-1 illustrates them.

Table F-1: Model coordinate systems

Coordinate	OpenSceneGraph	DIS
X	Right	Forward
Y	Forward	Right
Z	Up	Down



OSG coordinate system DIS coordinate system

Figure F-1. Model coordinate systems

When you create models, it is recommended that you use the OpenSceneGraph coordinate system. The simulation application will convert the coordinates, as follows:

- xmodel = yDIS.
- ymodel = xDIS.
- zmodel = -zDIS.

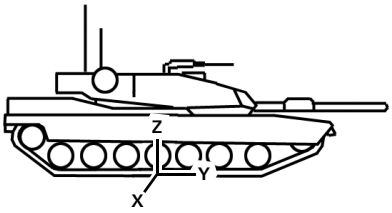
Location of the Origin for Models

The origin of the model's coordinate system should be located as follows, depending on the domain of the entity:

- Land: on the base of the vehicle, on the axis of yaw rotation.
- Surface: On the axis of the center of buoyancy, in the plane of the waterline for unloaded ship.
- Subsurface: On the axis of the center of buoyancy, in the plane of the waterline for surfaced submarine.
- Air and Space: At the center of gravity.

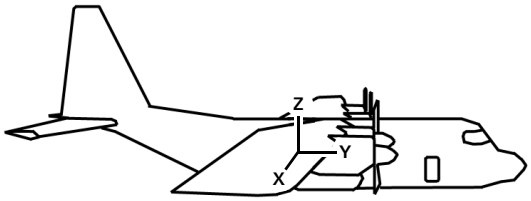
Figure F-2 illustrates the location of a model's origin for each platform domain.

Land



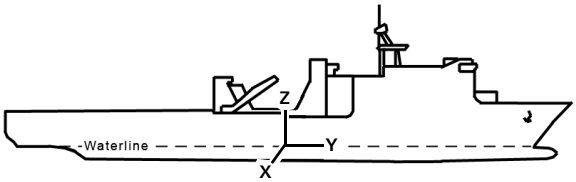
On the plane of ground contact, at the axis of yaw rotation.

Air



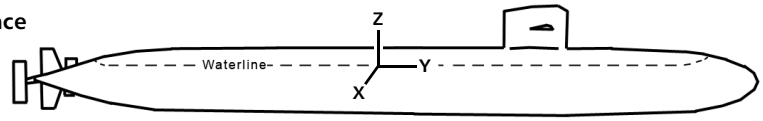
At the center of gravity.

Surface



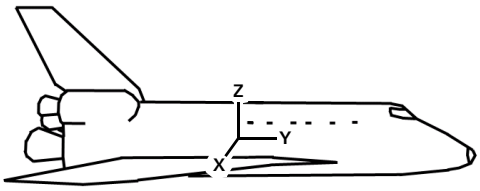
On the axis of the center of buoyancy, in the plane of the waterline for an unloaded ship.

Subsurface



On the axis of the center of buoyancy, in the plane of the waterline of a surfaced submarine.

Space



At the center of gravity.

Figure F-2. Location of origin by domain

F.4. Articulated Parts

In order for VR-Forces to properly depict the state of articulated parts, models must conform to the following specifications:

- There must be one DOF node for each articulated part. (This means that if there are several LODs, they should be children of the DOF.) Each articulation DOF should be a descendant of the DOF for the part to which it is attached (unless the parent part is just the base model itself). For example, the DOF for a gun should be a descendant of the DOF for a turret.
- Each articulated part DOF node must have all of the geometry and other nodes associated with the part underneath it. This DOF node must have a comment associated with it. The comment must be of the form:

  `@dis articulated_part` *`part-number`*

  where *`part-number`* is the enumeration for the particular type of part that this part of the model represents. For example, the part number of a turret is 4096, and the part number of a gun is 4416.

  Therefore, the child group of a turret's DOF must be commented with:

  ```
  @dis articulated_part 4096
  ```

  The child group of a gun's DOF must be commented with:

  ```
  @dis articulated_part 4416
  ```
- The WRM Model Specification specifies that information about the legal motions of each articulated part be encoded in the comment field. Currently, VR-Forces does not use this information.
- Do not include static offsets in the DOF attributes. That is, when you set all of the DOF parameters (X, Y, Z, heading, pitch, roll) to 0, the model should appear in its neutral position.

F.5. Entity Appearances

VR-Forces supports switching between different pieces of a model's geometry based on appearance attributes. For instance, a tank's turret should look different if the hatch is open or closed. An entire tank should look different if it is damaged or destroyed.

Switch nodes are used to represent a choice between several different children, based on a particular appearance attribute.

We define a switch node as a group node with a comment of the form:

```
@dis switch attribute
```

where `attribute` is the name of the attribute that should be used to select a child. (For example, damage, smoke, hatch, and so on.) "Entity Appearances," on page F-8, lists the attributes you can use with VR-Forces.

The children of the switch node represent the different portions of a model among which VR-Forces will select, based on the appearance attribute. If a switch node is commented with:

```
@dis switch hatch
```

it may, for example, have three children containing geometry for a closed hatch, popped hatch, and open hatch.

These children of the switch node must be commented so that VR-Forces knows which child matches which values of the appearance attribute. The comment is of the form:

```
@dis state value-list
```

`value-list` is of the form `m[,m]+` where `m` is one of the following:

- An integer representing the enumeration of a value that an appearance attribute may take on, for example, 1 for hatch closed.
- Two integers, a and b, separated by a hyphen, representing all enumerations from a through b, for example, 2-5 for all states whose enumerations are 2, 3, 4, or 5.
- The integer -1, which indicates that this child is the default child, to be used when the attribute state matches no values in any children.

For instance, the child of the hatch switch node that represents a closed hatch might be used when the hatch attribute value is either 0 (not-applicable), 1 (closed), or any value other than those enumerated in other children. This child would be commented:

```
@dis state 0,1,-1
```

The child with the popped hatch geometry should be used when the value is 2 (popped) or 3 (popped with person visible) and is commented:

```
@dis state 2,3
```

The child that contains the open hatch geometry should be used when the value is 4 (open) or 5 (open with person visible) and is commented:

```
@dis state 4,5
```

There may be many switch nodes for the same attribute. For example, there may be several pieces of a tank's geometry that are affected by the destroyed attribute.

The WRM Model Specification also discusses the inheritance of appearance attributes from ancestor nodes. VR-Forces does not support this functionality. To tell VR-Forces to, for example, display a camouflaged tank when the paint scheme attribute is set to camouflage, and a normal tank otherwise, you must use the switch node method described previously.

In Figure F-3, the turret DOF node is attached to the body Group node. The barrel, gun, and hatch DOF nodes are attached to the turret. This allows the turret to be positioned in the coordinate system of the body, and the barrel, gun, and hatch to be positioned in the coordinate system of the turret.

