VR-Vantage

Configuration Guide

VR-Vantage Steatlh
VR-Vantage PVD
VR-Vantage IG

VT MÄK
A company of VT Systems

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Contents

Preface

This manual is for persons who will configure VR-Vantage. The manual assumes that you are familiar with basic administrative tasks and the graphical window environment for your operating system.

For the latest product information, please see release-specific documentation for your version of VR-Vantage.

How the Manual Is Organized

This manual is organized as follows:

Chapter 1, *Windows, Channels, and Display Engines*, explains how to add windows and channels and how to configure them. It also explains how to set up multi-channel displays.

Chapter 2, *Display Engine Tutorials*, shows how to create display engine configurations, save them, and load them.

Chapter 3, *Composing Terrains*, explains how load terrains and how to build composable terrains and scenes.

Chapter 4, *Streaming Data Using Earth Files*, explains some of the details of how to set up *.earth* files to configure terrain servers.

Chapter 5, *Terrain Tutorials*, has tutorials that show how to create a terrain and how to configure a terrain server using local data.

Chapter 6, *Processing MetaFlight Files*, explains how to process MetaFlight files so that you can open them in VR-Vantage.

Chapter 7, *Model and Element Definitions*, explains how to create and edit schemas, model definitions, and element definitions.

Chapter 8, *Model Tutorials*, has tutorials that show how to add an entity model and how to add a SpeedTree.

Chapter 9, *Mapping Entity Types to Element Definitions*, explains how to map 3D models to objects and effects.

Chapter 10, *Configuring Emitter Volumes*, explains how to configure sensor volume color and segment size.

Chapter 11, *Mapping CIGI Models and Components*, explains how to map CIGI models and components, which are different from the mappings used for DIS and HLA.

Chapter 12, *CIGI Host Emulator Tutorial*, shows how to use the CIGI host emulator with VR-Vantage.

Chapter 13, *Creating and Editing Key Mappings*, explains how to use the Key Map Editor to create and edit key maps for keyboard navigation.

Chapter A, *The WRM Specification (DIS Notes)*, explains the model specification for articulated parts.

Chapter B, *CIGI Packets Supported*, lists CIGI packets and the extent to which they are supported by VR-Vantage.

Chapter C, *CIGI Utilities*, describes a set of scripts that you can use to test your CIGI connection to VR-Vantage.

Documentation Set

Electronic versions of VR-Vantage documentation are in *vrvantagex.x/doc*. On Windows, the documentation is accessible from the VR-Vantage folder on the Start menu. The VR-Vantage documentation set is as follows:

- *VR-Vantage Users Guide* describes how to use the VR-Vantage applications.
- *VR-Vantage Configuration Guide* explains how to configure schemas, model definitions, and object definitions. It also describes how to create and manage terrains.
- *VR-Vantage Release Notes* lists system requirements, release-specific requirements, new features and updates, bug fixes, and known problems.
- Online help. The online help, accessible from the Help menu, replicates most of the information in *VR-Vantage Users Guide*.
- First Experience Guides. First Experience Guides are brief pamphlets that provide a guided tour of the most important features of each application. They are primarily for new users and persons evaluating VR-Vantage.
- *VR-Vantage Developers Guide*. The developers guide provides a high level introduction to the APIs, and class documentation, which is generated from the header files. You can open the developers guide and class documentation from the Windows Start menu on the VR-Vantage Documentation submenu or by opening *./vrvantage2.0/doc/classdoc/index.html*.

MÄK Products

VR-Vantage 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.
- DI-Guy™. The DI-Guy product line is a set of software tools for real-time human visualization, simulation, and artificial intelligence. Every DI-Guy software offering comes with thousands of ready-to-use characters, appearances, and motions. DI-Guy enables the easy creation of crowds and individuals who are terrain aware, autonomous, and react intelligently to ongoing events. Save time, money and create outstanding simulations with DI-Guy. The DI-Guy product line includes the following products:
  - The DI-Guy SDK. Embed the DI-Guy library in your real-time application and populate your world with lifelike human characters.
  - DI-Guy Scenario™. Author and visualize human performances in a rich, user-friendly graphical environment. Use DI-Guy Scenario as an end visualization application or save scenarios and load them into your DI-Guy SDK enabled application.
  - DI-Guy AI. Generate crowds of autonomous characters to quickly populate your worlds with hundreds and thousands of terrain-aware, collision avoiding DI-Guys. Used as a module on top of DI-Guy Scenario and DI-Guy SDK.
  - Expressive Faces Module. Enable DI-Guy characters to have faces that display emotion, eyes that look in directions and blink, and lips that sync to sound files.
  - DI-Guy Motion Editor. Create or customize motions to your particular needs in an easy-to-use graphical application.

How to Contact Us

For VR-Vantage 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-Vantage home directory. For example, the directory *vrvantagex.x2.0/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.

Boost Software License - Version 1.0 - August 17th, 2003

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The copyright notices in the Software and this entire statement, including the above license grant, this restriction and the following disclaimer, must be included in all copies of the Software, in whole or in part, and all derivative works of the Software, unless such copies or derivative works are solely in the form of machine-executable object code generated by a source language processor.

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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/.

Freefont OpenType Font Set

VR-Vantage applications and VR-Forces use the Freefont OpenType font set from the Free Software Foundation. It is covered by the General Public License (GPL). For details, please see: http://www.gnu.org/licenses/gpl.html

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 "Third-Party Software and Content," on page 1-12, in *VR-Vantage Users Guide* for details.

1. Windows, Channels, and Display Engines

This chapter explains how to add and configure windows and channels and how to connect to remote display engines. For an introduction to display engines, please see Section 4.2, "The VR-Vantage Display Engine," in *VR-Vantage Users Guide*.

1.1. 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. Chapter 2, *Display Engine Tutorials*, shows how to edit a channel's attributes and how to save and load display engine configurations.

1.1.1. 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**). (The new window commands that are available on the File menu depend on which VR-Vantage application you are running.) A new window opens (Figure 1-1).

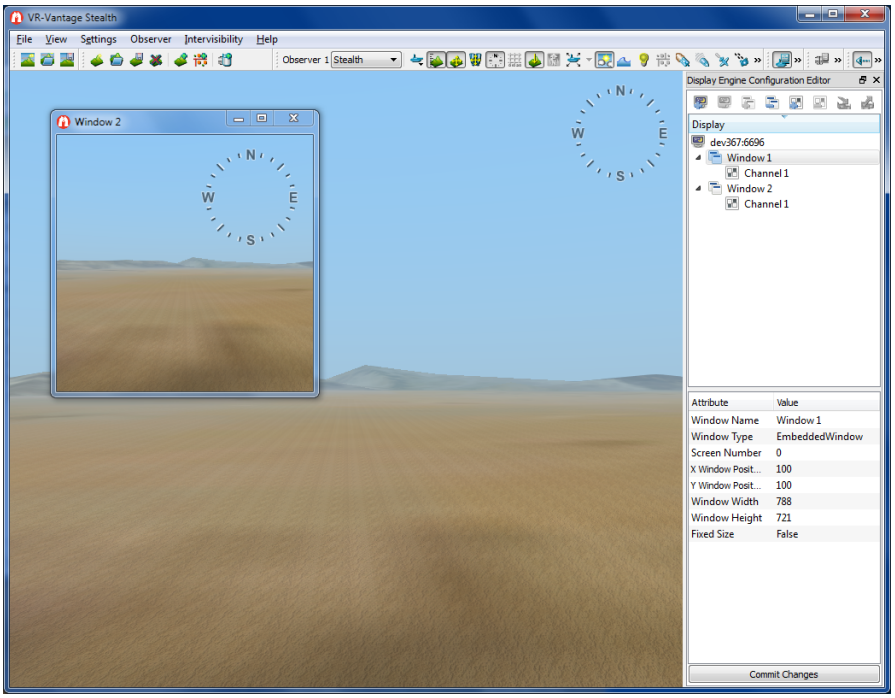


Figure 1-1. New window

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-Vantage window (Figure 1-2).

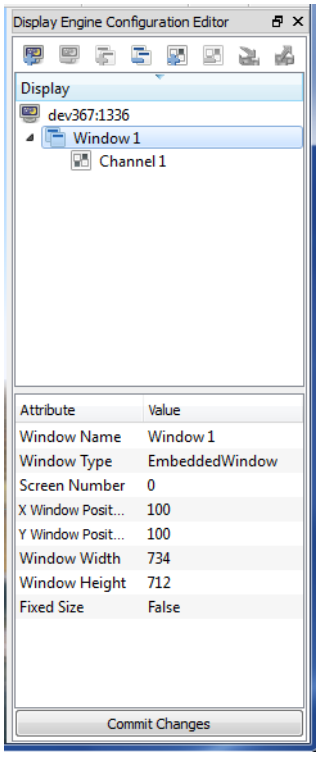


Figure 1-2. Display Engine Configuration Editor Panel

The Display Engine Configuration Editor Panel is available only in a VR-Vantage application, not on remote Display Engines.

2. Select the display engine at the top of the Display tree.
3. Click the Add a Window 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 1-3).

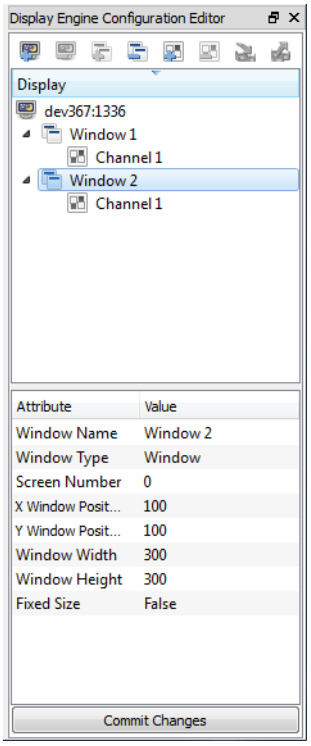


Figure 1-3. New window

1.1.2. 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 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 1-10). For details about editing channel attributes, please see "Changing a Channel's Attributes," on page 1-10.

1.1.3. 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 button (), or right-click the window name and choose **Remove Window** from the menu.

1.1.4. 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 button (), or right-click the window name and choose **Remove Channel** from the menu.

1.1.5. Saving a Display Engine Configuration

You can save a display engine configuration so that you can easily replicate the configuration at a later time.

If you are running two or more display engines, you cannot save the configurations for all of them at once. You have to save the configuration for each display engine individually.

To save a display engine configuration:

1. In the Display Engine Configuration Editor Panel, select the display engine whose configuration you want to save.
2. Click the Save Display Engine Configuration 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.
3. Type a name for the display engine configuration.
4. Click Save.

1.1.6. Loading a Display Engine Configuration

You cannot load multiple display engine configurations at the same time in the Display Engine Configuration Editor Panel. You can only load one configuration at a time. However, you can load multiple configurations from the command line. For details, please see "Loading Multiple Display Engine Configurations from the Command Line," on page 1-7.

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 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.

Loading Multiple Display Engine Configurations from the Command Line

VR-Vantage users often set up multichannel configurations that they wish to reuse. (For details, please see "Configuring Multichannel Displays," on page 1-23.) You can load these configurations (or any set of configurations) in the Display Engine Configuration Editor Panel, as described in "Loading a Display Engine Configuration," on page 1-7. However, you cannot load them as a group. You must load each one individually. To automate the process of loading multiple display engine configurations, you can load them from the command line.

You load multiple display engine configurations from the command line with the `--dispSetting` command line argument and the `-W` or `--withDisplayEngine` command-line argument. The syntax on Windows is:

```
vrvIG.exe --dispSetting masterdisplayConfigFile
  -W port@netAddress;remotedisplayConfigFile1 ....
  port@netAddress;remotedisplayConfigFileN
```

The syntax for Linux uses a colon instead of a semi-colon:

```
vrvIG.exe --dispSetting masterdisplayConfigFile
  -W port@netAddress:remotedisplayConfigFile1 ....
  port@netAddress:remotedisplayConfigFileN
```

The `--dispSetting` argument specifies the display engine configuration file for the VR-Vantage application. The `-W` argument specifies the display engine configuration files for the VR-Vantage display engines. The display engine configuration file name can be an absolute path or a path relative to the executable. For example, suppose that you have saved display engine configurations for a master display engine and two remote display engines. You save the configuration for each display engine as follows:

- Master display engine — *../appData/settings/stealth/machine1.dcx*.
- First remote display engine — *../appData/settings/stealth/machine2.dcx*.
- Second remote display engine — *../appData/settings/stealth/machine3.dcx*.

To load these three configurations:

1. Run the remote display engines on the two remote machines.
2. Start VR-Vantage. On Windows use the following command line:

```
vrvIG.exe
  --dispSetting ../appData/settings/stealth/machine1.dcx
  -W 22563@machine2;../appData/set-
  tings/stealth/machine2.dcx 22563@machine3;../app-
  Data/settings/stealth/machine3.dcx
```

On Linux use:

```
vrvIG.exe
  --dispSetting ../appData/settings/stealth/machine1.dcx
  -W 22563@machine2:../appData/set-
  tings/stealth/machine2.dcx 22563@machine3:../app-
  Data/settings/stealth/machine3.dcx
```

! Make sure there is a space between each display engine configuration listed.

1.2. 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 Section 4.2.4, "Window Types," in *VR-Vantage Users Guide*).
- 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 1-2).
2. Click the value of the attribute that you want to change.
3. To change a numeric value, type or select a value.

   To change the Window Type or Fixed Size, select a value from the 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.

1.3. 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.
- 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 1-4).

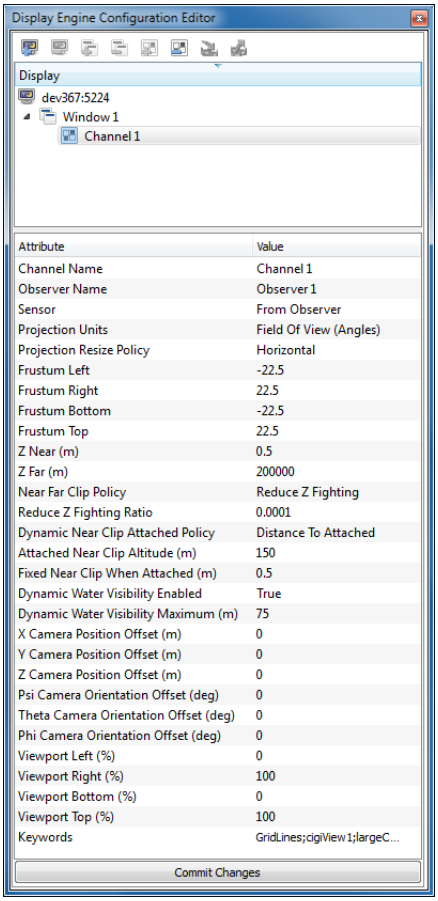


Figure 1-4. Channel attributes

2. Click the value of the attribute that you want to change.
3. To change a numeric value, type or select a new value.

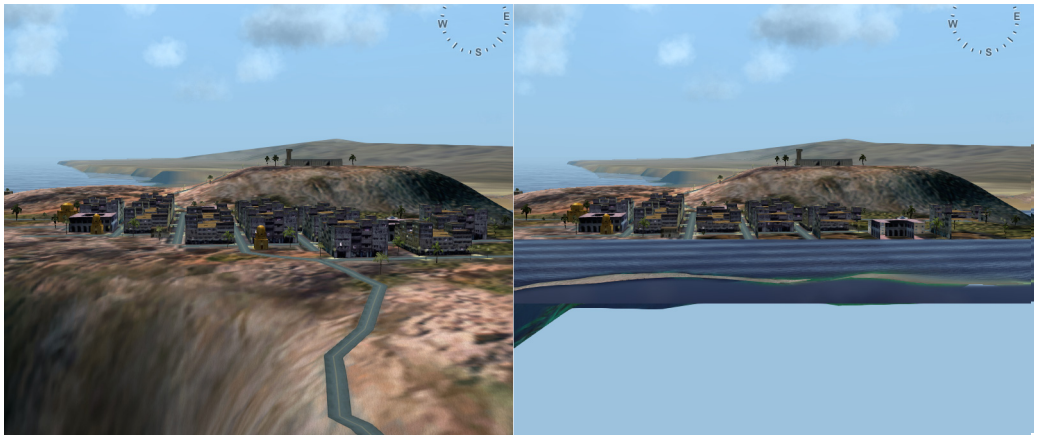
   To change the Observer Name, Sensor, Project Units, Projections Resize Policy, or Parent Channel, select a value from the list.

   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.

1.3.1. Setting the Clipping Planes

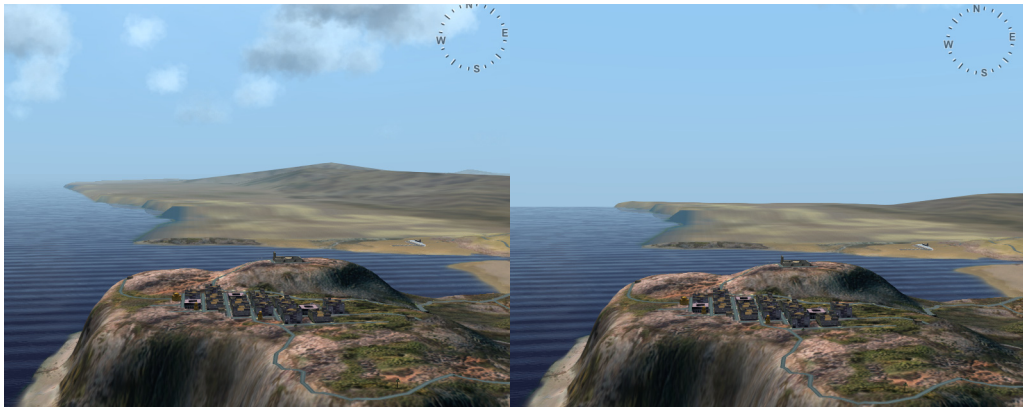
To improve performance, the graphics engine does not render anything that falls outside of a specified range of distances from the observer. This range is determined by the near and far clipping planes. Clipping planes are set on a per-channel basis.

Figure 1-5 illustrates the effect of changing the near clipping plane (the Z Near attribute). Figure 1-6 illustrates the effect of changing the far clipping plane (the Z Far attributes).



Z Near = 1 Z Near = 500

Figure 1-5. Near clipping



Z Far = 10000000 Z Far = 10000

Figure 1-6. 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-Vantage provides different policies for managing the way near and far clipping planes are determined.

VR-Vantage 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 attribute). The near clipping plane can get as large as needed to maintain the ratio. This policy is the default clipping plane 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-Vantage 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-Vantage 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.

1.3.2. 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 1-8 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 1-7).

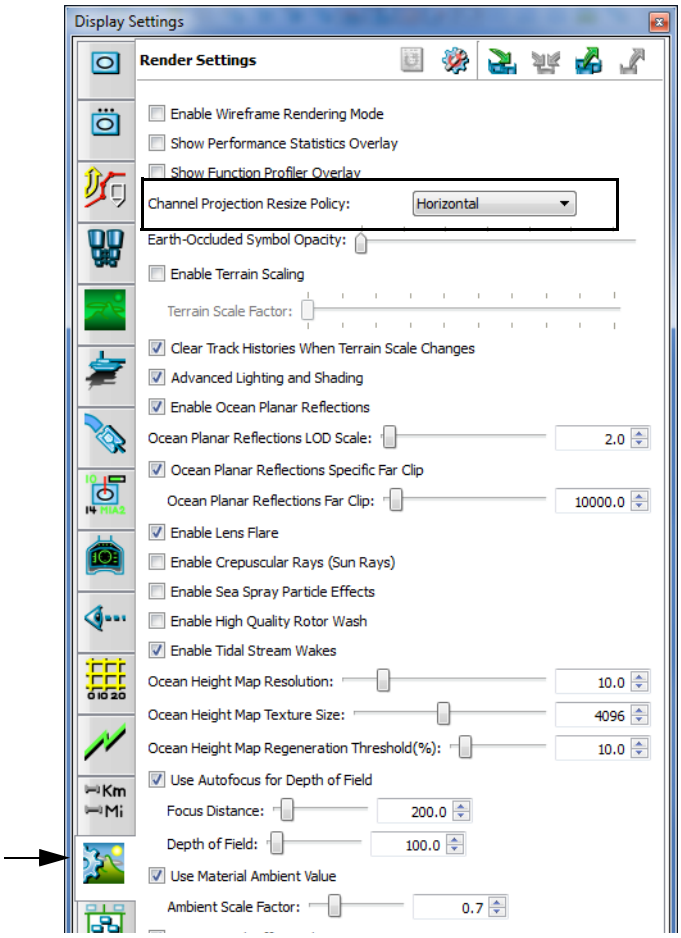
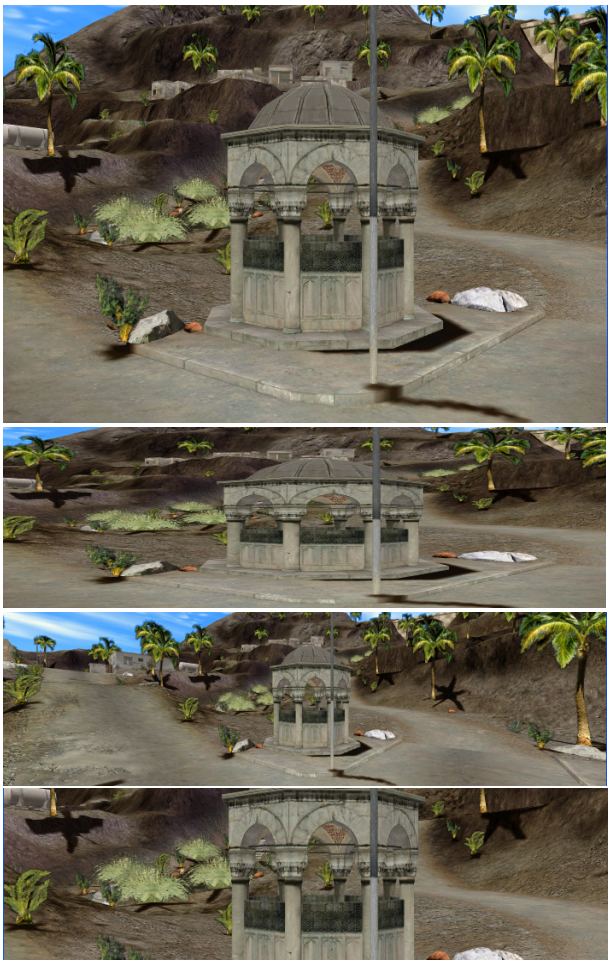


Figure 1-7. Display Settings, Render Settings page

3. Select an option on the Channel Projection Resize Policy list.



Initial view

Resized with Fixed resize policy

Resized with Horizontal resize policy

Resized with Vertical resize policy

Figure 1-8. Effect of different projection resize policies

1.3.3. 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 1-9 illustrates different field of view settings taken from the same observer location. The view on the left has frustum values -22.5, 22.5, -22.5, 22.5. The view on the right has the frustum values -10, 10, -10, 10.

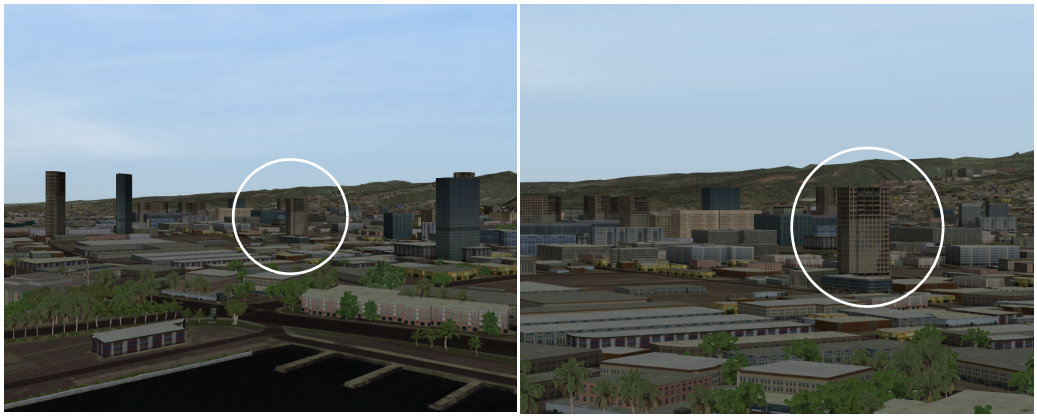


Figure 1-9. Field of view

➤ To change a channel's field of view, edit the frustum values in its attributes list.

1.3.4. 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 1-10 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.

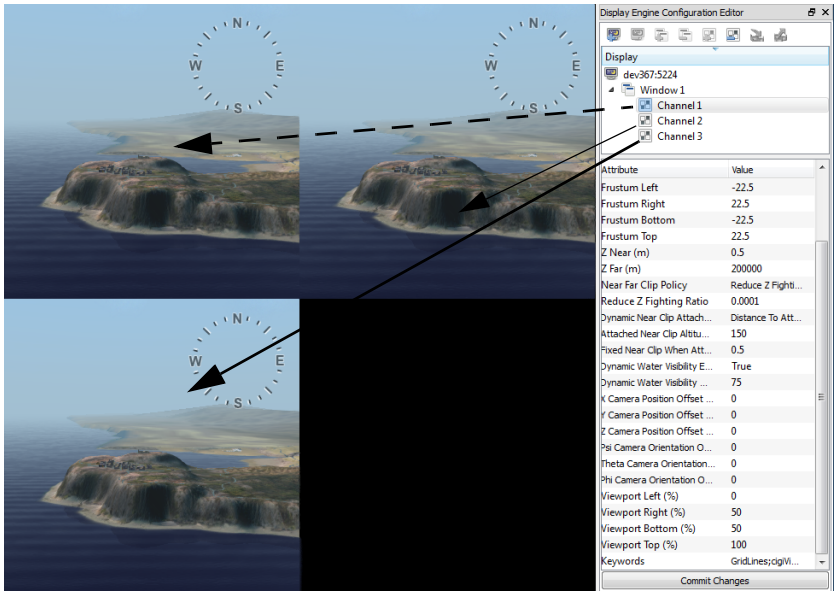


Figure 1-10. Window with three channels and three viewports

Viewports are specified as a percentage of the window from left to right and top to bottom. Figure 1-11 shows the percentage allocation for the viewports in (Figure 1-10).

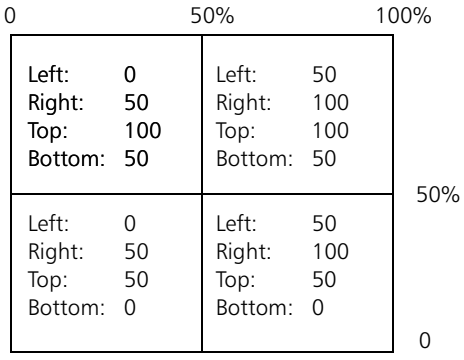


Figure 1-11. Viewport configuration

When you change viewports, the window might not completely refresh. To see the changes, resize the window.

1.3.5. Configuring Water Visibility

The water visibility attributes (along with the surface transparency setting on the Scene Settings dialog box, Environment Conditions Settings page) 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 Enabled attribute is used to increase transparency automatically as the observer's altitude increases. Dynamic Water Visibility Maximum specifies the maximum depth to which transparency is added (Figure 1-12).

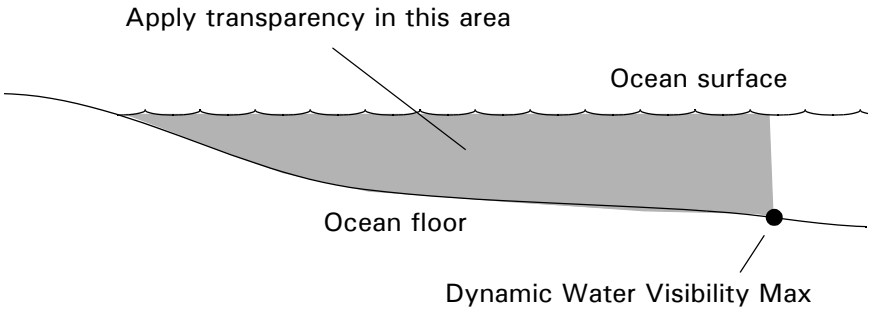


Figure 1-12. Dynamic water visibility

Dynamic water visibility is enabled by default. When Dynamic Water Visibility Enabled is True, VR-Vantage increases the water visibility depth from the value Surface Transparency setting (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-Vantage 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 Maximum value. (For details about setting the Ocean LOD Elevation, please see Section 3.5.3, "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.

1.4. Starting a VR-Vantage Display Engine

On Windows, you can start a display engine from the Start menu or by running a batch file. On Linux, you start a display engine from a script.

➤ To start a display engine on the Windows Start menu, choose **All Programs** → **MÄK Technologies** → **VR-Vantage 2.0** → **VR-Vantage Display Engine**.

➤ To start a display engine from the Windows console or on Linux, run:

`./bin64/displayEngine.`*`extension`*

where *`extension`* is the appropriate script extension for the platform.

1.5. Connecting to a Display Engine

If you want to control a display engine, you must first connect to it.

Connections are made using TCP networking. All computers running display engines together must be on the same network. The display engines listen for VR-Vantage on a TCP socket. A display engine can only be connected to a single master application.

- If you have trouble connecting to a remote display engine, make sure that your firewall is not blocking the port you are using to connect.
- The 64 bit version of VR-Vantage cannot connect to VR-Vantage running on a 32 bit computer.

It is possible to run multiple display engines on the same machine with different ports. However, this is not a recommended configuration.

To connect to a display engine:

1. On one computer (the master), run VR-Vantage.
2. On another computer, run the VR-Vantage Display Engine application, as described in "Starting a VR-Vantage Display Engine," on page 1-20.
3. On the master computer, choose **View** → **Display Engine Configuration Editor**. The Display Engine Configuration Editor Panel panel opens (Figure 1-2).
4. In the Display Engine Configuration Editor Panel, click the Connect a Display Engine button (), or right-click the main display engine icon and choose **Connect a Display Engine** on the popup menu. The Connect To Display Engine dialog box opens (Figure 1-13).

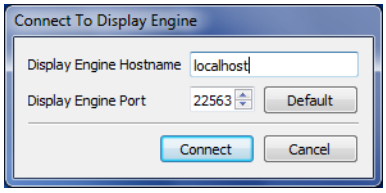


Figure 1-13. Connect to Display Engine dialog box

5. In the Display Engine Hostname box, type the host name or IP address of the computer on which the display engine is running.
6. Optionally, in the Display Engine Port box, specify a port for the display engine. The default is 22563. In most cases the default value will work well.
7. Click Connect. The display engine is added to the Display Engine list. A window is added to the display engine. It shows the same view as Window 1 on VR-Vantage.

1.5.1. Disconnecting from a Display Engine

To disconnect from a display engine:

1. In the Display Engine Configuration Editor Panel, select the display engine that you want to disconnect.
2. Click the Disconnect a Display Engine button (), or right-click the display engine name and choose **Disconnect a Display Engine** on the menu.

You cannot disconnect the master display engine.

1.6. 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 1-14). Since VR-Vantage just sends out its view, if you do not configure the displays for multichannel, the subordinate monitors display the exact same view as the master (Figure 1-16, default window views). Therefore, for multiple views, you must configure the channels to calculate an offset from the master view.

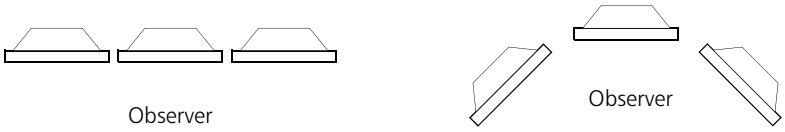


Figure 1-14. Multi-channel displays (top-down view)

The distribution of the view across multiple channels is controlled by the frustum. Figure 1-15 illustrates the default frustum for Channel 1. It has a 60° field of view, from -30° to +30°.

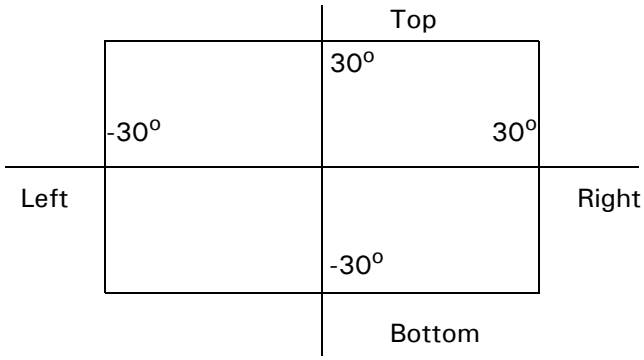


Figure 1-15. Default frustum for Channel 1

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 1-16. The field of view is the same: -30° to +30°. However, now each channel shows a 20° segment of the total field of view.

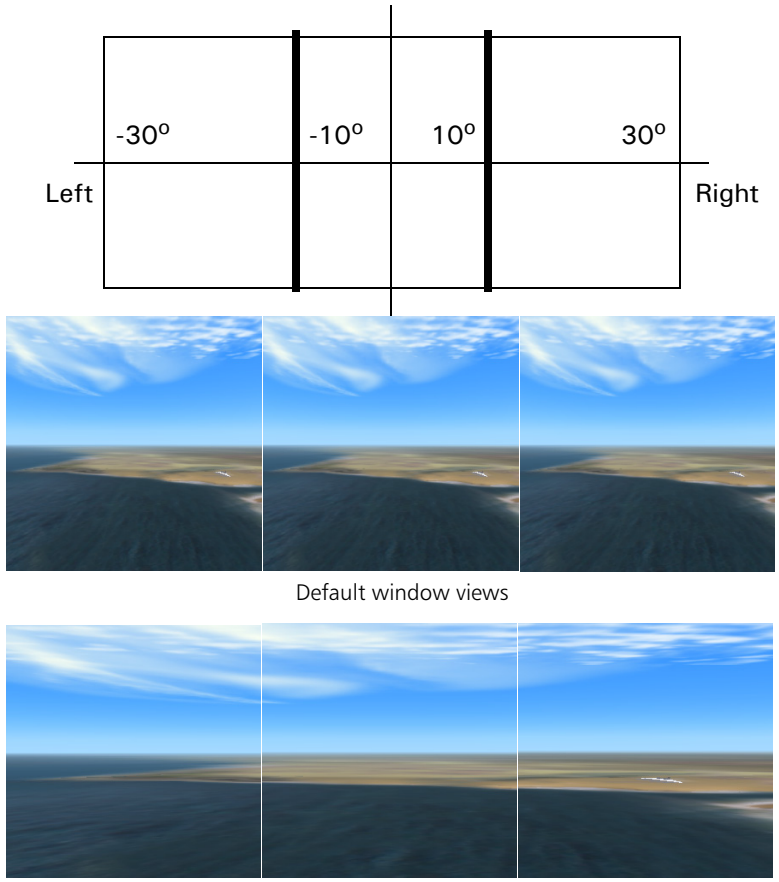


Figure 1-16. Frustum values for three channels

1.6.1. 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 1-17. (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).

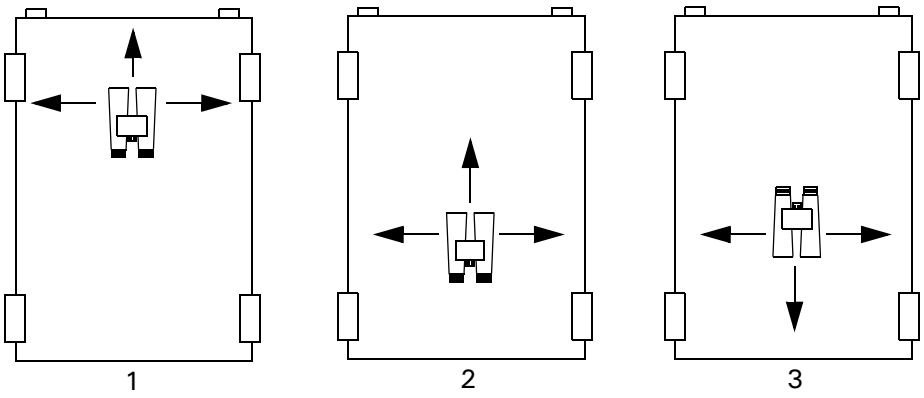


Figure 1-17. Position and orientation offsets

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).

1.6.2. Creating a Multichannel Configuration

A multichannel configuration is a set of display engine configurations. You must save each configuration individually. Chapter 2, *Display Engine Tutorials* shows how to create, save, and load a multichannel display engine configuration.

To save a multichannel configuration:

1. Start VR-Vantage and one or more VR-Vantage Display Engines.
2. In the Display Engine Configuration Editor Panel, connect the display engines.
3. Configure the display engines with the windows and channels that you want them to have.
4. For each display engine in the Display Engine Configuration Editor Panel:
   a. Select the display engine.
   b. Click the Save Display Engine Configuration button ( ).
   c. Type a name for the configuration.
   d. Click Save.

1.6.3. Loading a Multichannel Configuration

You can load a multichannel configuration in the Display Engine Configuration Editor Panel or from the command line. If you load it in the editor, you must load each configuration individually. For details about loading multiple configurations from the command line, please see "Loading Multiple Display Engine Configurations from the Command Line," on page 1-7.

To load a multichannel configuration:

1. Start VR-Vantage and one or more VR-Vantage Display Engines.
2. In the Display Engine Configuration Editor Panel, connect the display engines.
3. For each display engine in the Display Engine Configuration Editor Panel:
   a. Select the display engine.
   b. Click the Load Display Engine Configuration button ( ).
   c. Select the configuration you want to load.
   d. Click Load.

1.7. 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-Vantage uses OpenSceneGraph for most of its rendering, all three should be possible in VR-Vantage.

- 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-Vantage, 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-Vantage, 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-Vantage.

1.7.1. Configuring Anaglyphic Stereo

You can configure OpenSceneGraph for anaglyphic stereo rendering through environment variables. To use VR-Vantage in anaglyphic mode, run it with the environment variables described in Table 1-1.

Table 1-1: Environment variables for anaglyphic stereo

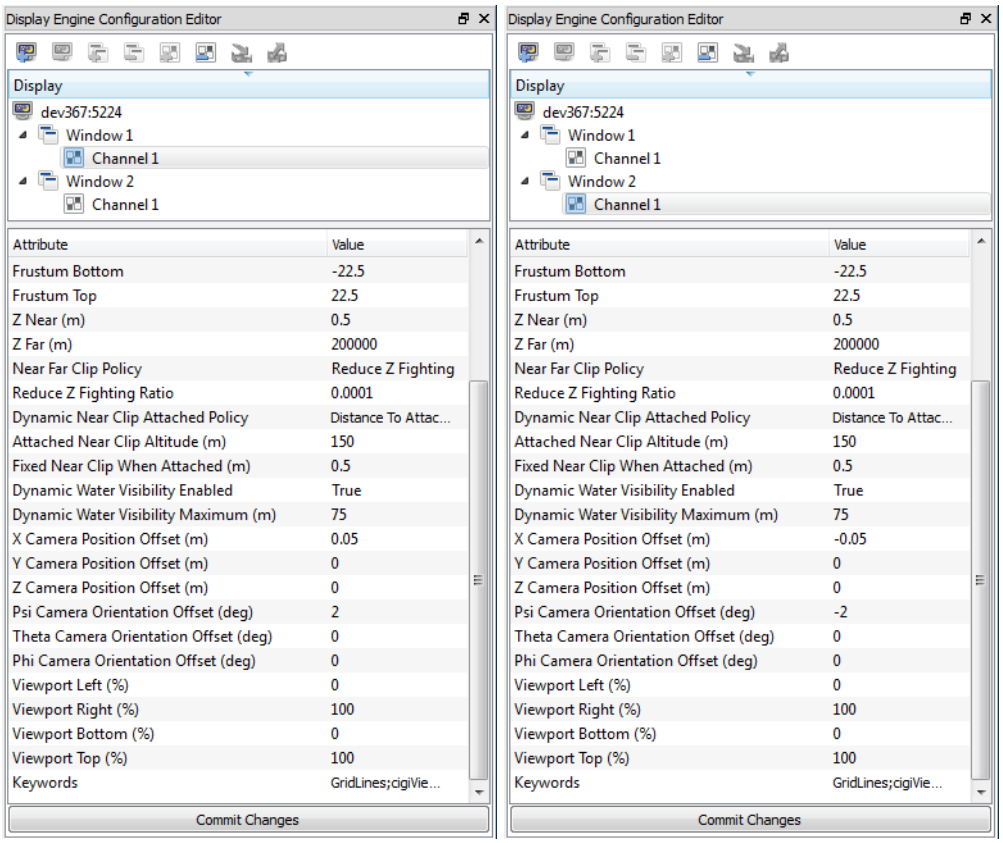
Environment Variable	Description	Default
OSG_STEREO	Turn stereo on.	ON
OSG_STEREO_MODE	Use anaglyphic stereo when in stereo.	ANAGLYPHIC
OSG_SCREEN_DISTANCE	Specifies the distance, in meters, that the viewer is from the screen.	0.50
OSG_SCREEN_HEIGHT	Specifies the height of the image, in meters, on the 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.

1.7.2. Configuring Polarized Stereo

You can configure polarized stereo by taking advantage of VR-Vantage'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 1-18 shows an example configuration.



Left channel Right channel

Figure 1-18. 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.

1.8. Display Issues on Linux

VR-Vantage does not support two separate X screens. The reason is that when you create two separate X screens and try to create two OpenGL windows, they may not share OpenGL contexts. A number of VR-Vantage components require sharing contexts for our rendering to work. These include: SilverLining, SpeedTree, and our 2D overlays (possibly also GL Studio).

The work-arounds to support two screens include:

- Use Nvidia driver's TwinView mode. This behavior is identical to the Window multi-monitor behavior and VR-Vantage works correctly with this setting.
- Use Xinerama, which is an X extension that behaves similar to TwinView.
- Run VR-Vantage on one X Screen and run a Remote Display Engine on the other. This will require two installs to ensure that the appData directories are not compromised.