This model also contains a switch node that is flagged with animation. The comment on this node is `@dis switch moving`. This switches between two Group nodes – Stop and Go. Under the Stop node there is a single mesh of the treads of the tank. Under the Go node there is a Group node, with the animation flag set on. This creates a flipbook animation of all nodes below this Group node. There are three meshes in different states of moving: Frame 1, Frame 2 and Frame 3. At runtime OpenSceneGraph will animate these meshes when the velocity is not 0.

If multiple color schemes are needed to represent camouflage, winter, and desert versions, another switch is needed.

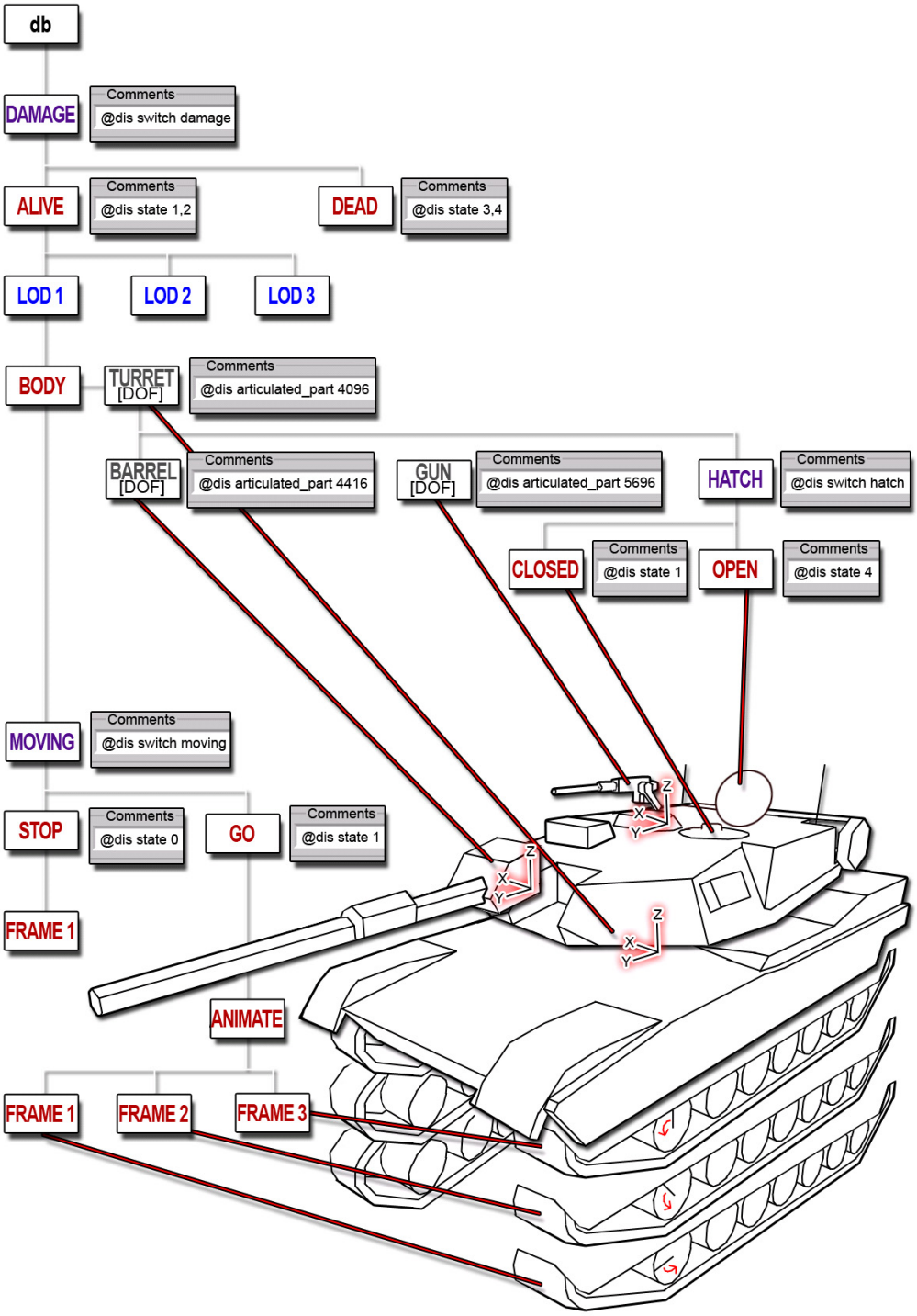


Figure F-3. 3D model structure

F.6. Animation

By default, animation sequences are displayed as quickly as possible. However, you can configure the animation sequence rate using a WRM animation comment in the animation node's comment field.

The comment syntax is as follows:

```
@dis animation num_frames_per_second [ skip | noskip ]
```

where:

- `animation` tells VR-Forces that animation instructions follow.
- *`num_frames_per_second`* is the rate at which VR-Forces should display the frames.
- `skip` and `noskip` indicate whether the elapsed time should be used to choose the next frame, or whether at most one frame should be advanced each frame.

F.7. DIS Keyword Values

Table F-2 lists the values that you can use for the `@dis switch` keyword. For any switch keyword, the supported state values (`@dis state [value 1],[value 1]...`) are listed in the State column. The Bit column lists the appearance bit for setting DIS appearances. (Some bit number are repeated because they are valid only for a particular platform.)

Table F-2: DIS Appearance and States (Sheet 1 of 4)

Values	Description	State/ Description	Bit
afterburner	State of an air platform's afterburner.	0 = Off 1 = On	16
anticollision_lights	State of anti-collision lights.	0 = Off 1 = On	14
blackout_brake_lights	State of blackout brake lights.	0 = Off 1 = On	27
blackout_lights	State of blackout lights.	0 = Off 1 = On	26
brake_lights	State of brake lights.	0 = Off 1 = On	14
camouflage_type	Type of camouflage.	0 = Desert 1 = Winter 2 = Forest 3 = Unused	17-18
compliance	Compliance of lifeform.	0 = Lifeform None 1 = Detained 2 = Surrender 3 = Using Fists 4 = Verbal Abuse 1 5 = Verbal Abuse 2 6 = Verbal Abuse 3 7 = Passive Resistance 1 8 = Passive Resistance 2 9 = Passive Resistance 3 10 = Non-Lethal Weapon 1 11 = Non-Lethal Weapon 2 12 = Non-Lethal Weapon 3 13 = Non-Lethal Weapon 4 14 = Non-Lethal Weapon 5 15 = Non-Lethal Weapon 6	

Table F-2: DIS Appearance and States (Sheet 2 of 4)

Values	Description	State/ Description	Bit
concealed	Type of concealment.	0 = Not Concealed 1 = In Concealed Position	19
damage	Damaged appearance of an entity.	0 = None 1 = Slight 2 = Moderate 3 = Destroyed	3-4
density	Density of environmental.	0 = Clear 1 = Hazy 2 = Dense 3 = Very Dense 4 = Opaque 5 = Unused	
fire_power	Characteristics of fire-power kill.	0 = No 1 = Yes	2
flaming	State of flames rising from an entity.	0 = No 1 = Yes	15
flashlight	State of lights.	0 = Off 1 = On	
formation_lights	State of formation lights.	0 = Off 1 = On	24
frozen_status	Frozen status of an entity.	0 = Not Frozen 1 = Frozen	21
hatch	State of the primary hatch.	0 = Not Applicable 1 = Closed 2 = Popped 3 = Popped and Person Visible 4 = Open 5 = Open and Person Visible 6 = Custom1 7 = Custom2	9-11
head_lights	State of headlights.	0 = No 1 = Yes	12
health	State of injury.	0 = None 1 = Slight 2 = Moderate 3 = Fatal	

Table F-2: DIS Appearance and States (Sheet 3 of 4)

Values	Description	State/ Description	Bit
interior_lights	State of interior lights.	0 = Off 1 = On	29
landing_lights	State of landing lights.	0 = Off 1 = On	12
launch_flash	Describes the presence of a guided munitions launch flash.	0 = No 1 = Yes	
launcher	State of the platform's primary launcher.	0 = Not Raised 1 = Raised	16
life_form_state	Lifeform action.	0 = None 1 = Upright Still 2 = Upright Walking 3 = Upright Running 4 = Kneeling 5 = Prone 6 = Crawling 7 = Swimming 8 = Parachuting 9 = Jumping 10 = Sitting 11 = Squatting 12 = Crouching 13 = Wading 14 = Surrender 15 = Detained	
lights	State of lights.	0 = Off 1 = On	
mobility	Characteristics of mobility kill.	0 = No 1 = Yes	1
navigation_lights	State of navigation lights.	0 = Off 1 = On	13
paint_scheme	Paint scheme of an entity.	0 = Uniform 1 = Camouflage	0
power_plant_status	State of the entity’s power-plant.	0 = Off 1 = On	22
ramp	State of a ramp.	0 = Down 1 = Up	25

Table F-2: DIS Appearance and States (Sheet 4 of 4)

Values	Description	State/ Description	Bit
running_lights	State of running lights.	0 = Off 1 = On	12
smoke	State or location of smoke and vapor.	0 = None 1 = Plume 2 = Engine 3 = Engine and Plume	5-6
spot_lights	Describes whether spot-lights are on or off.	0 = Off 1 = On	28
state	State of an entity.	0 = Active 1 = Deactivated	23
tail_lights	State of tail lights.	0 = Off 1 = On	13
tent	State of a tent extension.	0 = Not Extended 1 = Extended	24
trailing_effects	Size of the trailing effect for the entity.	0 = None 1 = Small 2 = Medium 3 = Large	7-8
weapon_1	State of primary weapon.	0 = None 1 = Stowed 2 = Deployed 3 = Firing Position	
weapon_2	State of secondary weapon.	0 = None 1 = Stowed 2 = Deployed 3 = Firing Position	

Table F-3 lists the supported values for the `@dis articulated_part` keyword. String values are part of the WRM specification, but are not currently supported.

Table F-3: DIS Articulations (Sheet 1 of 5)

Value	String	Description
3296	bridge_launcher	Position of the bridge launcher.
3328	bridge_section_1	Position of bridge section 1.
3360	bridge_section_2	Position of bridge section 2.
3392	bridge_section_3	Position of bridge section 3.

Table F-3: DIS Articulations (Sheet 2 of 5)

Value	String	Description
7616	fuselage_fold	Fold on plane's body.
1184	helicopter_main_rotor	Describes main rotor rotation.
1216	helicopter_tail_rotor	Describes tail rotor rotation.
3072	landing_gear	Landing gear on a plane.
3520	launcher_arm_primary	Position of the primary launcher arm.
1120	left_aileron	Position of the left aileron.
1056	left_flap	Position of the left flap.
3168	left_weapon_bay_door	Left door to weapon bay.
3552	other	Position of other articulated parts.
3424	primary_blade_1	Position of the primary blade 1.
3456	primary_blade_2	Position of the primary blade 2.
3488	primary_boom	Position of the primary boom.
5056	primary_defense_systems_1	Position of the primary defense systems 1.
5088	primary_defense_systems_2	Position of the primary defense systems 2.
5120	primary_defense_systems_3	Position of the primary defense systems 3.
5152	primary_defense_systems_4	Position of the primary defense systems 4.
5184	primary_defense_systems_5	Position of the primary defense systems 5.
5216	primary_defense_systems_6	Position of the primary defense systems 6.
5248	primary_defense_systems_7	Position of the primary defense systems 7.
5280	primary_defense_systems_8	Position of the primary defense systems 8.
5312	primary_defense_systems_9	Position of the primary defense systems 9.
5344	primary_defense_systems_10	Position of the primary defense systems 10.
4416	primary_gun_number_1	Position of the primary gun number 1.
4448	primary_gun_number_2	Position of the primary gun number 2.
4480	primary_gun_number_3	Position of the primary gun number 3.
4512	primary_gun_number_4	Position of the primary gun number 4.
4544	primary_gun_number_5	Position of the primary gun number 5.
4576	primary_gun_number_6	Position of the primary gun number 6.
4608	primary_gun_number_7	Position of the primary gun number 7.
4640	primary_gun_number_8	Position of the primary gun number 8.
4672	primary_gun_number_9	Position of the primary gun number 9.
4704	primary_gun_number_10	Position of the primary gun number 10.

Table F-3: DIS Articulations (Sheet 3 of 5)

Value	String	Description
4736	primary_launcher_1	Position of primary launcher 1.
4768	primary_launcher_2	Position of primary launcher 2.
4800	primary_launcher_3	Position of primary launcher 3.
4832	primary_launcher_4	Position of primary launcher 4.
4864	primary_launcher_5	Position of primary launcher 5.
4896	primary_launcher_6	Position of primary launcher 6.
4928	primary_launcher_7	Position of primary launcher 7.
4960	primary_launcher_8	Position of primary launcher 8.
4992	primary_launcher_9	Position of primary launcher 9.
5024	primary_launcher_10	Position of primary launcher 10.
5376	primary_radar_1	Position of the primary radar 1.
5408	primary_radar_2	Position of the primary radar 2.
5440	primary_radar_3	Position of the primary radar 3.
5472	primary_radar_4	Position of the primary radar 4.
5504	primary_radar_5	Position of the primary radar 5.
5536	primary_radar_6	Position of the primary radar 6.
5568	primary_radar_7	Position of the primary radar 7.
5600	primary_radar_8	Position of the primary radar 8.
5632	primary_radar_9	Position of the primary radar 9.
5664	primary_radar_10	Position of the primary radar 10.
4096	primary_turret_number_1	Position of the primary turret number 1.
4128	primary_turret_number_2	Position of the primary turret number 2.
4160	primary_turret_number_3	Position of the primary turret number 3.
4192	primary_turret_number_4	Position of the primary turret number 4.
4224	primary_turret_number_5	Position of the primary turret number 5.
4256	primary_turret_number_6	Position of the primary turret number 6.
4288	primary_turret_number_7	Position of the primary turret number 7.
4320	primary_turret_number_8	Position of the primary turret number 8.
4352	primary_turret_number_9	Position of the primary turret number 9.
4384	primary_turret_number_10	Position of the primary turret number 10.
1152	right_aileron	Position of the right aileron.
1088	right_flap	Position of the right flap.
3200	right_weapon_bay_doors	Right door to the weapon bay.