2. Display Engine Tutorials

This chapter has a tutorial that shows how to connect to a remote display engine, edit display engine configurations, and apply display engine configurations to display engines.

2.1. Saving and Loading Display Engine Configurations

This tutorial demonstrates how to:

- Connect a VR-Vantage application to a VR-Vantage Display Engine.
- Change a display engine configuration.
- Save display engine configurations.
- Load display engine configurations in the Display Engine Configuration Editor Panel.
- Load multiple display engine configurations from the command line.

2.1.1. Connect a VR-Vantage Display Engine

This tutorial assumes that you have two computers, one for your VR-Vantage application, and one for the remote display engine. You could run this tutorial on one computer if you have two monitors.

To create the display engine configurations:

1. On computer 1, start VR-Vantage.
2. Load *makland.mtf*.
3. Choose **View** → **Display Engine Configuration Editor Panel**. The Display Engine Configuration Editor Panel opens. It shows one window and one channel for the VR-Vantage window on the local computer (Figure 2-1).

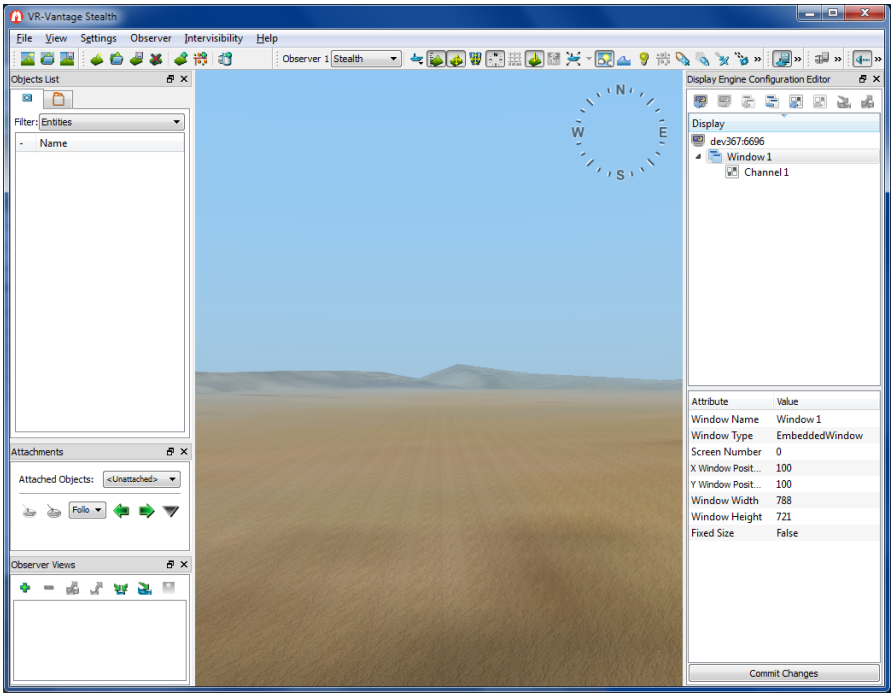


Figure 2-1. Display Engine Configuration Editor Panel and default window

4. On computer 2, on Windows, choose **Start** → **All Programs** → **MAK Technologies** → **VR-Vantage 2.0** → **VR-Vantage Display Engine**.

   On Linux, run:

   ```
   ./bin/displayEngine.extension
   ```

   where *`extension`* is the appropriate script extension.

   A VR-Vantage display engine opens. It does not show a default window.

5. On computer 1, in the Display Engine Configuration Editor Panel, click the Connect a Display Engine button (). The Connect to Display Engine dialog box opens.

6. In the Display Engine Hostname box, replace "localhost" with the name of computer 2. (If you are using one computer with two monitors, leave the text as localhost.)

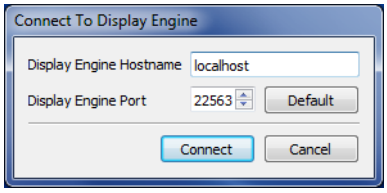


Figure 2-2. Connect to Display Engine dialog box

7. Click Connect. An entry for the remote display engine is added to the Display Engine Configuration Editor Panel (Figure 2-3). The remote display engine now displays the Makland terrain with the same view as the VR-Vantage application.

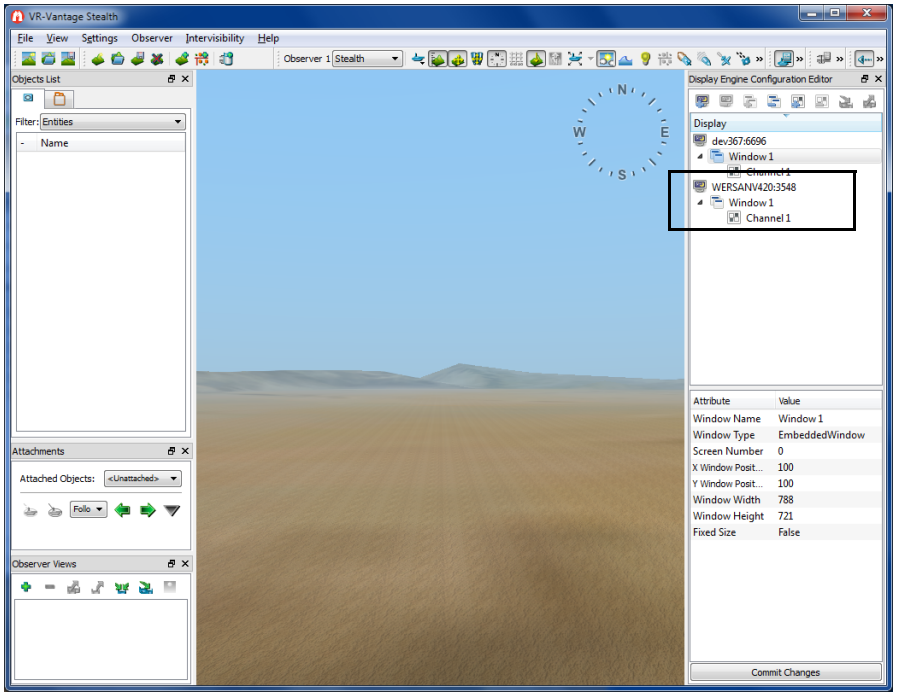


Figure 2-3. Remote display engine connected

2.1.2. Save Display Engine Configurations

By default, the views in the VR-Vantage window and the remote display engine window look exactly the same. So we will change the view in one of them so that when we load the display engine configurations later on, we can tell that each is different.

To edit the display engine configurations and save them:

1. Select Channel 1 of the remote display engine. Its attributes are displayed.
2. Change the value for the Viewport Right and Viewport Top attributes to 50 (Figure 2-4).

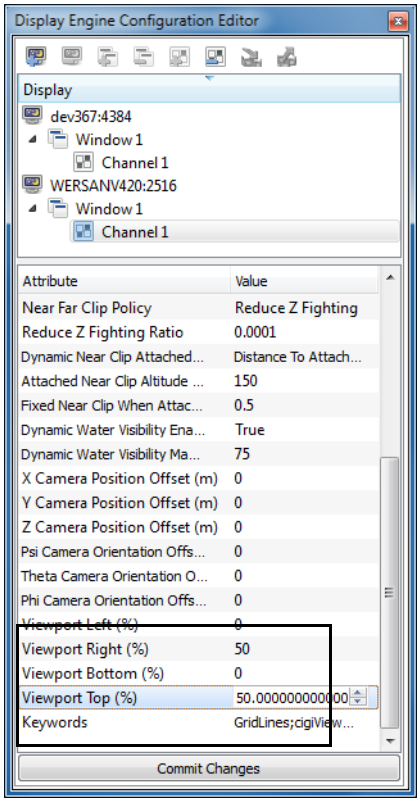


Figure 2-4. Channel with changed viewports

3. Click Commit Changes. The view of the terrain is now in the lower left quadrant of the display engine (Figure 2-5). (The full screen view of the terrain may also be visible until such time as the display engine refreshes.)

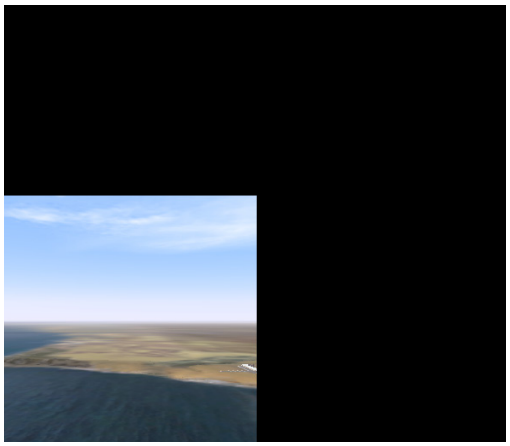


Figure 2-5. Remote display engine view after changing configuration

4. Select the display engine on the VR-Vantage application (in this example, WERSANV420).
5. Click the Save Display Engine Configuration button ( ). A save dialog box opens.
6. Call this configuration *mainwindow.dcx*.
7. Click Save.
8. Select the display engine on the remote display engine (in this example, WERSANV420).
9. Click the Save Display Configuration button. A save dialog box opens.
10. Call this configuration *remotedisplay.dcx*.
11. Click Save.

2.1.3. Load the Display Engine Configurations in the GUI

We now have two visually distinct display engine configurations. In this part of the tutorial, we simply load them into the two display engines to see that loading a display engine configuration changes the view in the window. This part of the tutorial also demonstrates that display engine configurations are not unique to a particular display engine and are not tied to one either. Any particular configuration can be loaded into any display engine.

To load the display engine configurations in the GUI:

1. Select the display engine on the VR-Vantage application.
2. Click the Load Display Engine Configuration Editor button (). The Load Display Configuration dialog box opens.
3. Select *remotedisplay.dcx*.
4. Click Open. The window on the VR-Vantage application now shows the terrain in the lower left quadrant. (You may need to press **`Space Bar`** to reset the observer.)
5. Reload the *mainwindow.dcx* configuration in the main window.
6. Try loading the two different configurations in the remote display engine.

2.1.4. Loading the Display Engine Configurations from the Command Line

As you have seen in the previous part of this tutorial, you can load display engine configurations for individual display engines through the GUI. However, you cannot load more than one at a time. If you have a complex set of display engines that you need to configure, loading them one at a time can be tedious. To load multiple display engine configurations at one time, you must start VR-Vantage from the command line.

You load multiple display engine configurations from the command line with the `--dispSetting` command line argument and the `-W` or `--withDisplayEngine` command-line argument. The syntax for Windows is:

```
vrvApplication.exe --dispSetting masterdisplayConfigFile
  -W port@netAddress;remotedisplayConfigFile1 ....
  port@netAddress;remotedisplayConfigFileN
```

The syntax for Linux is:

```
vrvApplication.exe --dispSetting masterdisplayConfigFile
  -W port@netAddress:remotedisplayConfigFile1 ....
  port@netAddress:remotedisplayConfigFileN
```

In this tutorial, we use the default port (22563). The netaddress for the remote display engine is the computer name (WERSANV420). The display engine configuration files are *mainwindow.dcx* and *remotedisplay.dcx*.

So the command line to load the two display engine configurations that we created would be:

```
vrvIG.exe --dispSetting ../appData/settings/van-
  tageIG/mainwindow.dcx -W 22563@WERSANV420;../app-
  Data/settings/vantageIG/remotedisplay.dcx
```

To load the tutorial configurations from the command line:

1. Open a command window.
2. Change directory to *./bin*.
3. On Windows, enter the command:

   ```
   vrvIG.exe --dispSetting ../appData/settings/van-
     tageIG/mainwindow.dcx -W 22563@WERSANV420;../app-
     Data/settings/vantageIG/remotedisplay.dcx
   ```

   On Linux, enter the command:

   ```
   vrvIG.exe --dispSetting ../appData/settings/van-
     tageIG/mainwindow.dcx -W 22563@WERSANV420:../app-
     Data/settings/vantageIG/remotedisplay.dcx
   ```

   VR-Vantage starts. The display engine configurations are visible in the main window and the remote display engine window.

4. Choose **View** → **Display Engine Configuration Editor Panel**. In the Display Engine Configuration Editor Panel, confirm that VR-Vantage is connected to the remote display engine.

3. 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 4.1, "Terrain Agility and Composability," in *VR-Vantage Users Guide* . "Composing a Terrain through the GUI," on page 5-2 is a tutorial that steps you through the entire process of creating a terrain.

3.1. Creating a Composed Terrain

The most common ways to compose a terrain in VR-Vantage are as follows:

- Load individual terrain components through the VR-Vantage GUI and then save the terrain as an MTF file.
- Create an earth file that specifies all the terrain components to load. Then load the earth file and save it as an MTF file.
- Load an earth file and add local terrain components. Then save the terrain as an MTF file.

This section describes the first option, creating a terrain by loading individual elevation, imagery, and feature files. The general procedure for composing a terrain this way 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 3-5.
3. Optionally, add imagery, as described in "Adding Images to a Terrain," on page 3-7.
4. Optionally, add feature data, as described in "Adding a Feature Layer," on page 3-11.
5. Optionally, add a dynamic ocean layer, as described in "Adding a Dynamic Ocean Layer," on page 3-12.
6. Optionally, add props or extract props, as described in "Adding Props from a Feature Layer," on page 3-27 and "Extracting Props from a Terrain Patch," on page 3-25.
7. Save the terrain, as described in "Saving a Terrain," on page 3-4.

"Composing a Terrain through the GUI," on page 5-2 demonstrates how to create a composed terrain.

3.1.1. Considerations and Limitations for Building Terrains

As you compose a terrain, consider the following issues:

- VR-Vantage 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, you can do so using an earth file. For details, please see "Loading Multiple DTED Files," on page 4-3.
- 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

3.1.2. Saving a Terrain

When you save a terrain, VR-Vantage 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 3-32.) Terrains get saved with the extension *.mtf*.

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.

3.2. 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 3-3.

! Each time you add a terrain patch, VR-Vantage 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 **File** → **Add Terrain Patch**, or click the Add Terrain Patch button () on the Terrain Toolbar. The Add Terrain Patch dialog box opens and an Open dialog box opens on top of it.

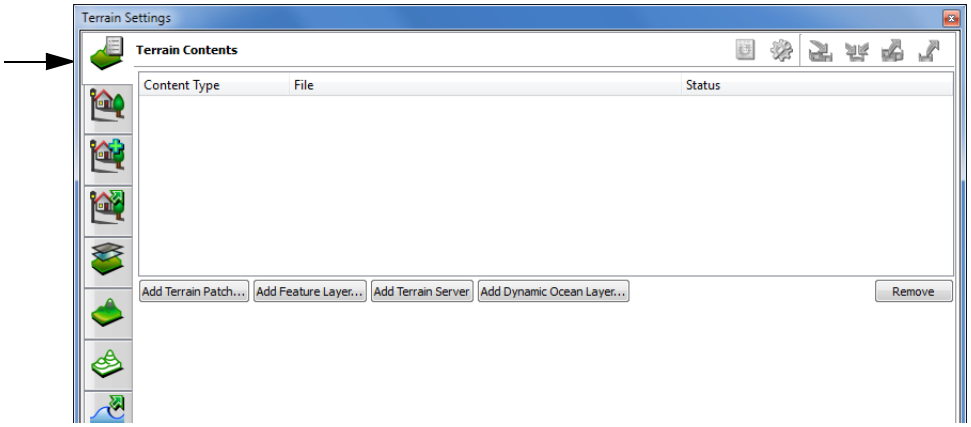


Figure 3-1. Terrain Contents page

2. Select a file in a supported format.
3. Click Open. The Add Terrain Patch dialog box displays details about the terrain patch (Figure 3-2).

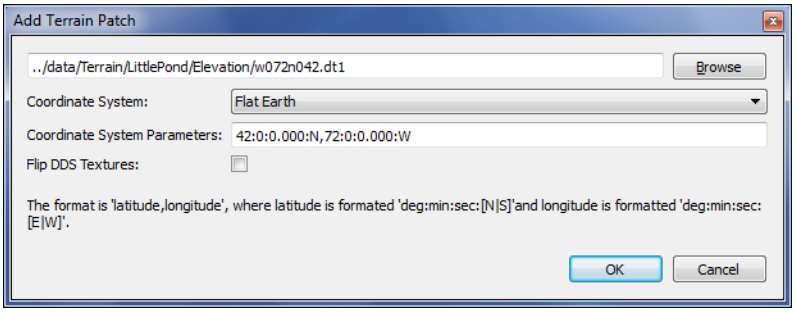


Figure 3-2. Add Terrain Patch dialog box

4. If the terrain patch has DDS textures that are upside down relative to VR-Vantage'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 3-35.)
5. Click OK. The terrain patch is added.
6. Optionally, add additional terrain patches.
7. Save the terrain.

3.3. 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-Vantage to crash. If you need to load very large images, load them using an 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-Vantage 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 3-3).

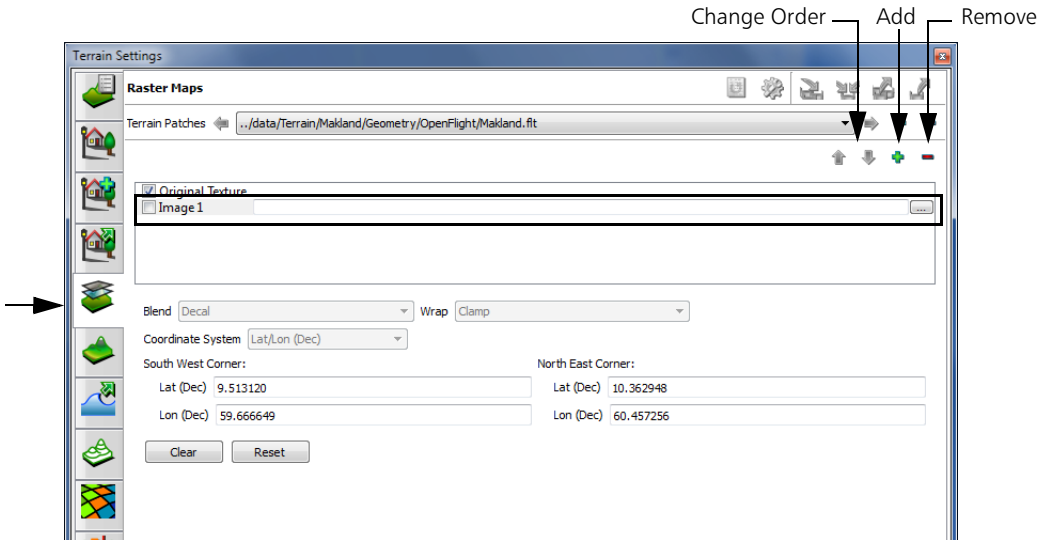


Figure 3-3. Raster Maps page

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 main window, select the check box to the left of the entry (Figure 3-4).

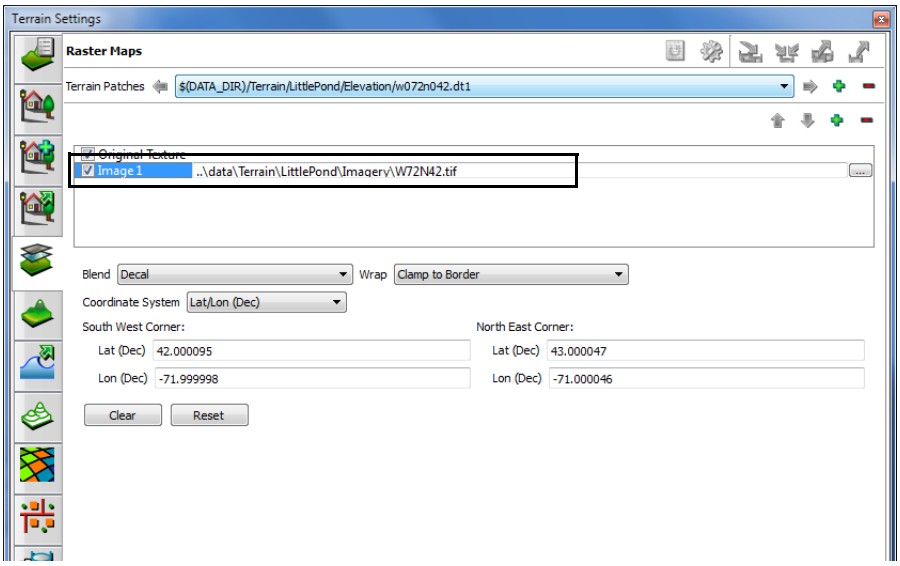
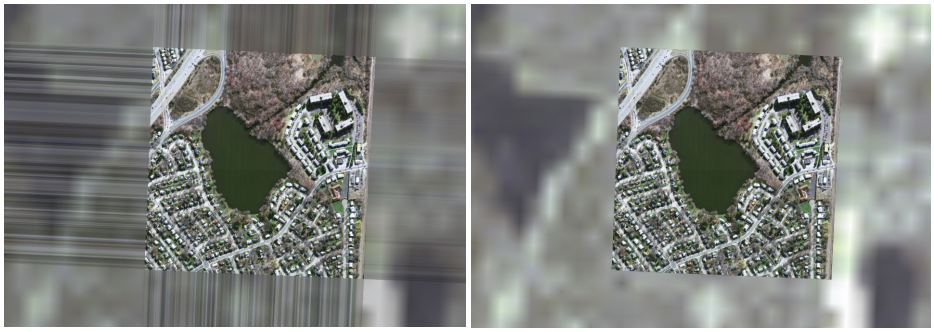


Figure 3-4. Making an image visible

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 3-5 and Figure 3-6:
     - 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.