Table F-3: DIS Articulations (Sheet 4 of 5)

Value	String	Description
7584	rotor_fold	Fold on helicopters rotors.
1024	rudder	Position of the rudder.
6656	secondary_defense_systems_1	Position of the secondary defense systems 1.
6688	secondary_defense_systems_2	Position of the secondary defense systems 2.
6720	secondary_defense_systems_3	Position of the secondary defense systems 3.
6752	secondary_defense_systems_4	Position of the secondary defense systems 4.
6784	secondary_defense_systems_5	Position of the secondary defense systems 5.
6816	secondary_defense_systems_6	Position of the secondary defense systems 6.
6848	secondary_defense_systems_7	Position of the secondary defense systems 7.
6880	secondary_defense_systems_8	Position of the secondary defense systems 8.
6912	secondary_defense_systems_9	Position of the secondary defense systems 9.
6944	secondary_defense_systems_10	Position of the secondary defense systems 10.
6016	secondary_gun_number_1	Position of the secondary gun number 1.
6048	secondary_gun_number_2	Position of the secondary gun number 2.
6080	secondary_gun_number_3	Position of the secondary gun number 3.
6112	secondary_gun_number_4	Position of the secondary gun number 4.
6144	secondary_gun_number_5	Position of the secondary gun number 5.
6176	secondary_gun_number_6	Position of the secondary gun number 6.
6208	secondary_gun_number_7	Position of the secondary gun number 7.
6240	secondary_gun_number_8	Position of the secondary gun number 8.
6272	secondary_gun_number_9	Position of the secondary gun number 9.
6304	secondary_gun_number_10	Position of the secondary gun number 10.
6336	secondary_launcher_1	Position of the secondary launcher 1.
6400	secondary_launcher_3	Position of the secondary launcher 3.
6432	secondary_launcher_4	Position of the secondary launcher 4.
6464	secondary_launcher_5	Position of the secondary launcher 5.

Table F-3: DIS Articulations (Sheet 5 of 5)

Value	String	Description
6496	secondary_launcher_6	Position of the secondary launcher 6.
6528	secondary_launcher_7	Position of the secondary launcher 7.
6560	secondary_launcher_8	Position of the secondary launcher 8.
6592	secondary_launcher_9	Position of the secondary launcher 9.
6624	secondary_launcher_10	Position of the secondary launcher 10.
6368	secondary_launcher_2	Position of the secondary launcher 2.
6976	secondary_radar_1	Position of secondary radar 1.
7008	secondary_radar_2	Position of secondary radar 2.
7040	secondary_radar_3	Position of secondary radar 3.
7072	secondary_radar_4	Position of secondary radar 4.
7104	secondary_radar_5	Position of secondary radar 5.
7136	secondary_radar_6	Position of secondary radar 6.
7168	secondary_radar_7	Position of secondary radar 7.
7200	secondary_radar_8	Position of secondary radar 8.
7232	secondary_radar_9	Position of secondary radar 9.
7264	secondary_radar_10	Position of secondary radar 10.
5696	secondary_turret_number_1	Position of the secondary turret number 1.
5728	secondary_turret_number_2	Position of the secondary turret number 2.
5760	secondary_turret_number_3	Position of the secondary turret number 3.
5792	secondary_turret_number_4	Position of the secondary turret number 4.
5824	secondary_turret_number_5	Position of the secondary turret number 5.
5856	secondary_turret_number_6	Position of the secondary turret number 6.
5888	secondary_turret_number_7	Position of the secondary turret number 7.
5920	secondary_turret_number_8	Position of the secondary turret number 8.
5952	secondary_turret_number_9	Position of the secondary turret number 9.
5984	secondary_turret_number_10	Position of the secondary turret number 10.
3104	tail_hook	Tail hook on a plane for aircraft carrier landings.
7584	wing_fold	Fold on plane's wings.

G

Processing MetaFlight Files

To display MetaFlight files in VR-Forces, you must first process them. This appendix explains how to do so.

Processing MetaFlight Files for Use in VR-Forces G-2
Splitting Datasets into Individual MetaFlight Files G-2
Converting Virtual Texture Datasets to Tiled Textures G-3
The mftTool G-3
Using the mftTool to Process MetaFlight Files G-5
Convert Geometry Grid Datasets with Tiled Textures G-6
Convert Source Data into MEDF Format G-6
Create an MTF File for the MetaFlight Terrain G-7

G.1. Processing MetaFlight Files for Use in VR-Forces

Before you can load a MetaFlight file in VR-Forces, you must process it as described in this appendix. If you try to load an unprocessed MetaFlight file, VR-Forces displays an error message. When running our processing tools, a MetaFlight database which does not conform will cause an error message to be sent to the console window.

To process a MetaFlight file, you must:

1. Convert source data into MEDF and MEIF format.
2. Split each dataset into its own MetaFlight file.
3. Convert geometry from using virtual texture datasets into using tiled textures. (If the terrain does not use virtual textures, you can skip this step.)
4. Use the VR-Forces terrain composition process to combine the MetaFlight terrain files and save them in MTF format.



Geometry files referenced by a MetaFlight file must be in OpenFlight format, and not in Vega Prime's binary format (*.vsb*). MÄK's terrain libraries do not support VSB files.

G.2. Splitting Datasets into Individual MetaFlight Files

Our tools work on one Geometry Grid Dataset (GGDS) at a time. Some MetaFlight files contain multiple GGDSs, so each one has to be moved into its own file. It is your responsibility to understand the syntax of the MetaFlight file and to know whether or not you need to split up datasets.

To split datasets:

1. Create a copy of the original file for each dataset. Give each a name that will identify which dataset it contains.
2. Open each copy of the original file in a text editor.
3. In each file, delete all of the <GeometryGridDataset> XML element blocks except the one for the dataset you want to have in this file.

When you are finished, each MetaFlight file will have only one GGDS and possibly one or more Virtual Texture Datasets (VTDS).

G.3. Converting Virtual Texture Datasets to Tiled Textures

The display engine does not handle virtual textures at runtime. Therefore you must convert the virtual texture datasets into tiled textures.

G.3.1. The mftTool

The mftTool is a command-line tool for converting virtual texture datasets into tiled textures so that they can be loaded by VR-Forces. It creates the highest resolution textures possible from the virtual texture dataset and binds them to individual tiles.

The syntax for mftTool is as follows:

```
mftTool -f filename [-c index -w index -l index -m string
   -r path ... -x size -s directory -t filename -A -g -e -u
   -p threads --extendLevelZero distance -- -v -h]
```

Table G-1 describes the command-line options.

Table G-1: mftTool command-line options

Option	Description
(-- | --ignore_rest)	Ignore all arguments after this one.
(-A | --regenerateAll)	Forces the regeneration of all Tiled Textures. This can be much slower and is needed less frequently if the Virtual Texture Dataset does not change.
(-c | --col) *index*	The column to convert, using a zero-based index.
(-e | --encryptImages)	The Tiled Textures will be generated in the MEIF file format. If not specified the file format will be DDS.
--extendLevelZero *distance*	Specifies the page-in range (in meters) of grid level zero in the MEDF and MetaFlight files that the mftTool creates. Use of this option is indicated if the terrain disappears when you zoom out, particularly in PVD mode. Increasing the range causes the terrain to page in at a greater distance.
(-f | --file) *filename*	The name of the MetaFlight file which contains the GGDS.

Table G-1: mftTool command-line options

Option	Description
(-g | --generateFiles)	Generate tiled textures from the Virtual Texture and generate tiles in MEDF format from the FLT tiles which use the new textures. Also an MFT file will be published. The output name will be equal to the MetaFlight file specified with the -f option with the string _medf appended to the end before the extension. Converting a file named *yourTerrain.mft* would create a new MetaFlight file named *yourTerrain_medf.mft* in the same directory as *yourTerrain.mft*. If the generated tiled texture already exists the file will not be regenerated. The -u and -g arguments are mutually exclusive.
(-h | --help)	Displays usage information.
(-l | --level) *index*	The level to convert, using a zero-based index.
(-m | --missing) *string*	The missing texture placeholder.
(-p | --threads) *threads*	Specifies the number of threads to run. Specifying zero will result in the number of threads equaling the number of logical processors the host machine has.
(-r | --searchDir) *directory*	Adds a directory to the search path when resolving external references. During processing any external references not found will be removed from the generated files.
(-s | --subDir) *directory*	The path to the substitution texture specified by the VTDS. The arguments -s and -t are mutually exclusive
(-t | --vtFile) *file*	The name of the MetaFlight file which contains the VTDS. The arguments -s and -t are mutually exclusive.
(-u | --publishMftOnly)	Publish a new MetaFlight file that can be loaded by VR-Forces. The output name will be equal to the MetaFlight file specified with the -f option with the string _medf appended to the end before the extension. Converting a file named *yourTerrain.mft* would create a new MetaFlight file named *yourTerrain_medf.mft* in the same directory as *yourTerrain.mft*. The -u and -g arguments are mutually exclusive.
(-v | --version)	Display version information and exit.

Table G-1: mftTool command-line options

Option	Description
(-w | --row) *index*	The row to convert, using a zero-based index.
(-x | --textureSize) *size*	Specifies the maximum texture size to generate in pixels per dimension. Larger textures use more memory and are slower page in, but allow for greater Virtual Texture resolution.

If neither the generate (-g) or the publish only (-u) argument is specified, mftTool prints out information regarding the MetaFlight terrain.

G.3.2. Using the mftTool to Process MetaFlight Files

To process a terrain with a single MetaFlight terrain file that has one GGDS and one VTDS, run the mftTool as follows:

```
mftTool -f C:\yourTerrain\yourTerrain.mft -s
  C:\yourTerrain\ds200-vt-otw-virtual-texture -g -A -e
```

The following example shows how to process a terrain with two MetaFlight terrain files, one with the GGDS and one with the VTDS. In this case, the tiles also contain external references to other OpenFlight models.

```
mftTool -f C:\yourTerrain\ds100-flight-terrain\ds100-
  flight.mft -t C:\yourTerrain\ds200-vt-otw-virtual-tex-
  ture\ds200-vt.mft -r C:\yourTerrain\textures -r C:\your-
  Terrain\objects -m C:\yourTerrain\MissingTexture.png -x
  4096 -g
```

This creates a new MetaFlight file that references the new geometry grid dataset with virtual textures bound to it.

G.3.3. Convert Geometry Grid Datasets with Tiled Textures

The mftTool only needs to publish the MFT when the GGDS uses tiled textures. Cultural feature datasets are often built this way. These can be converted using the medfTool like all other files. The command syntax for the medfTool is described in "Compressing Model Files," on page 11-7.

To only publish a new MetaFlight for the cultural dataset, do the following:

```
mftTool C:\yourTerrain\flt\
   ds7_culture_db5_building_area_new-hier_cult\
   ds7_culture_db5_building.mft -u -p 0
```

To convert a MetaFlight with tiled textures into a compressed format, use the medfTool, as follows:

```
medfTool -s C:\yourTerrain\flt\textures
   -s C:\yourTerrain\flt\objects
   --directory C:\yourTerrain\flt\
   ds7_culture_db5_building_area_new-hier_cult -x flt
   -m rgb -m rgba -m jpg -m bmp -p 0 -z 1
```

! The medfTool should never be run on a directory that contains GGDS tiles that use Virtual Textures.

G.4. Convert Source Data into MEDF Format

Many file formats, including OpenFlight files, are often slow to load so it is best to convert them to our fast loading MEDF (MAK Encrypted Data Format) format. This should be done on terrains without virtual textures (it is done automatically when creating Geometry Grid Datasets from virtual texture datasets) and on cultural feature datasets. This should be done on all data files being loaded, but is required by all external references used by MetaFlight terrains.

! You must convert the files to MEDF and MEIF before you run the mftTool.

To convert external references in separate directories:

```
medfTool -s C:\yourTerrain\flt\textures --directory
   C:\yourTerrain\flt\objects -x flt -m rgb -m rgba -m jpg
   -m bmp -p 0 -z 1
```

To convert external reference textures that are in the same directory:

```
medfTool --directory C:\yourTerrain\flt\textures -m rgb
   -m rgba -m jpg -m bmp -p 0 -z 1
```

G.5. Create an MTF File for the MetaFlight Terrain

Once you have processed all of the MetaFlight files, create an MTF file for the terrain.



Any missing models or white objects usually indicate missing external references. Fixing any missing search paths passed to the tools should resolve most problems.

To create an MTF file for the MetaFlight terrain:

1. Start VR-Forces.
2. Add each MetaFlight terrain as a terrain patch.
3. Save the terrain as an MFT terrain.

H

Editing Earth Files

This chapter provides an introduction to the syntax of Earth files.

Earth Files H-2
A Simple Earth File H-2
Adding Feature Layers to an Earth File H-4
Cut-in Sites – The mask Element H-7
Extruded Buildings H-7
Configuring Trees H-9
Configuring Options H-9

H.1. Earth Files

An Earth file is an XML configuration file used to display terrain databases in osgEarth. The file format is documented at http://osgearth.org/wiki/Documentation. This chapter supplements the information on the osgEarth web site. In particular, it explains how to configure streaming features, for which there is no GUI in VR-Forces.