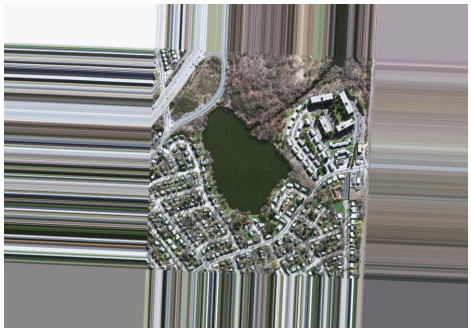
– Coordinate System specifies the coordinate system to use to place the image. Most options are self-explanatory. The Texture coordinate system specifies UV (X,Y) coordinates for placing textures on the terrain.

– 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-Vantage stretches it to cover the terrain patch. If you do not want the image to cover the entire terrain, you can specify the coordinates.

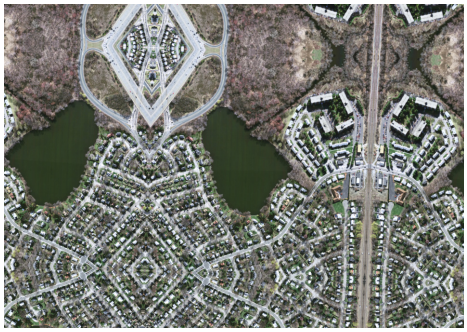


Clamp | Clamp to border

Figure 3-5. Raster image wrap effects (Clamp and Clamp to Border)



Clamp to edge



Mirror

Repeat

Figure 3-6. Raster image wrap effects (Clamp to Edge, Mirror, Repeat)

3.3.1. 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-Vantage.

Figure 3-7 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 3-7. 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 3-3).
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.

3.4. 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).

When VR-Vantage 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.

- Adding a feature layer does not, by itself, make any visible difference to a terrain. To see 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 3-25.
- 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.

To add a feature layer:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Terrain Contents page (Figure 3-8).

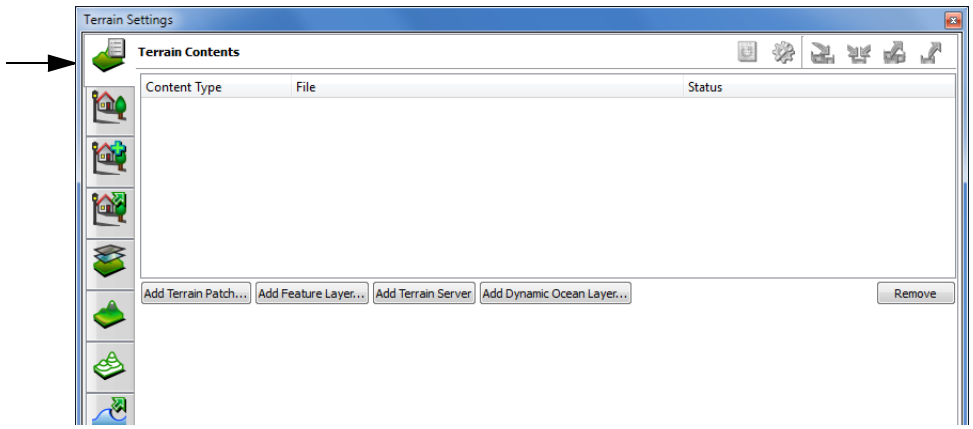


Figure 3-8. Terrain Contents page

3. Click Add Feature Layer. 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.

3.5. Adding a Dynamic Ocean Layer

VR-Vantage 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 3-9). This problem occurs because the ocean layer and the texture are both at the same height (0, or sea level).

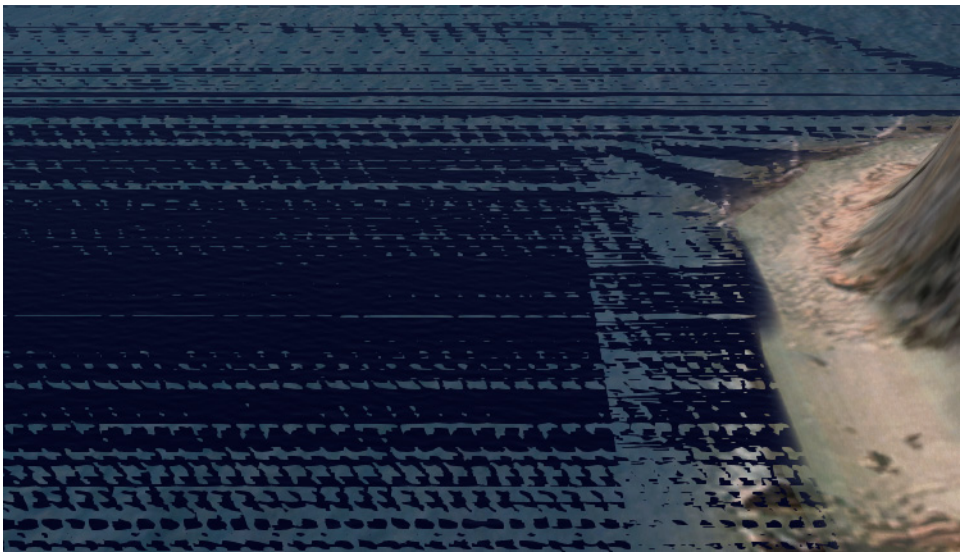


Figure 3-9. Z-fighting

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 3-10 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.

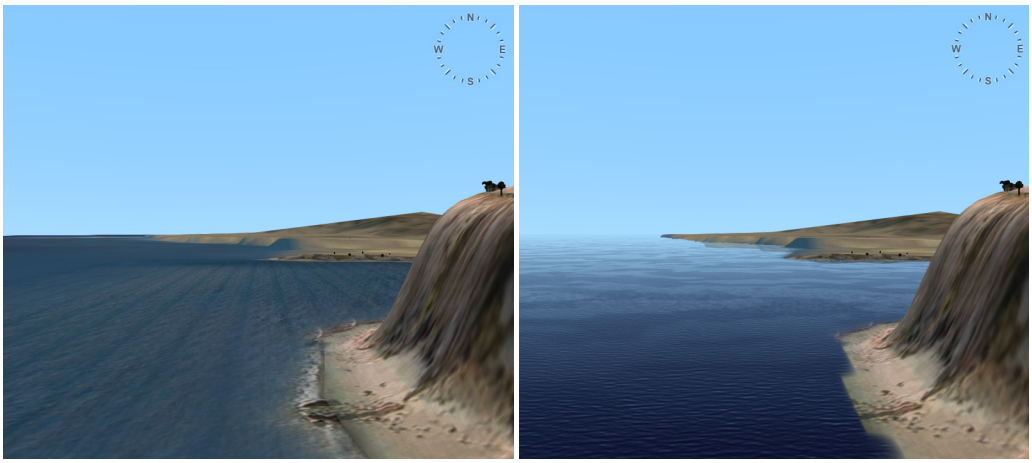


Figure 3-10. Ocean height

3.5.1. 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 3-11).

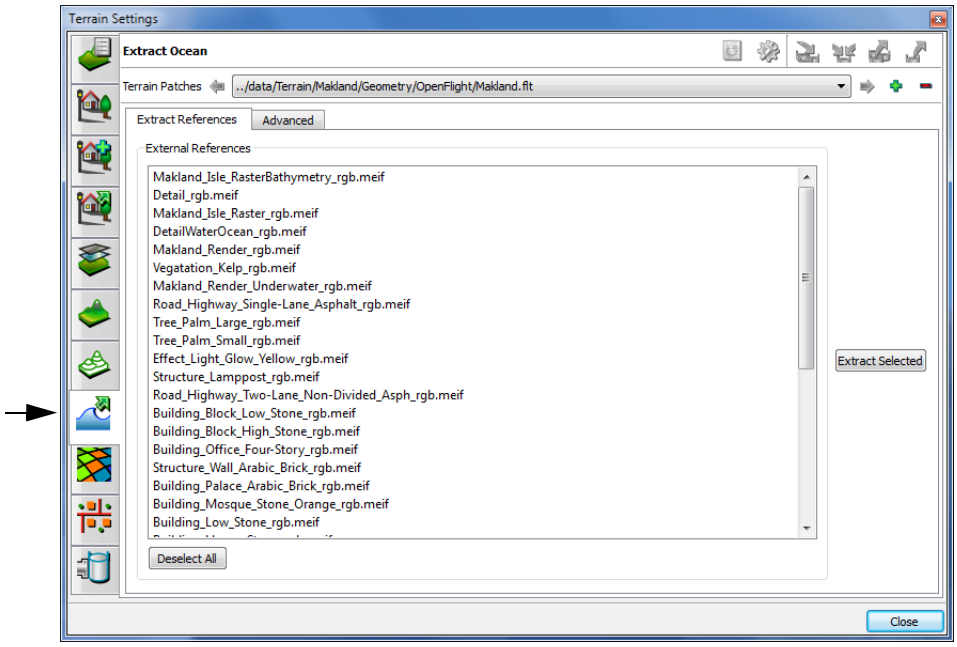


Figure 3-11. Terrain Settings dialog box, Extract Ocean page

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 3-12).
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 3-15.

3.5.2. 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 3-12).

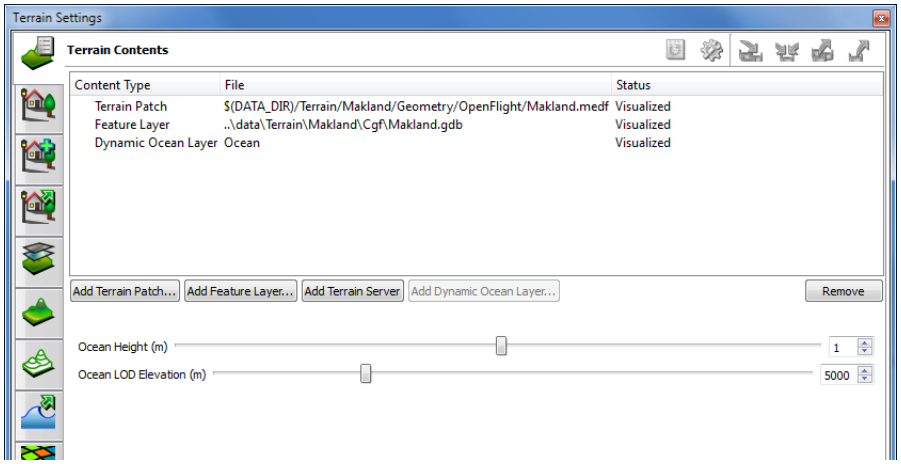


Figure 3-12. Terrain Contents with dynamic ocean layer

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 3-15.

3.5.3. Setting the Ocean LOD Elevation

Enabling dynamic ocean affects performance. Since the effects are hard to see once the observer is high above the ocean, VR-Vantage 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 3-12).
3. Adjust the Ocean LOD Elevation slider or change the value in the box.

3.5.4. Configuring the Ocean Height Map

The ocean height map is used to blend the dynamic ocean with the coastline. You can configure the height map resolution, its texture size, and the threshold for regenerating the height map. All of these settings interact to affect visual quality and performance.

Height map resolution is specified as meters per pixel. The height map texture size is specifed in pixels. Therefore these two settings determine the length of one side of the (square) area that the height map covers. For example, if the value for height map resolution is 10 meters per pixel and the texture size is 4096 pixels, this results in a height map that is 40960 meters on a side.

As height map resolution increases and texture size decreases, visual quality may improve, but performance can degrade. Conversely, decreasing resolution and increasing the texture size can improve performance at a cost of visual quality. You will need to experiment to determine the best values for your simulation.

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 3-13 shows a coastline at different levels of resolution.

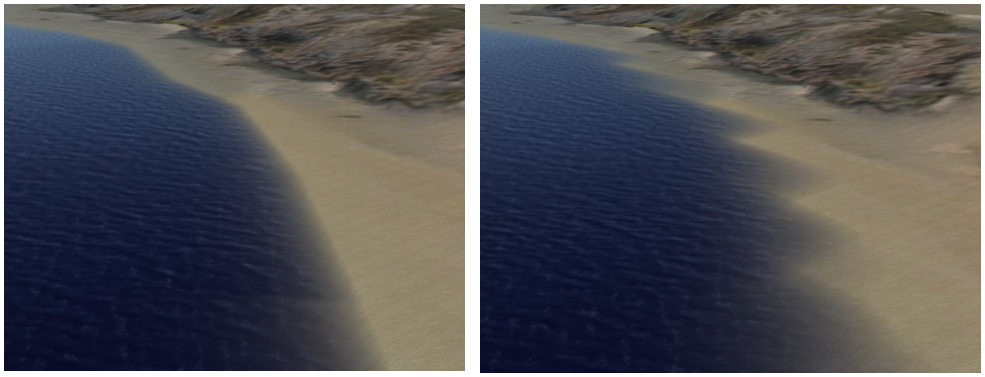


Figure 3-13. Ocean height map resolution

Setting the surface transparency also affects visualization of the shoreline. Experiment with these values to achieve the best results. For details about water transparency, please see Section 5.5.2, "Configuring Marine Conditions," in *VR-Vantage Users Guide*.

Setting the Ocean Height Map Resolution

The ocean height map resolution is specified at meters per pixel.

To set the ocean height map resolution:

1. Choose **Settings** → **Display**. The Display Settings dialog box opens.
2. Select the Render Settings page (Figure 3-14).

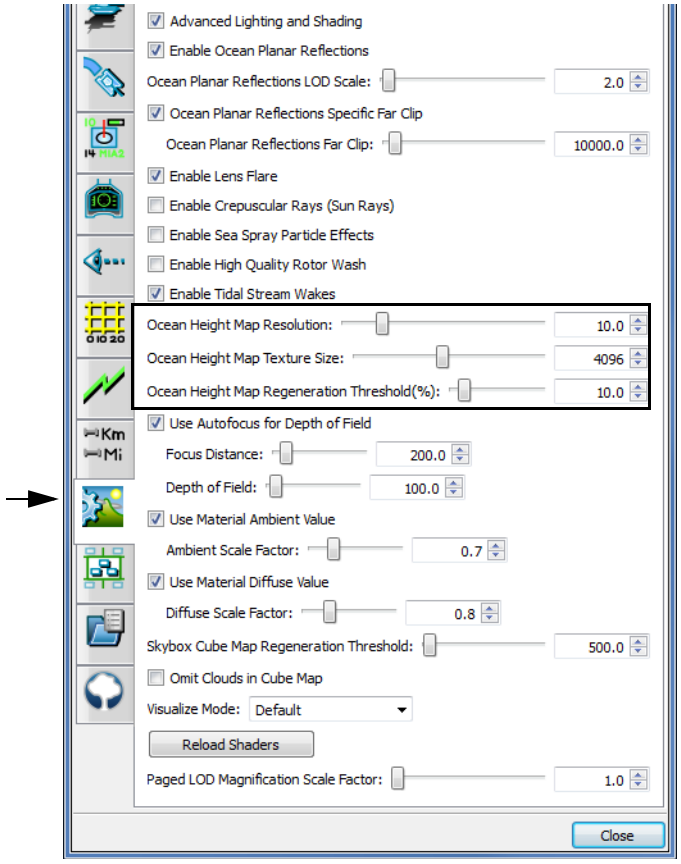


Figure 3-14. Render Settings page

3. Adjust the Ocean Height Map Resolution slider, or enter a value in the box.

Setting the Ocean Height Map Texture Size

The ocean height map texture size is specified in pixels.

To set the ocean height map texture size:

1. Choose **Settings** → **Display**. The Display Settings dialog box opens.
2. Select the Render Settings page (Figure 3-14).
3. Adjust the Ocean Height Map Texture Size slider, or enter a value in the box.

Setting the Ocean Height Map Regeneration Threshold

The ocean height map is recalculated as the observer moves. Generating the height map is computationally expensive. Therefore, it is done only when the observer moves by more than a specified threshold. You can adjust this threshold if you want to recalculate the height map more frequently. The default is 10% (0.1). This means that the observer must move by 10% of the length of one side of the height map before the height map is regenerated.

To set the ocean height map regeneration threshold:

1. Choose **Settings** → **Display**. The Display Settings dialog box opens.
2. Select the Render Settings page (Figure 3-14).
3. Adjust the Ocean Height Map Regeneration Threshold slider, or enter a value in the box.

3.6. Using Shader-based Effect Maps

VR-Vantage supports several types of shader-based effects texture maps. Shaders are computer programs that run on the graphics processing unit (GPU). VR-Vantage makes extensive use of them for lighting effects.

Effect maps are raster images that apply highly realistic textures to the terrain and models. By applying different types of effect maps to terrain and models, you can improve the visual qualities of your simulation without the overhead of high polygon counts.

VR-Vantage supports the following types of shader-based effect 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.
- Emissive maps. Emissive maps control the emissivity of whatever they are applied to based on the current ambient light values. The alpha channel is an ID that is set from 0-255. All the pixels that should light together (like a window, and perhaps a surrounding sill) should have the same ID. When the ambient light level drops below a given ID level, those pixels are emissive. Channel 2 (green) is used to indicate the intensity of the emissivity. These textures need to use a lossless compression scheme, such as PNG. *LittlePond.mtf* has sample emissivity textures on many of the houses.

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-Vantage uses a naming convention for effect 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*
- Emissive map: *filename_EMM.png*.

The map code must be uppercase on Linux.

To see the effect of effect maps, you must enable advanced lighting and shading. For details, please see Chapter 16, *Lighting Effects*, in *VR-Vantage Users Guide*.

3.6.1. Reloading Shaders

Developers who are fine tuning shaders for terrain and object models do so by editing text files that configure the shaders. They can load their new shaders without shutting down VR-Vantage.

To dynamically reload shaders:

1. Choose **Settings** → **Display**. The Display Settings dialog box opens.
2. Select the Render Settings page (Figure 3-14).
3. Click Reload Shaders.

3.7. Connecting to Terrain Servers

VR-Vantage supports the osgEarth libraries for creating terrains from remote or local data sources (Figure 3-15). Terrain servers support streaming of terrain data and are, therefore, ideal for displaying terrains that have large amounts of data.

Figure 3-15. Geocentric terrain

You can manipulate the terrain from the keyboard and mouse and can save it as an MTF terrain for quick loading.

VR-Vantage 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-Vantage. These servers, such as, *Local World.earth* and *SanLuisObispo.earth*, are examples of how you can use earth files to load local data.

"Creating a Terrain with an Earth File," on page 5-13, 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-Vantage 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 3-16).

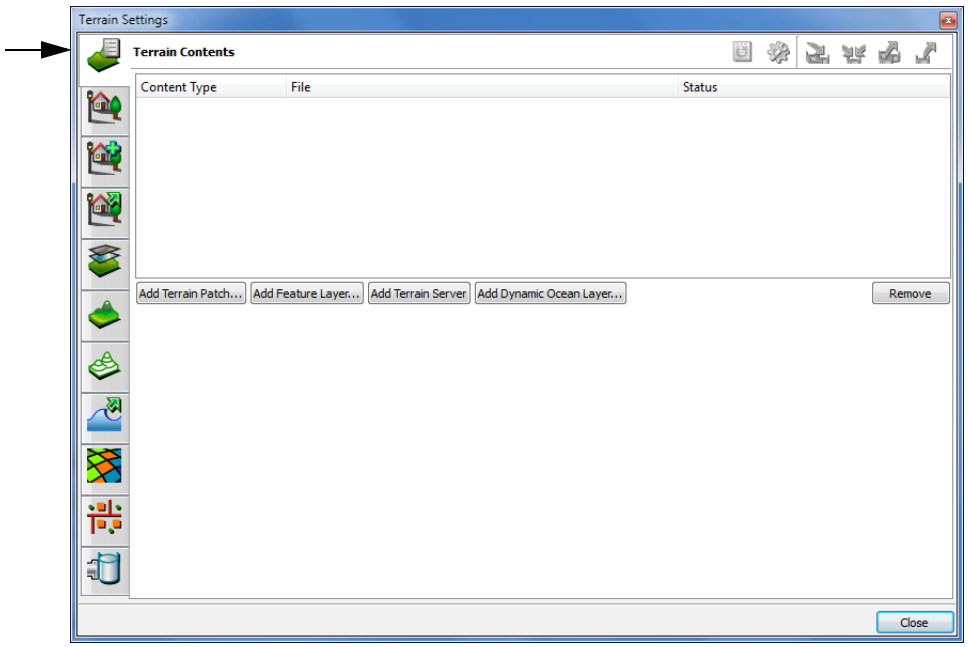


Figure 3-16. Terrain Contents

4. Click Add Terrain Server. The Add Terrain Server dialog box opens (Figure 3-17). 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 3-23.)

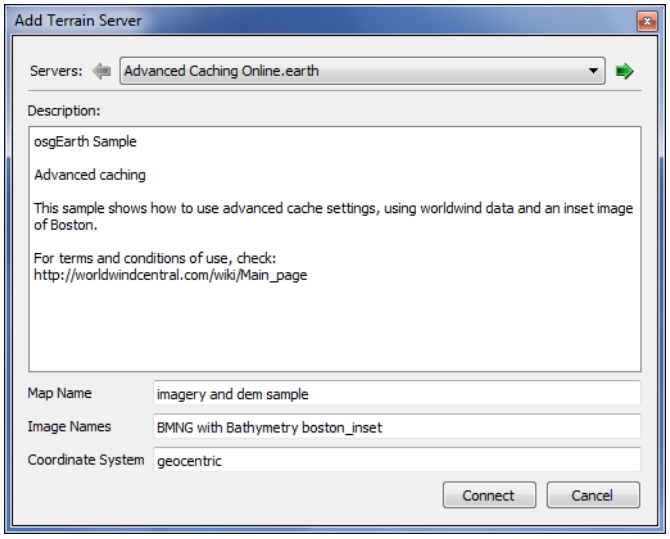


Figure 3-17. Add Terrain Server dialog box

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 3-4.

3.7.1. Adding Terrain Server Connections

You can add additional terrain server connections to the list provided with VR-Vantage. 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-Vantage 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. (Chapter 4, *Streaming Data Using Earth Files*, provides a brief introduction to earth file syntax.)

"Creating a Terrain with an Earth File," on page 5-13, 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 3-18). The dialog box displays the contents of the configuration file for the selected server.

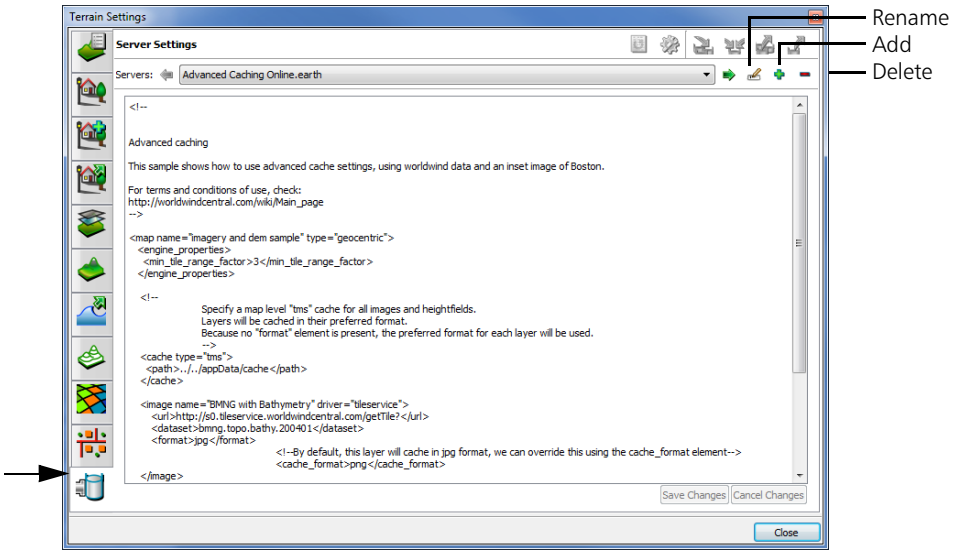


Figure 3-18. Server settings page

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*.

3.7.2. Editing a Terrain Server Configuration

VR-Vantage provides a text editor interface that lets you edit the osgEarth terrain server configuration files (earth 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 3-18). 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.

3.7.3. 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-Vantage 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-Vantage, the Choose a Terrain 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.

3.8. Loading MetaFlight Terrains

VR-Vantage 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 6, *Processing MetaFlight Files*.

When you load a MetaFlight file, VR-Vantage is actually loading many individual OpenFlight files. If file caching is enabled, VR-Vantage 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 3-32.

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.

3.9. 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.

3.9.1. Extracting Props from a Terrain Patch

When you extract props from a terrain patch, you have to tell VR-Vantage 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-Vantage 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-Vantage 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-Vantage auto-generate prop types. If you choose Auto Generate, VR-Vantage makes the prop type match the name of the referenced file. For example, a prop extracted from the file *Bridge_Arch_Stone.flt* 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-Vantage creates props using the geometry in the terrain patch. For example, if you chose *Trees.flt* as the referenced file, VR-Vantage creates props using the tree geometry in that file.

VR-Vantage 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 5-20.

To extract props from a terrain:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Extract Props page (Figure 3-19).

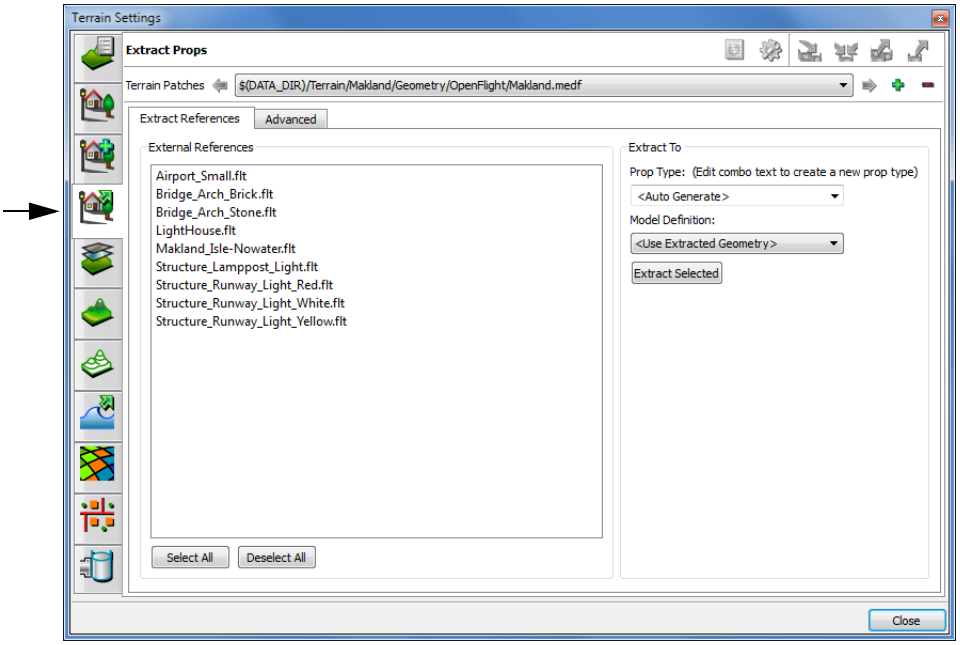


Figure 3-19. Extract Props page

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-Vantage 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-Vantage extracts the props, if any. You can view the list of props in the Props list on the Edit Existing Props page.

3.9.2. 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 5-9 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 3-20).

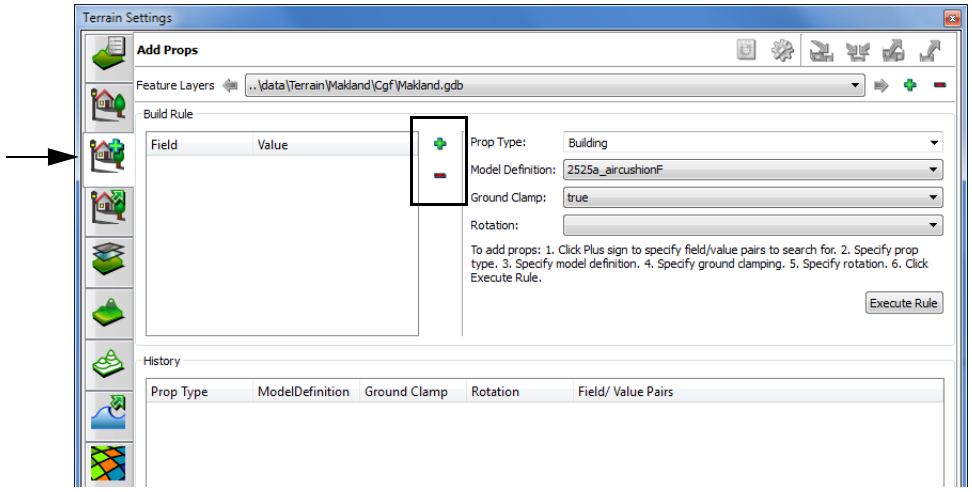


Figure 3-20. Terrain Settings, Add Props page

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 3-20). The Build Field/Value Pair dialog box opens (Figure 3-21).

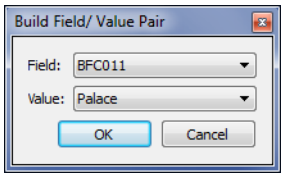


Figure 3-21. Build Field/Value Pair dialog box

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 3-22).

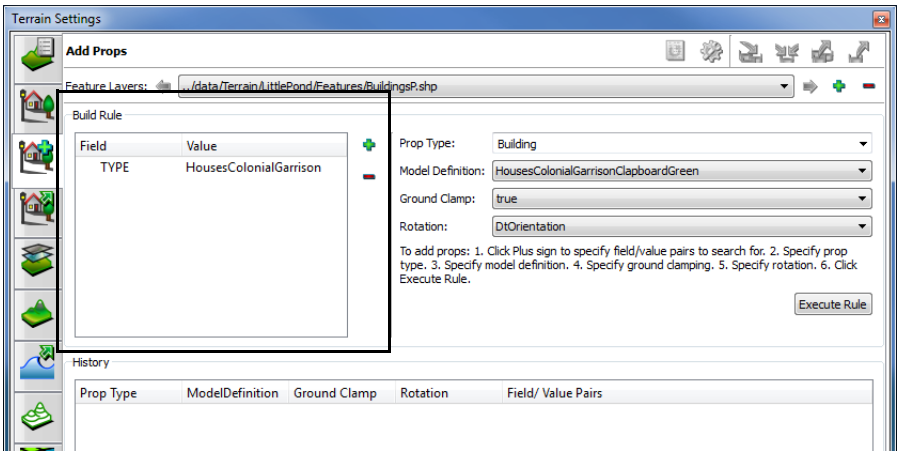


Figure 3-22. New Field/Value pair

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.

3.9.3. 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 3-23).

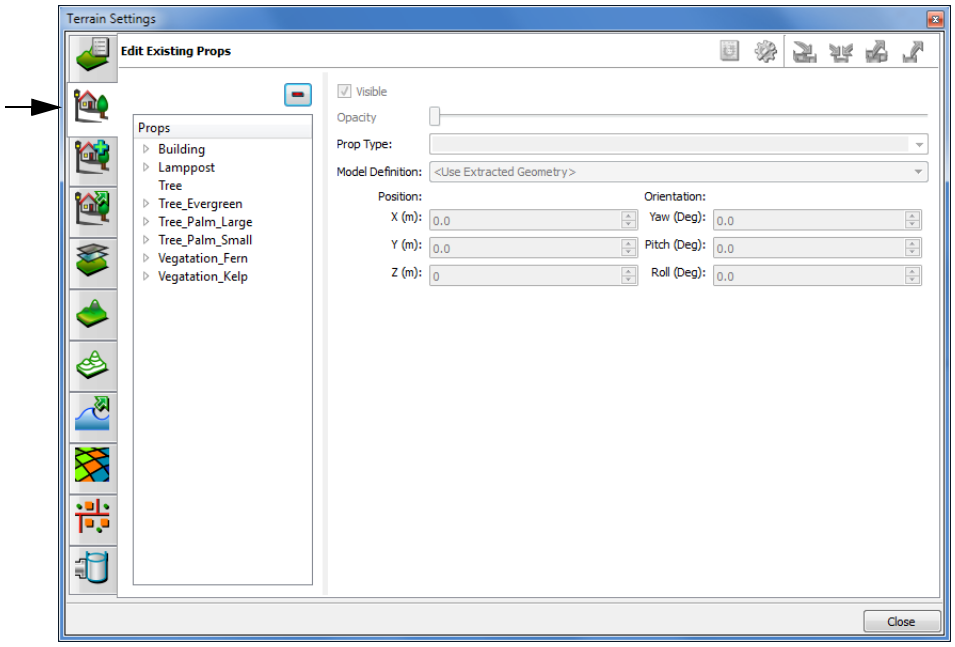


Figure 3-23. Edit Existing Props page

3. Expand the list to view the entries under a particular type of prop.

3.9.4. Selecting Props

➤ To select a prop, click it in the window or in the Objects List Panel, 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.

3.9.5. 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 3-24 illustrates a building at two levels of opacity.

100% 40%

Figure 3-24. 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 3-23).
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**.

3.9.6. 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 3-23).
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.

3.9.7. 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 3-23).
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.

3.9.8. Changing a Prop's Model Definition

You can change the model definition used to render a prop. For information about model definitions, please see Chapter 7, *Model and Element Definitions*. For an example of changing a prop's model definition, please see "Test the Model Mapping," on page 8-10.

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 3-23).
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.

3.10. Configuring File Caching

When file caching is enabled, VR-Vantage 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-Vantage 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 3-25).

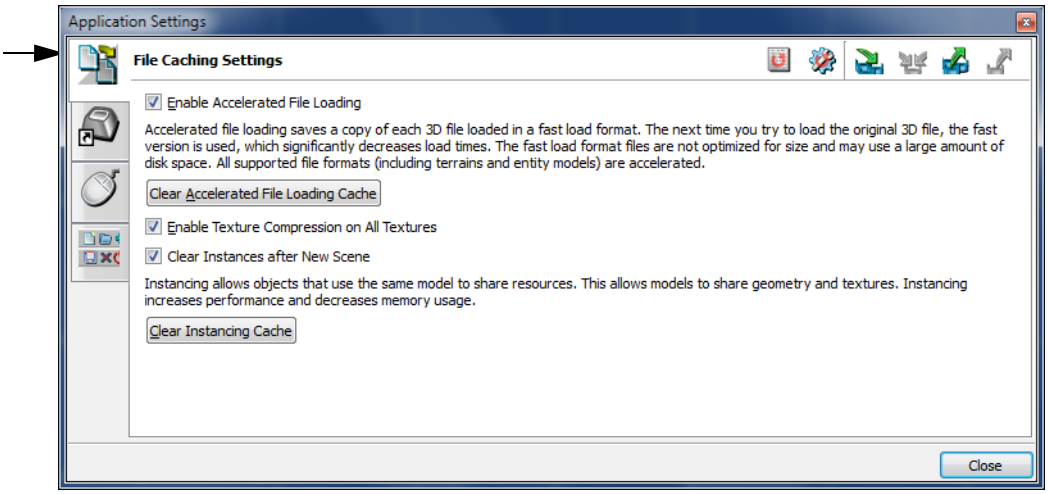


Figure 3-25. File Caching Settings page

3. Select or clear the Enable Accelerated File Loading check box.

3.10.1. Caching Terrain Server Data

When file caching is enabled, VR-Vantage 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.

3.10.2. Caching osgEarth Terrain Data Offline

VR-Vantage includes a tool, *./bin64/osgearth_cache*, that you can use to cache terrain data offline. When you need to use the terrain, the data will have already been cached. osgearth_cache caches imagery and elevation. It does not cache feature data. The syntax is as follows:

```
osgearth_cache --list file.earth | --seed file.earth
  [--estimate --min-level level --max-level level
  --bounds xmin ymin xmax ymax* --index shapefile --mp
  --mt --concurrency --verbose]| --purge file.earth
```

where:

- `--list` lists information about the cache in an earth file.
- `--seed` seeds the cache for an earth file.
- `--estimate` prints out an estimation of the number of tiles, disk space, and time it will take to perform the seed operation.
- `--min-level` *`level`* specifies the lowest LOD level to seed. Default: 0.
- `--max-level` *`level`* specifies the highest LOD level to seed. Default: highest available.
- `--bounds` *`xmin ymin xmax ymax`* specifies the geospatial bounding box to see, in map coordinates. You can include multiple instances of this option. Default: entire map.
- `--index` *`shapefile`* Use the feature extents in the specified shapefile to set the bounding boxes for seeding.
- `--mp` specifies use of multiprocessing to process the tiles. This is useful for GDAL sources because it avoids the global GDAL lock.
- `--mt` specfiies use of multithreading to process the tiles.
- `--concurrency` Specifies the number of threads or processes to use if `--mp` or `--mt` are used.
- `--verbose` displays the progress of the seed operation.
- `--purge` purges a layer cache in an earth file. This command is interactive.

The following example caches a file named *VR-TheWorldOnline.earth*:

```
osgearth_cache.exe --seed ../userData/servers/VR-TheWorld-
  Online.earth --max-level 2
```

The following example caches a portion of a file named *HawaiiLocalServer-mak.earth*:

```
osgearth_cache.exe --seed ..\userData\servers\HawaiiLo-
  calServer-mak.earth --max-level 18 --bounds
  -162.0013879999999915 14.9985579999999992
  -149.9985580000000027 25.0013879999999986
```

We strongly recommend that you specify `--max-level` and seed just the areas that you want.

3.10.3. 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 3-25).
3. Select or clear the Enable Texture Compression On All Textures check box.

3.10.4. 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 3-25).
3. Click Clear Accelerated File Loading Cache.

3.11. 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-Vantage assumes that images have the OpenGL orientation. However, sometimes images are not oriented properly and therefore you may have to tell VR-Vantage 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 7-37.)
- When you add a terrain patch. (For details, please see "Adding Elevation Data (Terrain Patches) to a Terrain," on page 3-5.)
- As a global setting. (For details, please see "Flipping DDS Textures Globally," on page 3-35.)

3.11.1. 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-Vantage'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 3-26).

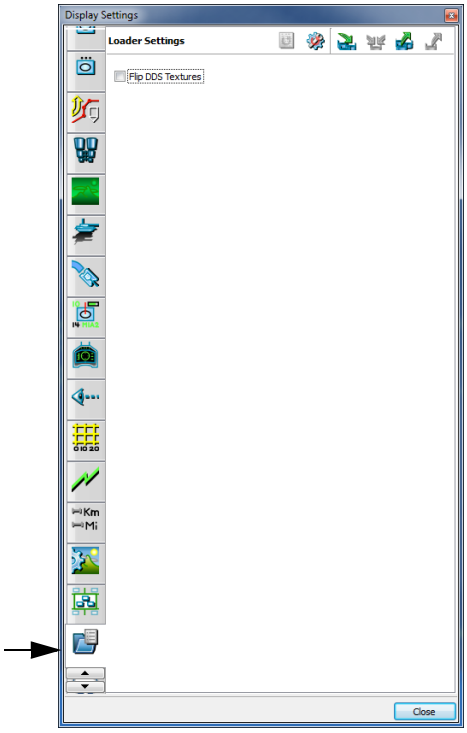


Figure 3-26. Loader Settings page

3. Select the Flip DDS Textures check box.
4. Click Close.

3.12. Building Efficient MetaFlight Terrains for VR-Vantage

VR-Vantage can only load MetaFlight terrains built with certain tools. All MetaFlight files must be pre-processed by VR-Vantage tools before they can be loaded. The following are recommendations for constructing MetaFlight terrains that can be processed and loaded into VR-Vantage:

- 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.)

3.13. Preprocessing Paged Terrains

VR-Vantage supports preprocessing external references used by paged terrains. VR-Vantage does not require terrain formats such as TerraPage or pageable IVE to be preprocessed. However these terrains may use external references in formats such as OpenFlight, which load slowly. Although VR-Vantage 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-Vantage 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-Vantage 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 9-7.

3.14. Configuring Paged and Streaming Terrains

You can improve performance for some terrains by configuring the following environment variables:

- OSG_MAX_PAGEDLOD. OSG_MAX_PAGEDLOD specifies the target maximum number of paged LODs to maintain. Default: 200. Set it to a lower value if you need to reduce memory consumption when using paged terrains.
- GDAL_CACHEMAX. GDAL_CACHEMAX specifies the maximum cache size for streaming terrain. The default value is 200 MB, which is often adequate. However, if you are using a highly detailed terrain, increasing the cache size to a larger value, such as 2000, can significantly improve performance.

3.15. Terrain Databases Provided with VR-Vantage

Table 3-1 describes the terrain databases provided with VR-Vantage. Some have variants, which indicate the coordinate system or other variations.

Table 3-1: Terrain databases shipped with VR-Vantage (Sheet 1 of 4)

Database	Variation	Description
Berkeley	Berkeley.mtf	UTM. OpenFlight. Feature data. Shows the area around Berkeley, California, USA. It is provided courtesy of Terrex.
Ground	ground-db.mtf	UTM. OpenFlight. A generic relatively flat ground terrain.