H.2. A Simple Earth File

The *VR-TheWorldOnline.earth* file is an example of a simple Earth file. It has one image layer and one elevation layer:

```
<!--
VR-TheWorld Online
This file connects to VR-TheWorld online and contains:
Imagery:VR-TheWorld Base Imagery: 15m SRTM 90 Imagery for the World
     Boston Inset Imagery
     Washington DC Imagery
     Austin, TX Imagery
     Afghanistan Imagery

Elevation:VR-TheWorld Base Elevation: 90m SRTM Elevation
-->
<map name="VR-TheWorld" type="geocentric" version="2">

<image name="VR-TheWorld Base Imagery" driver="tms"
 lod_blending="true" cacheid="VR-TheWorldBaseImagery">
    <url>http://vr-theworld.com/vr-theworld/tiles/1.0.0/22/</url>
</image>

<elevation name="VR-TheWorld Base Elevation" driver="tms"
 max_data_level=13 max_level=13 cacheid="VR-TheWorldBaseElevation">
    <url>http://vr-theworld.com/vr-theworld/tiles/1.0.0/34/</url>
</elevation>

<options>
  <lighting>true</lighting>

  <elevation_interpolation>triangulate</elevation_interpolation>
  <terrain>
    <min_tile_range_factor>3</min_tile_range_factor>
  </terrain>
  <cache type="filesystem">
    <path>../../appData/cache</path>
  </cache>
</options>
</map>
```

Table H-1 describes the XML elements in the file and their attributes.

Table H-1: Earth file elements and attributes

Element	Attribute	Description
<!-- -->		Comment block.
map		Root level element. All other elements must be in the map block.
	name	The name of the map.
	type	The projection - globe or projected.
	version	The VR-TheWorld Server version.
image		Specifies an image layer.
	name	The name of the layer.
	driver	The driver to use to fetch tiles, for example, TMS, WMS, or GDAL.
	url	The location of the files. This could be a web address or a local path.
elevation		Specifies an elevation layer.
	name	The name of the layer.
	driver	The driver to use to fetch tiles, for example, TMS, WMS, or GDAL.
	url	The location of the files. This could be a web address or a local path.
options		Specifies options that affect the entire map. For more information, please see "Configuring Options," on page H-9.

H.3. Adding Feature Layers to an Earth File

You can add the XML for feature layers to an Earth file.

The following Earth file has cut-in sites and feature data.

```
<!--
Hawaii
Oahu with cut in site and extruded buildings
-->
<map name="Hawaii" type="geocentric" version="2">
  <image name="BaseImagery" driver="tms">
    <url>http://vr-theworld/tiles/1.0.0/1/</url>
  </image>
  <image name="ImCol" driver="tms">
    <url>http://vr-theworld/tiles/1.0.0/213/</url>
  </image>
  <heightfield name="elcol" driver="tms">
    <url>http://vr-theworld/tiles/1.0.0/212/</url>
  </heightfield>
  <!-- the masking geometry -->
    <mask name="HonoluluRunway26L-8R-mask" driver="feature" >
        <features driver="ogr">
              <geometry>
               POLYGON((-157.908913 21.306395 2.161207, -157.947497
 21.306406 2.163878, -157.947499 21.307210 1.366011, -157.908913
 21.307204 2.364334))
              </geometry>
           </features>
    </mask>
<!-- Extruded buildings -->
    <model name="buildings" driver="feature_geom">

        <features name="buildings" driver="ogr">

  <url>../../data/Terrain/Hawaii/Features/StructuresA.shp</url>
           <typename>2</typename>
        </features>

       <layout>
            <tile_size_factor>45</tile_size_factor>
            <level name="default" max_range="20000">
                <selector class="buildings"/>
            </level>
        </layout>

        <styles>
            <library name="us_resources">
                <url>../../appData/osgEarth/catalog.xml</url>
            </library>

            <style type="text/css">
                buildings {
                    extrusion-height:      [hgt2d];
                    extrusion-flatten:     true;
                    extrusion-wall-style:  building-wall;
                    extrusion-roof-style:  building-rooftop;
                    extrusion-random-seed: 1;
                    altitude-clamping:     terrain;
                }
```

```
54                  building-wall {
55                      skin-library: us_resources;
56                      skin-tags:    building;
57                      fill:         #ffffff;
58                  }
59                  building-rooftop {
60                      skin-library: us_resources;
61                      skin-tags:    rooftop;
62                      skin-tiled:   true;
63                      fill:         #ffffff;
64                  }
65              </style>
66          </styles>
67          <lighting>true</lighting>
68
69      </model>
70
71       <model name="point trees" driver="feature_geom">
72
73          <features name="points" driver="ogr">
74
       <url>../../data/Terrain/Hawaii/Features/VegetationP.shp</url>
75              <build_spatial_index>true</build_spatial_index>
76          </features>
77
78          <styles>
79              <style type="text/css">
80                  points {
81                     marker:              [LongType];
82                     marker-scale:        1;
83                     altitude-clamping:   terrain;
84                     altitude-offset:     0;
85                  }
86              </style>
87          </styles>
88      <clustering>false</clustering>
89          <lighting>true</lighting>
90      </model>
91
92
93
94   <!-- Trees
95       <model name="trees" driver="feature_geom">
96
97
98          <features name="forest" driver="wfs">
99             <url> http://vr-theworld/features/wfs </url>
100            <typename>7</typename>
101         </features>
102
103
104         <clustering>true</clustering>
105
106
107         <layout>
108             <crop_features>true</crop_features>
109             <level max_range="100000" min_range="0">
110                 <selector class="parks-outline"/>
111             </level>
112             <level max_range="10000">
```

```
113                 <selector class="parks-1"/>
114             </level>
115             <level max_range="5000">
116                 <selector class="parks-2"/>
117             </level>
118             <level max_range="1500">
119                 <selector class="parks-3"/>
120             </level>
121         </layout>
122
123         <styles>
124             <style type="text/css">
125                 parks-1 {
126                    marker:              model("../data/tree.osg");
127                    marker-placement:    random;
128                    marker-density:      1000;
129                    marker-scale:        2;
130                    altitude-clamping:   terrain;
131                 }
132                 parks-2 {
133                    marker:              model("../data/tree.osg");
134                    marker-placement:    random;
135                    marker-density:      1000;
136                    marker-scale:        2;
137                    altitude-clamping:   terrain;
138                    marker-random-seed:  1;
139                 }
140                 parks-3 {
141                    marker:              model("../data/tree.osg");
142                    marker-placement:    random;
143                    marker-density:      1000;
144                    marker-scale:        2;
145                    altitude-clamping:   terrain;
146                    marker-random-seed:  2;
147                 }
148                 parks-outline {
149                    stroke:              #00ff00ff;
150                    altitude-offset:     25;
151                    altitide-clamping:   terrain;
152                 }
153
154             </style>
155         </styles>
156      </model> -->
157
158    <options>
159          <lighting>true</lighting>
160       <elevation_interpolation>triangulate</elevation_interpolation>
161          <terrain>
162         <min_tile_range_factor>3</min_tile_range_factor>
163          </terrain>
164          <cache type="filesystem">
165              <path>../../appData/cache</path>
166          </cache>
167      </options>
 </map>
```

H.3.1. Cut-in Sites – The mask Element

In the Earth file in the previous section, lines 16-24 are a `mask` element. When you build a map, there may be areas of the terrain where you want to use high-resolution hand-modeled terrain, rather than the base data for your terrain database. To do this, you create the terrain in a modeling tool and then cut it into the served terrain. The `mask` element lets you essentially cover the base terrain data with your hand-modeled data. Table H-2 describes the mask element and its sub-elements.