Table 3-1: Terrain databases shipped with VR-Vantage (Sheet 2 of 4)

Database	Variation	Description
HarrisAfghan-Village	HarrisAfghanVillage-FlatEarthMetaFlight.mtf	Paged terrain using flat earth projection. A terrain of Afghanistan with a high resolution inset of a small village. This terrain was created in VR-Vantage from source data. The terrain data is provided courtesy of Harris, Inc.
	HarrisAfghanVillage-FlatEarth.mtf	A static terrain database of Afghanistan with a high resolution inset.
	HarrisAfghanVillageGdal.mtf	A streaming version of this terrain using local data.
	HarrisAfghanVillageGeocentricMetaFlight.mtf	Paged terrain using geocentric coordinates.
Kabul	Kabul.mtf	UTM. OpenFlight. The area around Kabul, Afghanistan.
Little Pond	LittlePond.mtf	Flat earth. DTED. Shape data. Imagery. A detailed suburban inset in a larger, less detailed terrain covering Boston, Massachusetts, U.S.A. and points west. This terrain was created in VR-Vantage using source data as described in "Composing a Terrain through the GUI," on page 5-2.
Makland	Makland.mtf	UTM. OpenFlight. A fictional terrain created by MÄK. It includes a variety of terrain and feature data, including underwater features. It is placed in the Indian Ocean.
	MaklandCgfTopoMap.mtf	A topographic map laid on top of the Makland terrain.
	MaklandLocalWorld.mtd	Geocentric. Low resolution local terrain.
	MaklandNoSpeedtrees.mtf	No SpeedTrees for improved performance.
Nellis	Nellis.mtf	UTM. An example of a SAF terrain suitable for simulation, but not typically used in 3D imaging. A terrain covering the area around the Nellis Air Force Base, in Nevada, U.S.A.
SanLuisObispo	SanLuisObispo.mtf	Flat earth. DTED. Imagery. A terrain that covers a portion of California, U.S.A.
	SanLuisObispoTopoGdal.mtf	Geocentric. San Luis Obispo in topographic coordinates as local streaming terrain using an earth file.

Table 3-1: Terrain databases shipped with VR-Vantage (Sheet 3 of 4)

Database	Variation	Description
TerraSim_SampleUrban	TerraSim_SampleUrban.mtf	UTM. An urban database based on Pittsburgh, Pennsylvania, U.S.A., with a highly detailed segment that includes feature data and buildings with multiple floors. It is provided courtesy of TerraSim.
	TerraSimSampleUrban-MetaFlight.mtf	A MetaFlight version of this terrain.
VR-TheWorldOnline	VR-TheWorldOnline.mtf	Lets you quickly connect to the publicly available VR-TheWorld Server for streaming terrain.
	VR-TheWorldOnline - MAK Earth.mtf	The base VR-TheWorld Online terrain plus a high resolution inset for Honolulu, Hawaii, USA and the surrounding area. Includes streaming feature data.
	VR-TheWorldOnline - MAK Earth - Base.mtf	The base VR-TheWorld Online terrain plus a high resolution inset for Honolulu, Hawaii, USA and the surrounding area. Does not include streaming feature data.
	VR-TheWorldOnline - Little Pond.mtf	Little Pond features inset into VR-TheWorld Online.
	VR-TheWorldOnline - Massachusetts S-57.mtf	VR-TheWorldOnline with S-57 data (as shapefiles) for Boston harbor.
	VR-TheWorldOnline - VR-Village Afghanistan.mtf	Geocentric. The high resolution data from *VR-Village.mtf* is inset in Afghanistan in VR-TheWorld online server.
	VR-TheWorld Online - Mak Earth - with point feature buildings.mtf	The Ala Moana, Hawaii inset has buildings defined by point features (in addition to the extruded buildings).
VR-Village	VR-Village.mtf	GDB. Feature data. OpenFlight terrain. VR-Village is a fictional database created by VT MÄK. It has a highly detailed small town in a larger, sparsely detailed desert environment. The town includes multi-level buildings, underground tunnels, and a road that tunnels through a mountain. The coordinates place it off the west coast of Africa.
	VR-VillageNoSpeedTrees.mtf	VR-Village with no SpeedTrees for improved performance.

Table 3-1: Terrain databases shipped with VR-Vantage (Sheet 4 of 4)

Database	Variation	Description
World	WorldFlatEarthNoElevation.mtf	Flat earth. Low resolution projected image of the world.
	WorldGeocentric.mtf	Geocentric. Low resolution projection of the world.

4. Streaming Data Using Earth Files

This chapter provides an introduction to the syntax of Earth files and explains how to configure them to stream various types of terrain and feature data.

4.1. 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-Vantage.

4.2. 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 4-1 describes the XML elements in the file and their attributes.

Table 4-1: 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 "Earth File Options," on page 4-10.

4.3. Loading Multiple DTED Files

You can load multiple DTED files from an earth file. To do so, in the `heightfield` element, specify a directory instead of a specific file, for example (from *SanLuisObispo-Topo.earth*):

```
<heightfield name="SanLuisObispo Elevation" driver = "gdal">
  <url>../../data/Terrain/SanLuisObispo/Elevation</url>
  <extensions>dt0;dt1;dt2</extensions>
  ...
</heightfield>
```

The `extensions` element lets you specify which files to load based on their file extensions. If you do not include an extensions list, the GDAL driver tries to load every file in the directory.

4.4. Adding Feature Layers to an Earth File

You can add the following types of features to a terrain:

- Point features, such as trees, buoys, and buildings.
- Linear features, such as roads and waterways.
- Areal features, such as forests (areal trees), bodies of water, and extruded buildings.

You can add the XML for feature layers to an earth file.

Features layers are added to an earth file using the `model` element. Table 4-2 describes the `model` element, its attributes, and sub-elements.

Table 4-2: `model` element attributes

Element	Attribute	Description
model		Base element for specifying a feature layer.
	name	Name of the layer. This can be any text.
	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.		
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. This element is mandatory.
library		A texture library.
	name	Name of the texture library.
	url	The location of the library.

Table 4-2: `model` element attributes

Element	Attribute	Description
style		A specific style. The name, which precedes the curly brace ({) can be any text you want. For information about the attributes that you can specify in a style, please see http://docs.osgearth.org/en/latest/references/symbology.html.
lighting		Specifies whether or not to enable lighting. Usually true.

When you load a file using the OGR driver, OGR decides what the layer names will be. For shapefiles it is always the name of the file (minus the extension). Other files (like S-57) can have multiple layers, and the names are decided by a format-specific algorithm. For example, an S-57 file has an enumerated list of layer names.

4.4.1. Configuring Point Features

Point features, such as trees, use the `model` element. The following code, from *VR-theWorld Online - MAK Earth.earth*, adds point trees:

```
<model name="Alamoana point trees" driver="feature_custom">

   <!-- streaming point trees -->

   <features name="Vegetation" driver="ogr">

  <url>../../data/Terrain/Hawaii/Features/AlaMoanaVegetationP.shp</url>
     <typename>5</typename>
   </features>
   <layout>
     <tile_size_factor>3</tile_size_factor>
   </layout>

   <styles>
     <style type="text/css">
       Vegetation {
       marker:              "Trees" + [veg] + "ST" ;
       marker-scale:        1;
       marker-placement: vertex;
       altitude-clamping:   terrain;
       altitude-resolution: 0.00008583068847656250;
       altitude-offset:     0;
       }

     </style>
   </styles>
   <clustering>True</clustering>
   <lighting>true</lighting>
```

```
</model>
```

4.4.2. Configuring Linear Features

Linear features, such as roads, rivers, or railways, use the `model` element. The following code, from *VR-theWorld Online - MAK Earth.earth*, configures roads:

```
<model name="Oahu_Roads" driver="feature_geom" overlay="true"
 enabled="false">

  <features name="Roads" driver="wfs">
    <url>http://vr-theworld.com/vr-theworld/features/wfs</url>
    <typename>55</typename>
  </features>

  <!-- Sets the name property on each geometry to the value of the
 "name" attribute -->
  <feature_name>[name]</feature_name>

  <!-- Appearance details -->
  <style type="text/css">
    Oahu_Roads {
    stroke: #ff0000;
    stroke-width: 10.0;
    altitude-offset: 10;
    }
  </style>

</model>
```

4.5. Using Cut-in Sites for High Resolution Insets

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 should cut out the relevant areas of terrain provided by the server and add your high resolution terrain to the cut out area. For example, the VR-Vantage terrain *VR-theWorld Online - MAK Earth.mtf* has two terrain patches, *VR-theWorld Online - MAK Earth.earth*, which provides the base terrain from VR-theWorld Server, and *./data/Terrain/Hawaii/Geometry/OpenFlightAlaMoana/AlaMoanaModified-GeocentricProxy.osg*, which is a locally stored high resolution inset.

The `mask` element lets you cover the base terrain data with your hand-modeled data. A mask element in an 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>
```

VR-Vantage includes a tool, the osgEarth Boundary Generation Tool, that can calculate the geometry of an OpenFlight file. 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.

Table 4-3 describes the `mask` element and its sub-elements.

Table 4-3: `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.

4.5.1. Using the Boundary Generation Tool

The Boundary Generation 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 Generation Tool against an OpenFlight file.
2. Insert the output of the of the boundary generation tool in a `mask` element in your earth file. (For details about `mask` elements, please see "Using Cut-in Sites for High Resolution Insets," on page 4-7.)
3. Load the terrain.
4. Add the FLT file as a terrain patch.
5. Save the terrain.

Running the Boundary Generation Tool

The output from the Boundary Generation Tool tool, in *boundary.txt* or the output file you specify, 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.

To run the boundary generation tool:

1. Open a console window.
2. Change directory to *./bin64*.
3. Run the tool:

   ```
   osgearth_boundarygen [--out file_name --no-geocentric
     --convex_hull --verbose --view --precision precision --
     tolerance tolerance] model_file
   ```

   Table 4-4 describes the options.

Table 4-4: osgEarth Boundary Generation Tool command-line options

Option	Description
`--convex_hull`	Calculate a convex hull instead of a full boundary.
`model_file`	The input model file.
`--no-geocentric`	Skips geocentric reprojection. Use for flat databases.

Table 4-4: osgEarth Boundary Generation Tool command-line options

Option	Description
`--out` *`file_name`*	Specifies the output file for boundary geometry. Default: *boundary.txt*
`--precision` *`precision`*	Specifies the number of significant digits in the output coordinates. Default: 12
`--tolerance` *`tolerance`*	Specifies the tolerance for combining similar vertices along a boundary. Default: 0.005.
`--verbose`	Prints progress messages to the console.
`--view`	Show the result in a 3D window.

4.6. 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 areal 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.

The following code (from *VR-theWorld Online - MAK Earth.earth*) adds extruded buildings to the terrain:

```
<!-- Extruded buildings Oahu -->
<model name="buildings" driver="feature_geom">

  <!-- Streamed buildings -->
  <features name="buildings" driver="wfs">
    <url>http://vr-theworld.com/vr-theworld/features/wfs</url>
    <typename>65</typename>
  </features>

  <layout>
    <tile_size_factor>3</tile_size_factor>
  </layout>

  <styles>
    <library name="us_resources">
      <url>http://vr-theworld.com/vr-
theworld/filemanager/download/public/Library/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;
        altitude-resolution: 0.0001;
      }
      building-wall {
```

```
            skin-library: us_resources;
            skin-tags:    building;
            skin-random-seed: 1;
            fill:         #ffffff;
          }
          building-rooftop {
            skin-library: us_resources;
            skin-tags:    rooftop;
            skin-tiled:   true;
            skin-random-seed: 1;
            fill:         #ffffff;
          }
        </style>
      </styles>
      <lighting>true</lighting>
      <cluster_culling>false</cluster_culling>

    </model>
```

For descriptions of the elements in a model block, please see Table 4-2.

4.7. Earth File Options

An earth file can have `option` elements that affect the entire map. Table 4-5 describes the option elements.

Table 4-5: `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.

4.8. Streaming Buoys and Beacons

VR-Vantage can display models of buoys and beacons specified in shapefiles and S-57 data and streamed in using earth files. VR-Vantage can map the S-57 data to buoy models in either of the following ways:

- Include style information for buoy color and numbering.
- Use a texture atlas to choose the correct color and numbering.

4.8.1. Specifying Model Definitions for Streamed Buoys

Streamed features (including buoys) are organized into layers. In the *.earth* file, the names in the **styles** block specify the layer the streamed features will belong to. By default, VR-Vantage defines seven layers for buoys. They correspond to the different buoy layers in an S-57 file. These layers are named LateralBuoys, SafeWaterBuoys, ISDBuoys, RegulatoryBuoys, InstallationBuoys, CardinalBuoys, and SpecialPurpose-Buoys.

The names are specified in *./appData/importConfig/s57_layer_list.csv*. (This file also specifies beacon styles.) The first value in the list is a name used to identify the remaining styles as a group and specify defaults. The names following the first are all style names specified in the *.earth* file used to stream the feature. You can add, remove, or change the names of these layers to anything you like - they just need to match the style name. The style block within an osgEarth model block should have one of these names for streamed buoys.

Any number of model blocks with the same layer name can exist. *VRTW - Massachusetts S-57 buoys.earth* has three model blocks using each of the six layer names for a total of eighteen model blocks, one for each layer for each of the three different S-57 files referenced.

The following is an example of a **style** block for a buoy (Special Purpose Buoys):

```
<model name="buoys" driver="feature_custom">
  <features name="Special Purpose Buoys" driver="ogr">
   ...
  </features>
  <layout>
   ...
  </layout>
  <styles>
    <style type="text/css">
        <!-- | | | This is the layer name -->
        <!-- v v v                        -->
      SpecialPurposeBuoys {
      ......
      }
    </style>
  </styles>
```

Model Definitions

Within each style block, you can specify the model definition for a streamed buoy by specifying a model definition or by building a model definition.

Specifying a Model Definition for a Buoy

To specify the model definition directly, you specify it as the marker name:

```
<styles>
   <style type="text/css">
    SpecialPurposeBuoys {
    marker:              "BuoysSpecialPurpose" ;
    ...
```

In this case, the model definition "BuoysSpecialPurpose" is used for all buoys streamed in for that SpecialPurposeBuoys layer.

Building a Model Definition for a Buoy

Instead of specifying a model definition, you can build a model definition using the buoy's attributes. Buoy attributes can be strings or enumerated values (such as shape (BOYSHP), color (COLOUR), and COLPATcolor pattern (COLPAT)).

The following code results in model definitions like "Buoys352". This method provides a mechanism to specify a string to be substituted for each enumerated value for each attribute type that uses enumerations.

```
<styles>
  <style type="text/css">
    SpecialPurpose {
    marker: "Buoys" + [BOYSHP] + [COLOUR] + [COLPAT];
```

The enumerated value-to-string mappings are in the file *./appData/importConfig/s57_attr_map.csv*. You can change them to any strings that you want to use. Given this information, you can specify your model definition as a pattern and provide the enumerated attribute values. VR-Vantage uses them to decode and build the requested model definition. The pattern and attribute values are specified as a colon (:)-separated list of the following form:

```
"pattern:Attribute1=value:Attribute2=value" ...
```

The pattern itself indicates where attribute values should be replaced using '[Attribute]' substrings. For example, consider an input string such as:

```
"Buoys[COLOUR][BOYSHP]:COLOUR=5:BOYSHP=3"
```

The default mappings for COLOUR and BOYSHP in *s57_attr_map.csv* are as follows:

```
BOYSHP,,Nun,Can,Spherical,Pillar,Spar,Barrel,Super,Ice
COLOUR,,White,Black,Red,Green,Blue,Yellow,Grey,Brown,Amber,Violet,Orange
  ,Magenta,Pink
COLPAT,,HorizontalStriped,VerticalStriped,DiagonalStriped,Squared,Stripe
  d,BorderStriped
```

Therefore, the model definition would be BuoysBlueSpherical, since the enumerated COLOUR value '5' (the fifth value in the list) is mapped to "Blue", and the BOYSHP value '3' is mapped to "Spherical". Some of these attributes, such as COLOUR, may be lists of enumerated values. The strings for enumerated lists are simply concatenated. The following input string:

```
"Buoys[BOYSHP][COLOUR][COLPAT]:COLOUR=3,1:BOYSHP=2:COLPAT=2
```

results in the model definition "BuoysCanRedWhiteVerticalStriped".

To generate the input string like the one above from a *.earth* file, you would use:

```
marker: "Buoys[BOYSHP][COLOUR][COLPAT]"
            + ":COLOUR=" + [COLOUR]
            + ":BOYSHP=" + [BOYSHP]
            + ":COLPAT=" + [COLPAT]
```

The order that the actual attribute/value pairs are encoded (after the pattern) does not matter.

Designators

Many buoys have some form of one to three number and/or letter symbols that appear on the buoy itself. S-57 does not provide an attribute that indicates what this symbol is, but it is usually found at the end of the OBJNAM attribute, such as "Boston South Channel Buoy 13" or "President Roads Junction Lighted Buoy PR". If the OBJNAM attribute is provided, the model definition builder tries to extract this symbol. It must be 3 characters or less, and be all numerics, all capital letters, or a mix of the them. You can add this to a model definition pattern using the [DESIGNATOR] substring, for example:

```
marker: "Buoys[BOYSHP][COLOUR][COLPAT][DESIGNATOR]"
+ ":COLOUR=" + [COLOUR]
+ ":BOYSHP=" + [BOYSHP]
+ ":COLPAT=" + [COLPAT]
+ ":OBJNAM=" + [OBJNAM]
```

This code, when streaming in "Boston South Channel Buoy 13", would result in a model definition of "BuoysCanGreen13", since the BOYSHP attribute for that buoy maps to "Can" and COLOUR attribute to "Green".

Unique Buoys

There may be cases where you want to use a specific model definition for a particular buoy. The buoy might be a special landmark that needs to be recognizable. The file *appData/importConfig/s57_modeldef_by_name_map.csv* contains a list of buoy names (the OBJNAM attribute) and model definition pairs. If the OBJNAM attribute value is provided in the marker string and if it matches one of the buoy names in *s57_modeldef_by_name_map.csv*, then the specified model definition is used instead of a generated definition.

4.8.2. Configuring Streaming Beacons

You can specify beacon feature styles the same way you specify buoys. You can add any number of beacon styles names. They are configured in *s57_layer_list.csv*.

The following code is an example of a beacon model block:

```
<model name="beacons" driver="feature_custom" enabled="true">
  <features name="Lateral Beacons" driver="ogr">
    <!-- From S-57 data -->
    <ogr_driver>S57</ogr_driver>

    <url>../../data/Terrain/Massachusetts/Features/US5MA10M.000</url>
    <layer>BCNLAT</layer>
  </features>
  <layout>
    <tile_size_factor>3</tile_size_factor>
  </layout>
  <styles>
    <style type="text/css">
      LateralBeacons {
      marker:
      "Beacons[COLOUR][COLPAT][BCNSHP][DESIGNATOR]"
          + ":BCNSHP=" + [BCNSHP]
          + ":COLOUR=" + [COLOUR]
          + ":COLPAT=" + [COLPAT]
          + ":OBJNAM=" + [OBJNAM] ;
          marker-scale:        1;
          marker-placement: vertex;
          altitude-clamping:   terrain;
          altitude-resolution: 0.00008583068847656250;
          altitude-offset:     0;
      }
    </style>
  </styles>
</model>
```

Model definitions for beacons work the same way as for buoys. They are configured in *s57_attr_map.csv*. It can contain enumeration mappings for any enumerated S-57 attribute that you want to use to create model definitions. Default values are in *s57_defaults.csv*. This contains the default name and default model definition for each style group specified in *s57_layer_list.csv*. The delivered *s57_defaults.csv* contains:

```
# If the final model definition generated does not exist, one of these
  model definitions will be used
Buoys,DefaultModelDefinition,BuoysGreenPillar1
Beacons,DefaultModelDefinition,BuoysRedPillar2

# If the feature has no name, use one of these
Buoys,DefaultName,Unnamed Buoy
Beacons,DefaultName,Unnamed Beacon
```

4.8.3. Configuring Streamed Navigation Lights

Navigation lights are managed somewhat differently from other streamed features. These lights do not result in actual objects added to the scene. The information is used to create and attach light controllers to existing objects. The lights themselves need to already exist as part of the buoy or beacon model they appear on.

Each model that has a light should have a comment-tagged switch for choosing a light group of the specified color. Each light in turn has a switch for turning the light itself on or off. We use the tag `@dis light_color` to tag a color switch, with values 0-3 corresponding to white, green, red, and yellow. The switch to turn lights off and on is `@dis navigation_lights`.

VR-Vantage streams in light data using model blocks similar to those used for buoys and beacons. Again, style names can be applied and *light_layer_list.csv* controls which styles will be read. *VRTW - Massachusetts S-57 buoys.earth* uses a single style name for all lights, **NavigationLights**. An example light model block is shown below:

```
<model name="lights" driver="feature_custom"  enabled="true">
  <features name="Navigation Lights" driver="ogr">
    <!-- From S-57 data -->
    <ogr_driver>S57</ogr_driver>