Table H-2: `mask` element

Element	Attribute	Description
mask		Element for cutting in geometry.
	name	Name of the mask.
	driver	The driver to use.
features		List of features in the mask.
	driver	The driver to use. OGR reads raw vector feature data from shapefiles and other formats.
geometry		Specifies the 3D boundaries of the site. You must know this information.
	geometry_url	The location of the file with the feature data.

VR-Forces includes a tool, the Boundary Tool, that gets the boundary of an OpenFlight file. For details, please see "Cutting in Sites for a Terrain Server," on page 10-25.

H.3.2. Extruded Buildings

If you are simulating in an urban environment, you want your terrain to have realistic 3D buildings. However, modeling hundreds or thousands of buildings by hand would be an arduous and expensive task. osgEarth can extrude buildings from point features and apply textures to them to create a realistic environment with relatively little work. Publicly available GIS data that has footprint and height data can provide the input.

In the example Earth file, lines 26-69 configure extruded buildings in a model element. Table H-3 describes the `model` element, its attributes, and sub-elements.

Table H-3: `model` element – extruded buildings

Element	Attribute	Description
model		Base element for specifying a feature layer.
	name	Name of the layer.
	driver	Driver to use for creating models.
The `features` and `layout` elements specify how to get and load the feature data. The `features` block is mandatory. `layout` is optional.		

Table H-3: `model` element – extruded buildings

Element	Attribute	Description
features		Specifies source of data.
	name	Name of the element.
	driver	Driver to use to get the data.
	url	Location of the feature data.
layout		Specifies how to load the data.
tile_size_factor		The data specified in the features element gets cut into tiles. This attribute specifies how aggressively to tile it.
level	name	The level specifies the level (LOD) beyond which not to display the features.
	max_range	Distance beyond which the feature is not displayed.
selector	class	Specifies the type of feature.
styles		The `styles` element and sub-elements specify how to render the scene. In this case, it shows how to render buildings. This element is mandatory.
library		A texture library.
	name	Name of the texture library.
	url	The location of the library.
style		A specific style.
	type	
	buildings	How to extrude the buildings. The extrusion-height attribute matches an attribute in the shape file.
	building-wall	Specifies the texture library to use. Note that it matches the name value in the `library` element.
lighting		Specifies whether or not to enable lighting. Usually true.

H.3.3. Configuring Trees

In addition to extruding buildings, this terrain has many point trees (lines 71-90). The elements and attributes used for point trees are similar to those used for extruded buildings. The additional element to note is `clustering`. Clustering takes all pieces of geometry in a tile and aggregates them into a single piece of geometry. This improves performance, because one object renders more quickly than many. However, when you do this all of the objects have the same center point. Since trees are billboards and rotate around the center point, to cluster point trees would result in odd looking behavior, so `clustering` is disabled.

The terrain also has trees that are not rendered individually, but as forests. They are configured in lines 95-156. Note that `clustering` is enabled for this model block.

H.3.4. Configuring Options

The Earth file has several `option` elements that affect the entire map. Table H-4 describes the option elements.

Table H-4: `option` element

Element	Attribute	Description
lighting		Enables or disables lighting for the entire map. This is usually true.
elevation_interpolation		Specifies how OSG interprets elevation between grid posts. If you are using VR-Forces or visualizing a VR-Forces simulation, set this to triangulate to ensure correlation.
cache		Specifies caching for terrain data.
	type	The type of caching to use.
	path	The location of the data cache.

I

Configuring Feature Data

This appendix explains how to update the feature data configuration file so that the simulation engine can understand feature data.

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I.1. Introduction

VR-Forces can import feature data, such as shapefiles, that provide information about roads, buildings, waterways, and other terrain features. The front-end and back-end handle feature data differently. The front-end must render the data visually. The back-end must understand how features are to be used as it simulates entities on the terrain.

To use feature data correctly for simulation, the VR-Forces simulation engine must know some things about the feature data. For example, when an areal feature is loaded from a feature source, VR-Forces needs to know how to determine whether that feature is a building footprint, lake boundary, forest boundary, or something else entirely.

The simulation engine determines how features should be used by sending queries to the terrain database. The queries that VR-Forces uses are defined in *./appdata/settings/featureconfig.txt*. Feature data is defined using attributes. Attributes have names and values. If the feature data that you are using uses the attributes that VR-Forces knows about, it will be able to process your terrain correctly. If not, you will have to edit *featureconfig.txt* so that VR-Forces can understand your data. The configuration file is commented. This appendix provides additional documentation about querying feature data.

I.2. Named Queries

Named queries are used throughout the VR-Forces code and configuration to determine what features are. For example, the following named query is evaluated on a feature to determine whether it should be treated as a building:

```
MAK_BUILDING:  (mak_layer="buildings") OR (mak_layer="BuildingsP") OR
   (DTDESCRIPTION = "Building") OR (DTFIDCODE = 181)
```

In this query definition, `mak_layer`, `DTDESCRIPTION`, and `DTFIDCODE` are attribute names. If a feature has one of these attributes with the specified value, VR-Forces knows to treat the feature as a building.

Please see *./appdata/settings/featureconfig.txt* for information about Query syntax.

Queries that begin with “MAK_” are referred to either in simulationModelSet configuration, or in the VR-Forces code. Do not change the names of these queries.

I.3. Feature Configuration Attributes

When VR-Forces loads a feature in the simulation engine, it adds attributes that indicate where the feature came from. VR-Forces may add one or more of the following features:

- MAK_LAYER. This attribute represents the source of the data – either the name of the file for features loaded from a local file, or the name of the feature layer in a *.earth* file. In the example in "Named Queries," on page I-2, MAK_LAYER would match a file named *BuildingsP.shp*, for example, or a *.earth* feature layer named "buildings".
- MAK_EARTH_FILE. If the feature is loaded from a *.earth* file, the file it was loaded from.
- MAK_SOURCE_FILE. The file from which you loaded the terrain. This could be an MTF file, a *.earth* file, or another format that VR-Forces can load directly.

I.4. Attribute Transformations

Attribute transformations allow you to configure attributes on features matching a specific query. These are used in VR-Forces to:

- Create common names for attribute concepts, such as "width", which may be named differently depending on the source.
- Create new attributes whose value is derived from other attributes, which can be modified through configuration instead of in the code.
- Add entirely new attributes to features that match the given query.

I.4.1. Transformations as Aliases

Different sources of feature data often use different names for the same information. For example, a height attribute could be named "height", "hgt", "h", or some other name. Attribute transformations can be used to create an "alias" for the different names so that a single attribute name can be used in code and configuration.

As an example, see the line defining the attribute `MAK_WIDTH`:

```
Transform ALL: double MAK_WIDTH = [ width | w | wdt | gdb_width | dtwidth
  | wid2d ]
```

This adds, to each feature matching the named query `ALL`, a new double attribute named `MAK_WIDTH`. The value of `MAK_WIDTH` will be the value of the first attribute found in the bracketed list.

I.4.2. Transformations as Derived Attributes

Transformations can be used to create derived attributes – that is, attributes whose value depends on the value of another attribute. For example, the following line defines `MAK_NUM_LANES`, which depends on the width of a road:

```
Transform MAK_ROAD: int MAK_NUM_LANES = MAK_WIDTH / 4
```

This adds, to each feature matching the named query `MAK_ROAD`, a new int attribute named `MAK_NUM_LANES`. The value of this attribute is based on the value of `MAK_WIDTH`.

I.4.3. Transformations as New Attributes

Transformations can be used to add entirely new attributes – for example, to differentiate one way roads from two way roads. In this example, a query for one way road is created, and a new attribute `MAK_ONEWAY` is added to each feature that matches the query:

```
MAK_ONEWAYROAD: MAK_ROAD AND (ONEWAY = "yes" OR ONEWAY = 2)
Transform MAK_ONEWAYROAD: int MAK_ONEWAY = 2
```

By doing this, we can query the attribute `MAK_ONEWAYROAD` on any feature, and its existence will mean that the feature represents a one way road.

I.4.4. Writing Multiple Transforms to Account for Possible Failures

You can write multiple transforms for a particular feature if you anticipate that the preferred transform might fail. A transform might fail if it refers to a feature attribute that is not present in the feature data being processed. If you include multiple transforms in the file, they are processed in order until one is successful.

For example consider the following transforms:

```
Transform MAK_S57_DEPTH_AREAS: double MAK_MIN_DEPTH = DRVAL1
Transform MAK_S57_DEPTH_AREAS: double MAK_MIN_DEPTH = 0
```

This transform configures S-57 depth areas. The first transform uses the value of DRVAL1. If the data does not have the DRVAL1 attribute, it sets the depth to 0.

I.5. Source-Specific Configuration

Since different sources of feature data can have different, even contradictory, definitions of the same data, it is possible to create additional configuration files that exist alongside specific data sources.

I.5.1. Loading Source-Specific Configuration Files

Whenever a feature source is loaded, VR-Forces looks for a configuration file that is specific to that source. The filename that it looks for depends on the source of the data. See *featureconfig.txt* for the details of source-specific configuration file loading by source type.

I.5.2. Redefining Queries

Source-specific configuration files can redefine queries in the main configuration file, so the main configuration file can be kept as simple as possible. In the following example, the terrain loaded points to two different *.shp* files, each with a different concept of a main road.

Test.mtf points to two different Shape files:

- *./data/Terrain/Test/Features/RoadL.shp*. Any feature with the attribute "HIGHWAY" set to 1 is a main road.
- *./data/Terrain/Test/Features/MainRoads.shp*. All features are main roads.

Here is the definition of a main road in the main configuration file:

```
MAINROAD: MAK_ROAD AND MAK_NUM_LANES >= 4
```

To specify a different definition of `MAINROAD` for each source, two new configuration files can be created:

- *RoadL.mfc* contains the following definition:

  ```
  MAINROAD: HIGHWAY = 1
  ```

- *MainRoads.mfc* contains the following definition:

  ```
  MAINROAD: ALL
  ```

At runtime, these queries will be combined, using the `mak_layer` attribute, to create a single definition of the `MAINROAD` query:

```
OR
  AND
    MAK_ROAD
    MAK_NUM_LANES >= 4
  AND
    MAK_LAYER = "RoadL"
    HIGHWAY = 1
  MAK_LAYER = "MainRoads"
```



In this example it is possible to create this query entirely within *featureconfig.txt*. Here the source-specific configuration is used for readability.

I.6. Extracting Feature Data from GDB to Shapefiles

When you load feature data from a shapefile, it is used more efficiently than if you load it from a GDB file. (For details about loading feature data into a feature layer, please see Section 10.4, "Adding a Feature Layer," in *VR-Forces Configuration Guide*.) If you have GDB terrains that contain feature data, you can extract that data to shapefiles with the vectorNetworkToShapeFiles utility. The syntax for the utility is as follows:

```
./bin/vectorNetworkToShapeFiles.exe terrain_file
  [output_directory]
```

where:

- `terrain_file` is the GDB file to read.
- *`output_directory`* is the directory in which to create the shapefiles. If *`output_directory`* is not specified then output files are named based on the name of the input file.

I.7. Converting S-57 Features Data to Shapefiles

S-57 feature data does not have a spatial index, so it loads slowly. By contrast, shapefiles have a spatial index, so they load quickly. Therefore, we recommend that you convert S-57 data to shapefiles. VR-Forces includes a command-line tool, ogr2ogr, that you can use to convert your S-57 data. (OGR is a sublibrary of GDAL, which VR-Forces uses to load feature data. Complete documentation is available at http://www.gdal.org/ogr/drv_s57.html and http://www.gdal.org/ogr2ogr.html.)

S-57 files have many layers of data. A shapefile only contains one layer of data. So, to convert your S-57 data, you will have to create a shapefile for each layer of data that you want to convert. Since VR-Forces does not use all of the data in an S-57 file, this is a simpler process than it might sound.

Before running ogr2ogr, set the following environment variables:

S57_CSV = *<full_path_to>/appData/gdal_data*. (The environment variable should specify a full path. If you use a relative path, it is relative to the path from which you run ogr2ogr, not from the VR-Forces root. If you run ogr2ogr from *./appData/gdal_data*, you do not have to set the variable.)

OGR_S57_OPTIONS = "RETURN_PRIMITIVES=ON,RETURN_LINKAGES=ON,LNAM_REFS=ON". This setting works for the layers that VR-Forces needs. If you want to convert other layers, you will have to research the proper environment variable settings.

The command syntax is:

```
ogr2ogr -skipfailures [-nlt type] output_file input_file
  layer
```

where:

- `-nlt type` is the geometry type of the output layer. `type` can be NONE, GEOMETRY, POINT, LINESTRING, POLYGON, GEOMETRYCOLLECTION, MULTIPOINT, MULTIPOLYGON or MULTILINESTRING. Add "25D" to the end to make these 3D points.
- `input_file` is the input data source (the S-57 file).
- `output_file` is the name of the output file (the layer name with *.shp* at the end). All output files should be placed in the same directory. This will simplify configuring the *.earth* file that references them.
- `layer` is the name of the layer from the source to convert.

The following example commands convert the layers that VR-Forces needs:

```
ogr2ogr -skipfailures SOUNDG.shp S57FILE SOUNDG
ogr2ogr -skipfailures -nlt POLYGON LNDARE.shp S57FILE
  LNDARE
ogr2ogr -skipfailures DEPARE.shp S57FILE DEPARE
ogr2ogr -skipfailures M_COVR.shp S57FILE M_COVR
```

There will be some output errors for each of these because they have some attributes that cannot be represented in shapefiles (like lists of numbers and strings).

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