    <url>../../data/Terrain/Massachusetts/Features/US5MA10M.000</url>
    <layer>LIGHTS</layer>
  </features>
  <layout>
    <tile_size_factor>3</tile_size_factor>
  </layout>
  <styles>
    <style type="text/css">
      NavigationLights {
        marker: "COLOUR=" + [COLOUR] + ":SIGSEQ=" + [SIGSEQ] +
":EXCLIT=" + [EXCLIT];
        marker-scale:        1;
        marker-placement: vertex;
        altitude-clamping:   terrain;
        altitude-resolution: 0.00008583068847656250;
        altitude-offset:     0;
      }
    </style>
  </styles>
</model>
```

Since we are not building model definitions, we do not need to map enumerated values to strings. However, we do map S-57 light colors to the 4 colors that we currently support. This mapping is in *light_attr_map.csv*. VR-Vantage associates light controllers with other streamed features based on the S-57 or shape file locations of the lights and features, as folows:

- If the COLOUR attribute is provided, the attached light controller sets the light color using the light color switch.
- If the SIGSEQ attribute is provided, the light will be turned on and off according to the specified sequence.
- If the EXCLIT attribute is provided, the light controller enables or disables the light based on daylight and fog conditions.

The light color switch and light switch values can be changed by specifying different ones through the API, specifically using:

```
de.scene().terrain().navigationLightManager().
    setLightColorSwitchNumber()
```

and

```
de.scene().terrain().navigationLightManager().setLightSwitchNumber()
```

4.8.4. Configuring Seasonal Buoys and Beacons

Seasonal buoys and beacons are supported. Include the PERSTA/PEREND attributes in the *.earth* file as part of the marker field, and buoys and beacons will only appear during the correct season. Example:

```
marker: "Buoys[COLOUR][COLPAT][BOYSHP][DESIGNATOR]"
  + ":BOYSHP=" + [BOYSHP]
  + ":COLOUR=" + [COLOUR]
  + ":COLPAT=" + [COLPAT]
  + ":PERSTA=" + [PERSTA]
  + ":PEREND=" + [PEREND]
  + ":OBJNAM=" + [OBJNAM] ;
```

4.8.5. Streaming Daymarks

VR-Vantage supports streamed daymarks for buoys. A limited number of daymark models and textures are provided as examples. *VRTW - Massachusetts S-57 buoys.earth* has a model statement to stream daymarks from the Boston Harbor S-57 data. As with buoys and beacons, the model entry specifies a style name (in these examples, 'Daymarks', which correspond to layers specified in the *daymark_layer_list.csv* and OSGEarth models that use the feature_custom driver. They have a style name that is found in the layer list file will be processed as daymarks. S-57 attribute values can be mapped using the *daymark_attr_map.csv* file.

Our beacon models contain multiple daymark placard shapes (Diamond, Square, and Triangle), which are switch-selected based on the TOPSHP attribute. The TOPSHP attribute is mapped to '0', '1', or '2', which are the switch values for the diamond, square, or triangle shaped marks. Other attribute values, including TOPSHP, COLOUR, COLPAT, and CATSPM are used to look up UV coordinates in the model's texture atlas. The mappings are found in *./data/Objects/Beacons/daymark.dtxc*. These daymark shapes, plus textures provided, represent all the daymarks attached to beacons in Boston Harbor.

4.8.6. Generating Signal Sequences

The S-57 attribute SIGSEQ (signal sequence) specifies the flashing sequence that a navigational aid light on a buoy or beacon displays. These sequences (along with color) are used to distinguish among different buoys and beacons at night. However, this is not a required S-57 attribute. If the SIGSEQ attribute is not present, VR-Vantage tries to generate a signal sequence using the LITCHR (light characteristic), SIGPER (signal period) and SIGGRP (signal group) attributes for the most commonly seen sequences.

As part of the class responsible for generating these sequences, the VR-Vantage API includes a virtual function for each sequence type that is not implemented, so that a developer can implement it. The assumption is that not many of the other sequence types will be used, but it is data-specific. Once we know what sequences are needed for the S-57 data in use, it should be relatively straight-forward to implement those additional sequence generation methods.

The class used to generate signal sequences is *DtLightSignalSequenceGenerator*, in the vrvCore library. *DtLightSignalSequenceGenerator.h* provides documentation, including which methods are implemented and which are not. To extend this class, a creator is provided, *DtLightSignalSequenceGeneratorCreator*, an extended instance of which can be registered through a plug-in with the display engine.

5. 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 chapter contains tutorials that demonstrate how to combine various procedures to create terrains and how to create a local terrain server.

5.1. Composing a Terrain through the GUI

This tutorial shows how to compose a terrain by combining elevation data, imagery, and feature data in the VR-Vantage GUI. It recreates a portion of the LittlePond terrain that is included with VR-Vantage. 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 Little-Pond terrain provided with VR-Vantage. If you want to completely recreate the LittlePond terrain, you will have to continue to add props on your own.
- To see a set of brief videos that illustrate this tutorial, on the Start menu, choose **VR-Vantage 2.0** → **Documentation** → **VR-Vantage Video Tutorials**, or open *./doc/vrvantage_tutorialvideos.htm*.

The basic steps for composing a terrain are:

1. Add elevation data (a terrain patch) ("Add Elevation Data (Add a Terrain Patch)," on page 5-3).
2. Add imagery ("Add Imagery," on page 5-4).
3. Add a feature layer ("Add a Feature Layer," on page 5-8).
4. Add props ("Add Props," on page 5-9).

5.1.1. 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. Choose **File** → **New Scene**. This results in an empty window (Figure 5-1).

Figure 5-1. No terrain loaded

2. Choose **File** → **Add Terrain Patch**. The Add Terrain Patch dialog box opens and an Open dialog box opens on top of it.
3. In the Open dialog box, navigate to *./data/Terrain/LittlePond/elevation*.
4. Select *w072n042.dt1*.
5. Click Open. Information about this terrain patch is displayed in the Add Terrain Patch dialog box (Figure 5-2).

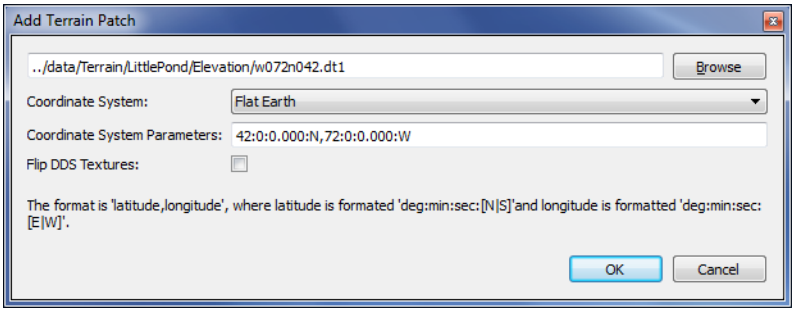


Figure 5-2. Add Terrain Patch

6. Click OK. The terrain is added to the scene (Figure 5-3).

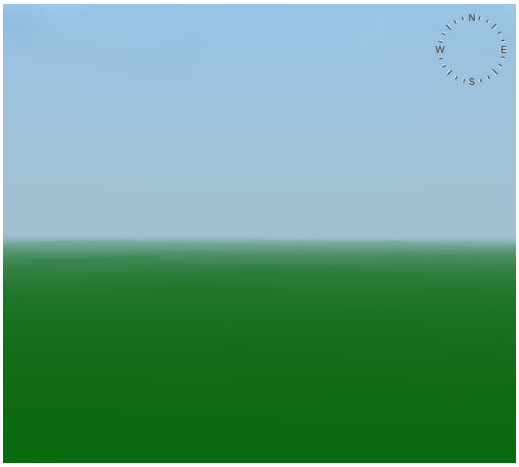


Figure 5-3. Terrain patch added

5.1.2. 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 5-4). However, this still does not provide the rich 3D environment you expect to see in a product like VR-Vantage. Now we will add image data.

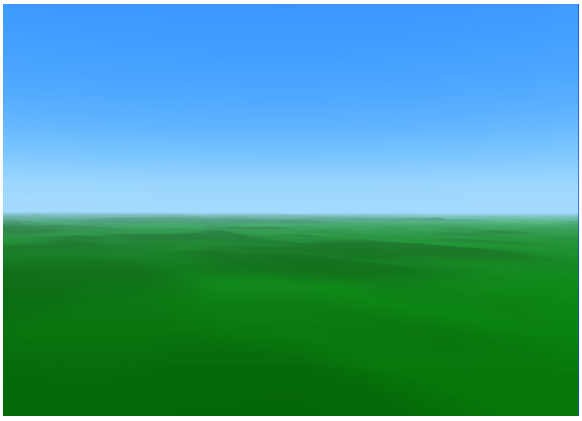


Figure 5-4. Elevation coloring

To add image data:

1. Choose **Settings** → **Terrain**. The Terrain Settings dialog box opens.
2. Select the Raster Maps page (Figure 5-5).

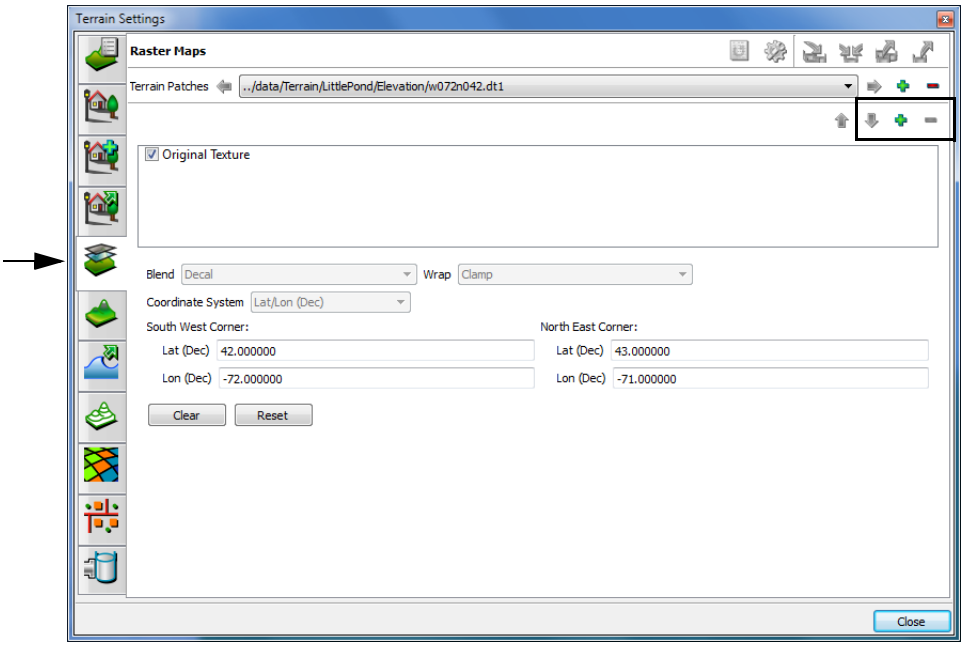


Figure 5-5. Raster Maps page

3. Clear the Original Texture check box. (If you leave this selected, the terrain will be green.)
4. Click the Add button (+) that is at the upper right of the list window (Figure 5-5). A line labeled Image 1 is added to the list in the window (Figure 5-6).

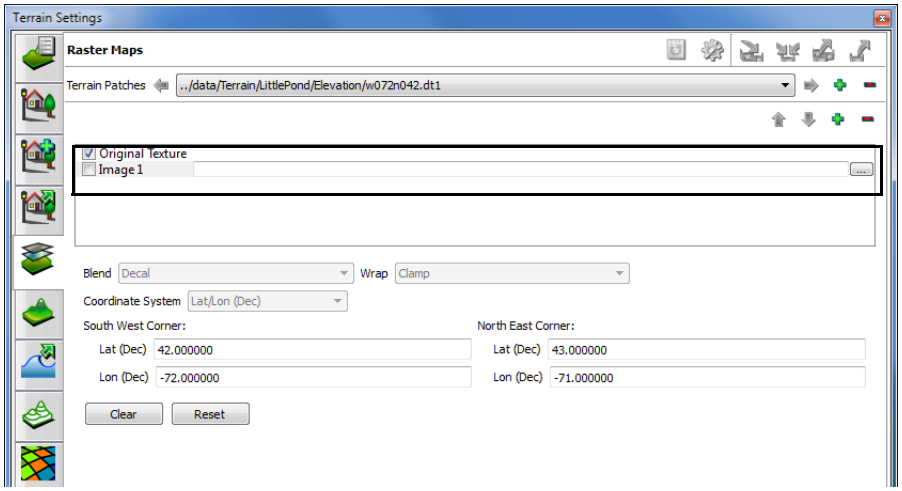


Figure 5-6. New image

5. Click the Browse button at the right end of the image entry. The Image File dialog box opens.

6. In the Image File dialog box, navigate to *./data/Terrain/LittlePond/imagery*.
7. Select *W72N42.tif*.
8. 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 5-7).

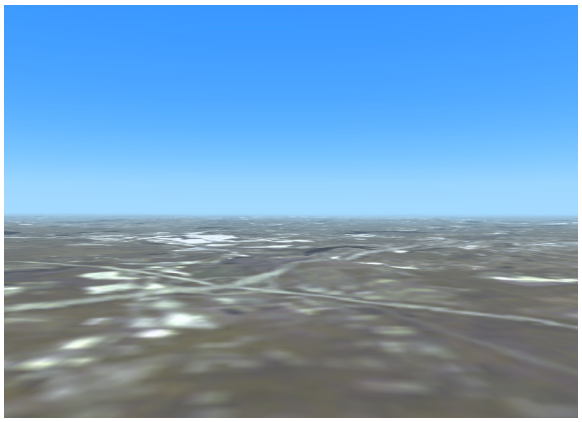


Figure 5-7. Low resolution image

9. Add another image. This time, select *LittlePond.tif*.
10. Select the check box for the *LittlePond.tif* image (Figure 5-8). A high resolution image is added to the Little Pond Area of the terrain (Figure 5-9). (The high resolution image might be hard to find. The next section explains how to find it quickly.)

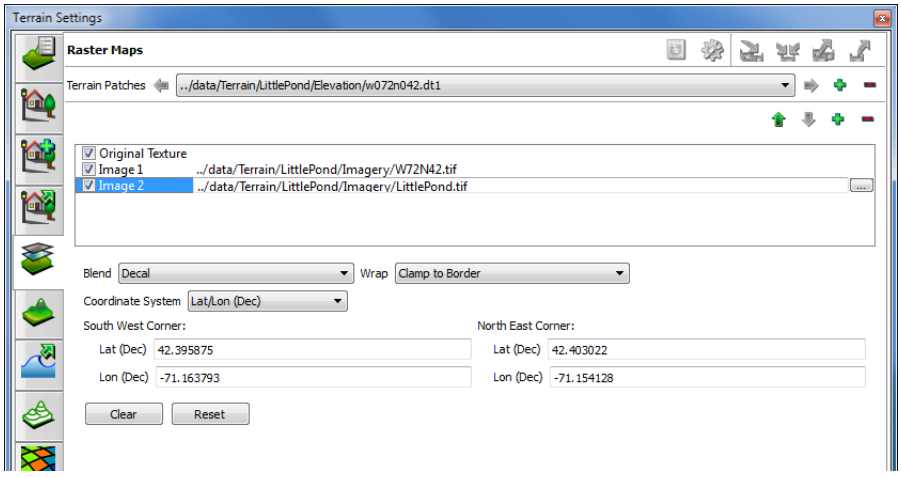


Figure 5-8. Raster Maps page with both images added

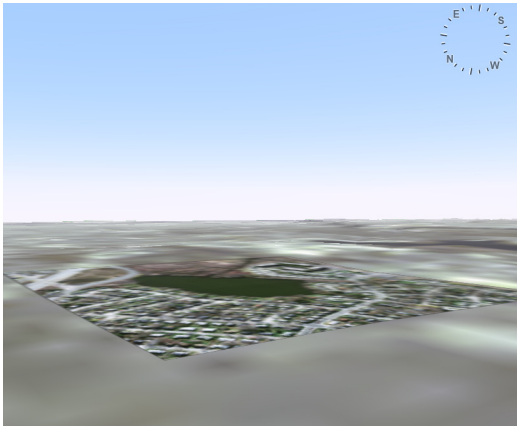


Figure 5-9. Little Pond image

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 5-9.

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.

5.1.3. 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 5-10).

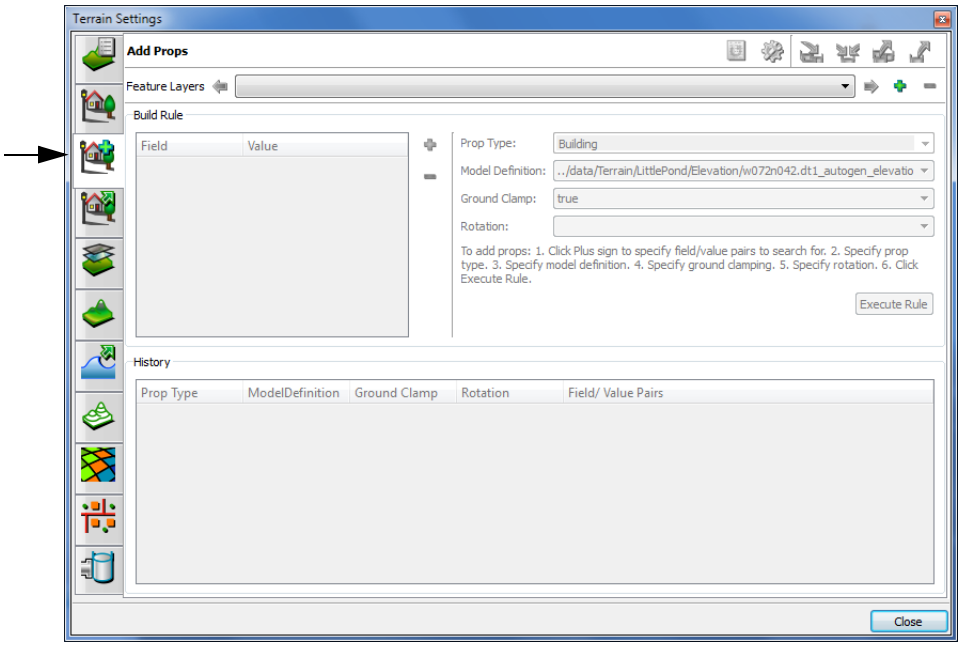


Figure 5-10. Add Props page

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.

5.1.4. Add Props

When you add a prop, VR-Vantage extracts data from a feature layer and maps it to a model definition. You have to tell VR-Vantage 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 5-11). The Build Field/Value Pair dialog box opens.

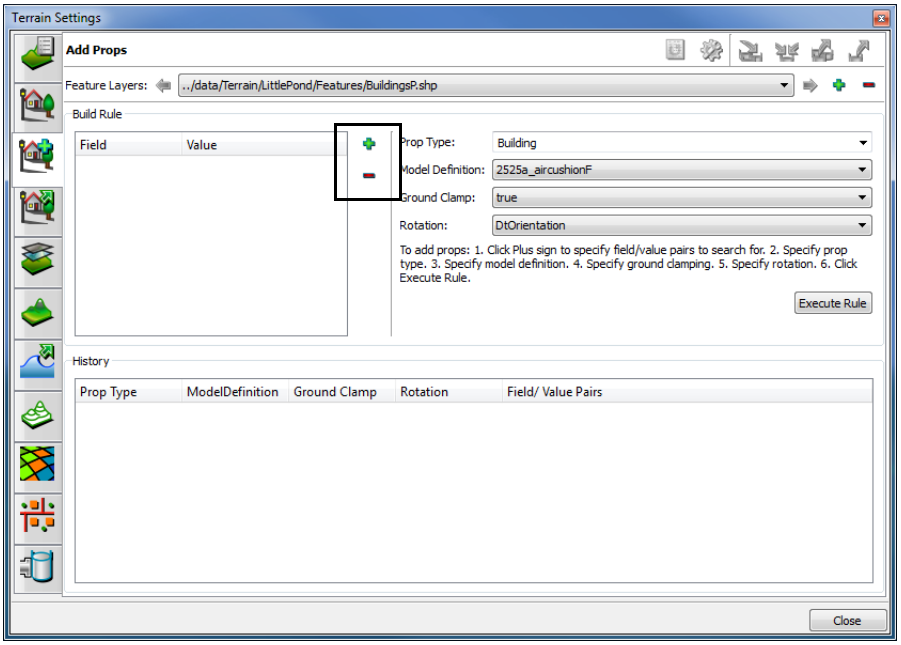


Figure 5-11. Add build rule

2. In the Field list, select TYPE.
3. In the Value list, select HousesColonialGarrison (Figure 5-12).

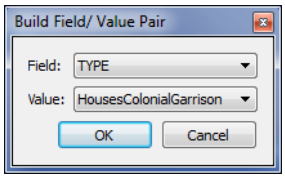


Figure 5-12. Build Field/Value Pair dialog box

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 HousesColonialGarrisonClapboardGreen.
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 5-13.

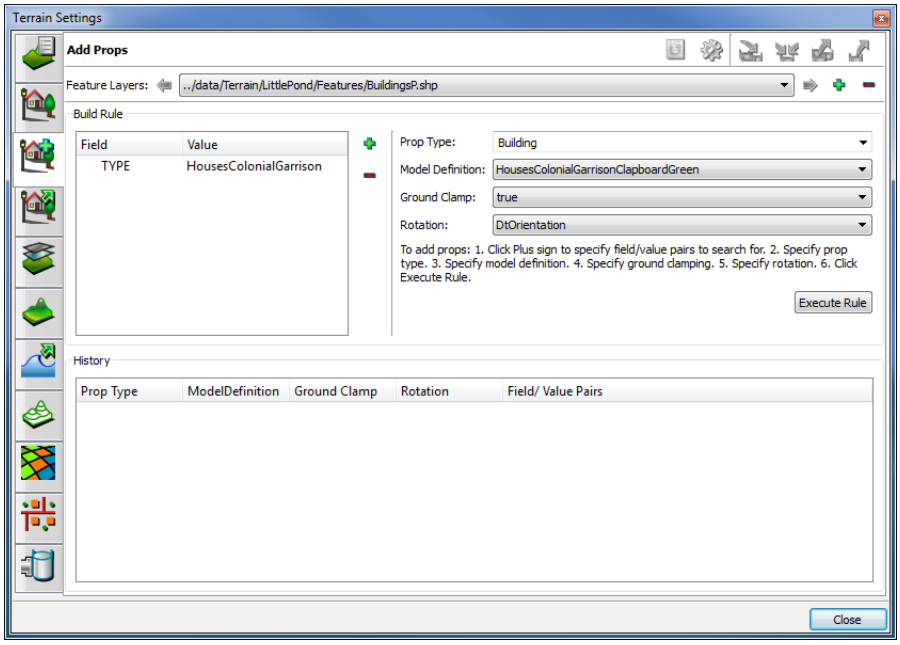


Figure 5-13. Completed rule

9. Click Execute Rule. The rule is executed. The Add Props page is updated (Figure 5-14) and houses are added to the terrain. Zoom in for a better look at them (Figure 5-15). (You might need to close the Terrain Settings dialog box or move it out of the way to see the terrain.)

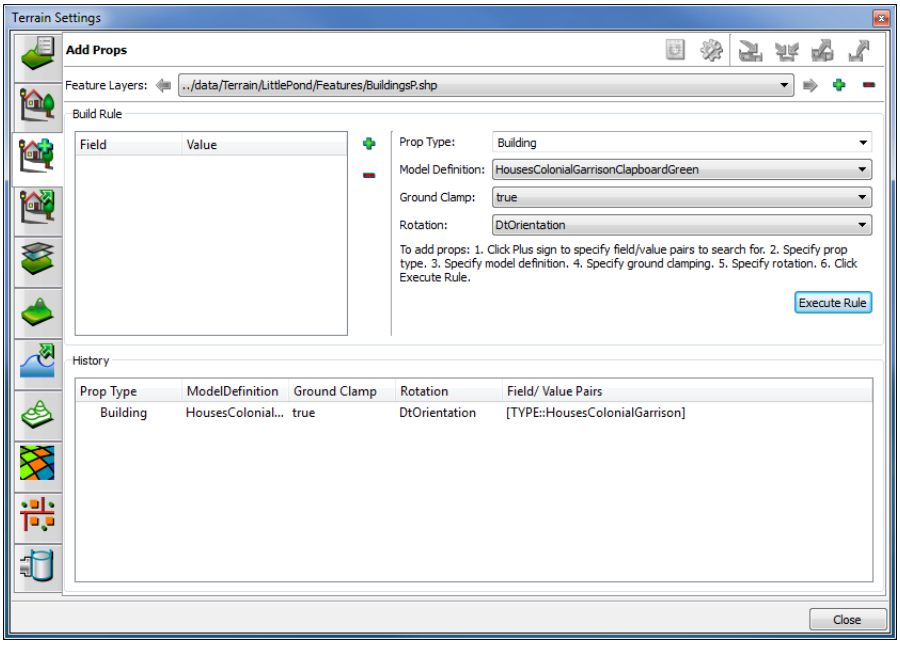


Figure 5-14. Build rule implemented

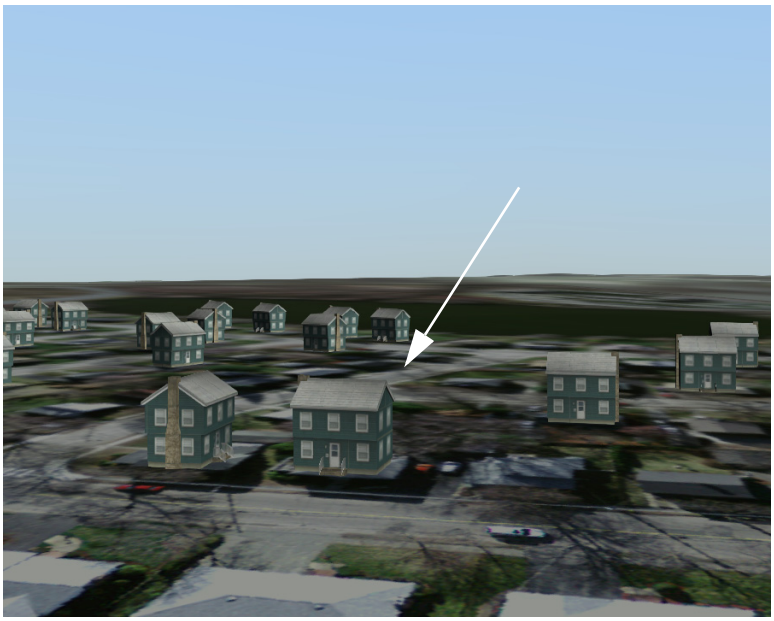


Figure 5-15. Props added to terrain

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 5-16.

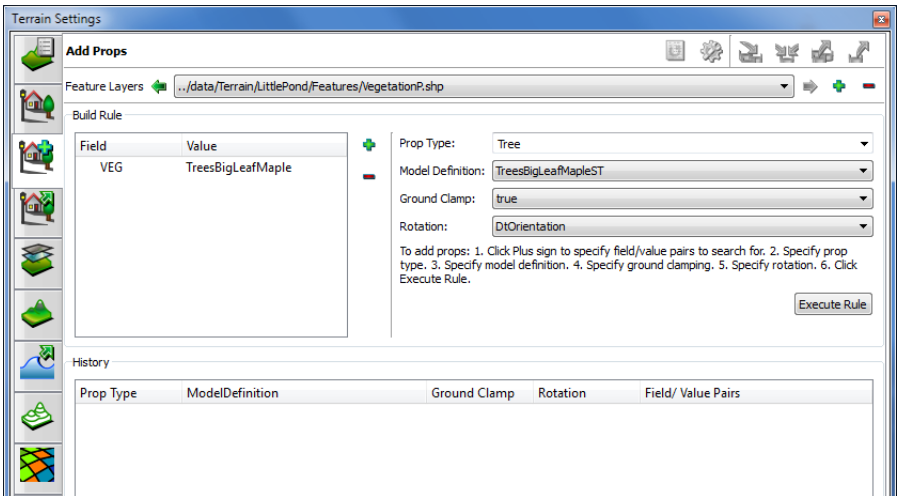


Figure 5-16. Rule for big leaf maples

12. Click Execute Rule. The page is updated and trees are added to the terrain (Figure 5-17).

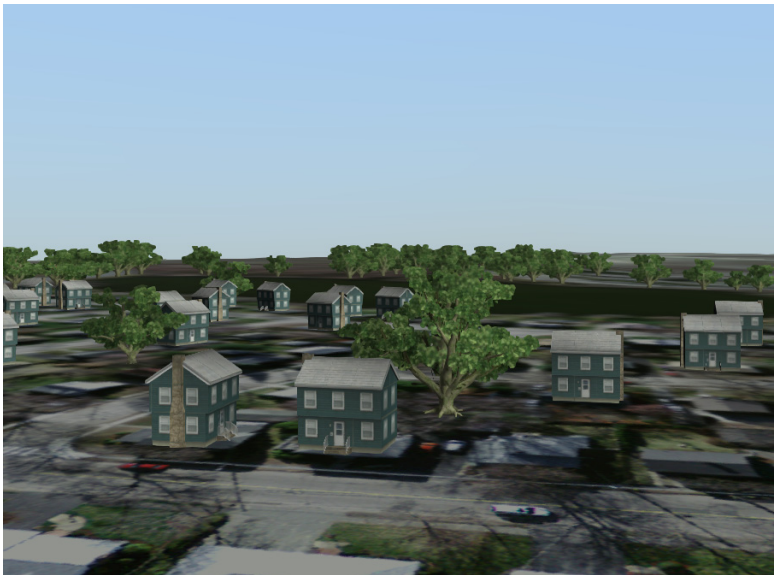


Figure 5-17. Little Pond with maples

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.

5.2. Creating a Terrain with an Earth File

In "Composing a Terrain through the GUI," on page 5-2, we showed you how to compose a terrain by adding various terrain components in the VR-Vantage GUI and saving the resulting terrain as an MTF file. Another way to load terrain into VR-Vantage is by using a terrain server. Terrain servers are configured in earth files, which are XML files using osgEarth syntax. All the information that VR-Vantage needs to load elevation, imagery, and feature data is provided. The data can be stored locally or elsewhere on a network or the internet. Data is streamed over the network and paged in as needed.

In this tutorial we use the same local data we used for the Little Pond terrain in the previous tutorial, except that instead of adding the data through the GUI, we create an earth file to load it.

VR-Vantage comes with a terrain *VR-theWorld Online - Little Pond.earth* that merges the local Little Pond data with streaming terrain from VR-theWorld Server. For this tutorial we will ignore the rest of the world and focus on Little Pond.

One approach to creating an earth file is to start with one of the earth files provided with VR-Vantage, keep the basic structure, and add, edit, or replace elements as needed. For this tutorial, we will start from an empty file and build all the major elements.

5.2.1. Add a Map Element and Some Basic Options

The root element in an earth file is the `map` element. It encloses all other elements. Open a text editor and add the following code. It is the map element and some basic options that we use in most of our earth files. In particular, it specifies a location for the cache:

```
<map name="Little Pond" type="geocentric" version="2">

  <options>
    <lighting>true</lighting>
    <elevation_interpolation>triangulate</elevation_interpolation>
    <terrain>
      <min_tile_range_factor>3</min_tile_range_factor>
      <skirt_ratio>0.1</skirt_ratio>
    </terrain>
    <cache type="filesystem">
      <path>../../appData/cache</path>
    </cache>
  </options>
</map>
```

5.2.2. Add Elevation Data to the Earth File

Elevation data is configured using an `elevation` element. We want to specify the same elevation data here that we did in the previous Little Pond tutorial. Add the following text after the `map` element, but before the `options` element:

```
<elevation name="Little Pond Elevation" driver = "gdal">
  <url>../../data/Terrain/LittlePond/Elevation/w072n042.dt1</url>
  <tile_size>32</tile_size>
</elevation>
```

The location of data in an earth file is provided in a `url` element. We need to use the gdal driver to load elevation data.

5.2.3. Add Imagery to the Earth File

Image data is configured using `image` elements. Add the following text after the `elevation` block:

```
<image driver="composite">
  <image name="Little Pond Imagery" driver="gdal">
    <url>../../data/Terrain/LittlePond/Imagery/W72N42.tif</url>
  </image>

  <image name="Little Pond Imagery" driver="gdal">
    <url>../../data/Terrain/LittlePond/Imagery/LittlePond.tif</url>
  </image>
</image>
```

The Little Pond terrain has two image files, a large low-resolution image and a smaller higher resolution image. If we were to simply add two `image` elements to the earth file, only the last one listed would be loaded. We would only see one of the images.

To use more than one image, we place an `image` element for each image file inside an `image` element that uses a composite driver. List the images from bottom most to topmost. If you list them in the opposite order from the code, *LittlePond.tif* would be underneath *W72N42.tif* and you would not be able to see it.

We use the gdal driver to load the images.

5.2.4. Add Feature Data to the Earth File

In earth files, you add feature data, such as buildings and vegetation, using a `model` element. You can add as many `model` elements as you need. A `model` element specifies the location of a shapefile. Then it adds `style` elements for each feature type to add from the shapefile. In the previous Little Pond tutorial, we added feature layers using *BuildingsP.shp* and *VegetationP.shp*. Then we added one kind of building (green colonial garrison house) and one kind of plant (big leaf maple tree). In this tutorial we will add one kind of house and all of the vegetation in the shapefile.

Add a Building to the Earth File

Add the following code to your earth file after the `image` block:

```
<model name="Little Pond Buildings" driver="feature_geom">
  <features name="Buildings" driver="ogr">
    <url>../../data/Terrain/LittlePond/Features/BuildingsP.shp</url>
  </features>
  <layout>
    <tile_size_factor>3</tile_size_factor>
  </layout>
  <styles>
    <style type="text/css">
    HousesColonialGarrison {
    model:
  "../../data/Structures/HousesColonialGarrisonClapboardGreen.medf";
    model-heading:       0-[rotation];
    model-scale:        1;
    model-placement: vertex;
    altitude-clamping:   terrain;
    altitude-resolution: 0.00008583068847656250;
    altitude-offset:     0;
    }
    </style>
    ...
    <selector class="HousesColonialGarrison">
      <query>
        <expr>TYPE = 'HousesColonialGarrison'</expr>
      </query>
    </selector>
  </styles>
  <clustering>false</clustering>
  <lighting>true</lighting>
</model>
```

As in the other elements, the `url` element specifies the location of the shapefile. To load buildings, you need to use the feature_geom driver for the `model` element and the ogr driver for the `features` element.

The `styles` element lets you specify a `style` for each building you want to display. This example shows just one building. Take a look at *VR-theWorld Online - Little Pond.earth* to see the other buildings that can be configured from this shapefile.

Each style has a name, in this case HousesColonialGarrison. The `model` attribute specifies the model used to display the object. The `selector` element matches the style to an entry in the TYPE column in the database file that accompanies the shapefile (*BuildingsP.dbf*).

To better understand this relationship, open *BuildingsP.dbf* in a spreadsheet application (Figure 5-18). Remember in the first Little Pond tutorial, you built a rule for extracting props from the feature layer. You chose TYPE in the field list. That is because the TYPE column lists the different types of buildings in the shapefile. You do the same thing with the `selector` element.

	A	B	C	D	E
1	LENGTH	WIDTH	HEIGHT	ROTATION	TYPE
203	8.21000000000	11.02000000000	9.00000000000	345	HousesColonialGarrison
204	8.21000000000	11.02000000000	9.00000000000	35	HousesColonialGarrison
205	8.21000000000	11.02000000000	9.00000000000	320	HousesColonialGarrison
206	8.21000000000	11.02000000000	9.00000000000	230	HousesColonialGarrison
207	8.21000000000	11.02000000000	9.00000000000	230	HousesColonialGarrison
208	8.21000000000	11.02000000000	9.00000000000	250	HousesColonialGarrison
209	8.21000000000	11.02000000000	9.00000000000	155	HousesColonialGarrison
210	8.21000000000	11.02000000000	9.00000000000	325	HousesColonialGarrison
211	8.21000000000	11.02000000000	9.00000000000	250	HousesColonialGarrison
212	8.21000000000	11.02000000000	9.00000000000	140	HousesColonialGarrison
213	8.21000000000	11.02000000000	9.00000000000	335	HousesColonialGarrison
214	8.21000000000	11.02000000000	9.00000000000	65	HousesColonialGarrison
215	8.21000000000	11.02000000000	9.00000000000	210	HousesColonialGarrison
216	8.21000000000	11.02000000000	9.00000000000	125	HousesColonialGarrison
217	8.21000000000	11.02000000000	9.00000000000	335	HousesColonialGarrison
218	8.21000000000	11.02000000000	9.00000000000	30	HousesColonialGarrison
219	8.21000000000	11.02000000000	9.00000000000	335	HousesColonialGarrison

Figure 5-18. *BuildingsP.shp*

Add Vegetation to the Earth File

To add vegetation to the terrain, add the following code to the earth file after the `model` block:

```
<model name="Little Pond Vegetation" driver="feature_custom">
  <features name="Vegetation" driver="ogr">
    <url>../../data/Terrain/LittlePond/Features/VegetationP.shp</url>
  </features>
  <layout>
    <tile_size_factor>3</tile_size_factor>
  </layout>
  <styles>
    <style type="text/css">
      Vegetation {
      marker:              [veg] + "ST" ;
      marker-scale:        1;
      marker-placement: vertex;
      altitude-clamping:   terrain;
      altitude-resolution: 0.00008583068847656250;
      altitude-offset:     0;
      }
    style>
  </styles>
  <clustering>true</clustering>
  <lighting>true</lighting>
</model>
```

The vegetation in VR-Vantage uses SpeedTree models. To load SpeedTrees from an earth file, you need to use the feature_custom driver in the `model` element. You use the ogr driver in the `features` element. Similar to the buildings, the `model` block for vegetation specifies a shapefile and styles. However, unlike with the buildings, we do not specify individual models to load. The marker attribute indicates that VR-Vantage should take every entry in the VEG column of *VegetationP.shp*, append ST to it, and look for a model of that name. For example, the column has several entries named TreesBigLeafMaple. VR-Vantage adds ST to form TreesBigLeafMapleST, finds the model definition TreesBigLeafMapleST, and loads the model specified in the model definition.

5.2.5. Save the Earth File

The convention for saving earth files is to save them in the *./userData/servers directory*. Save the file as *LittlePond.earth*.

5.2.6. Load the Earth File and Save is as an MTF File

Your earth file for Little Pond is complete. Now you can load it in VR-Vantage and compare it to the terrain you created through the GUI. After you load it, you should save it as an MTF file.

To load the earth file:

1. Start VR-Vantage.
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 *LittlePond.earth*.
6. Click Connect. The terrain loads. It is visible as a small patch on the earth's sphere (Figure 5-19).

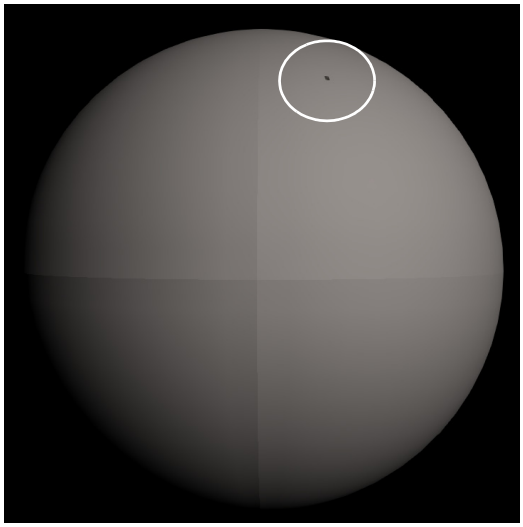


Figure 5-19. Little Pond terrain

7. Zoom in on the terrain (Figure 5-20). Compare it to the terrain you created in the first Little Pond tutorial. Notice that the buildings are the same, but there are more types of vegetation.

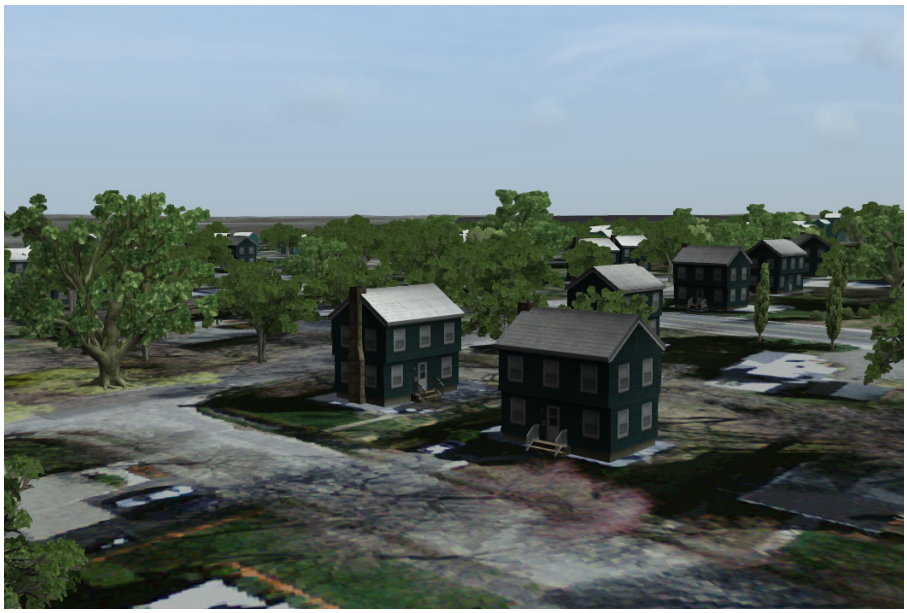


Figure 5-20. Little Pond terrain

8. Choose **File** → **Save Terrain**. The Save Terrain dialog box opens.
9. Give the terrain a name. Do not use Little Pond unless you want to overwrite the Little Pond terrain provided with VR-Vantage.

5.3. Extracting Props from a Terrain

In the tutorial "Composing a Terrain through the GUI," on page 5-2, 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 5-20).
2. Select the external references that you want to extract as props and extract them ("Extract the Props," on page 5-21).
3. Optionally, change the model definitions ("Change the Model Definition for a Prop," on page 5-23).

5.3.1. 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 **File** → **Add Terrain Patch**. The Add Terrain Patch dialog box opens and an Open dialog box opens on top of it.
3. Navigate to the *./data/Terrain/Makland/Geometry/OpenFlight* directory.
4. Select *Makland.flt*.
5. In the Add Terrain Patch dialog box, click OK. The terrain is loaded.

5.3.2. 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 5-21.

Figure 5-21. 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 5-22). 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.

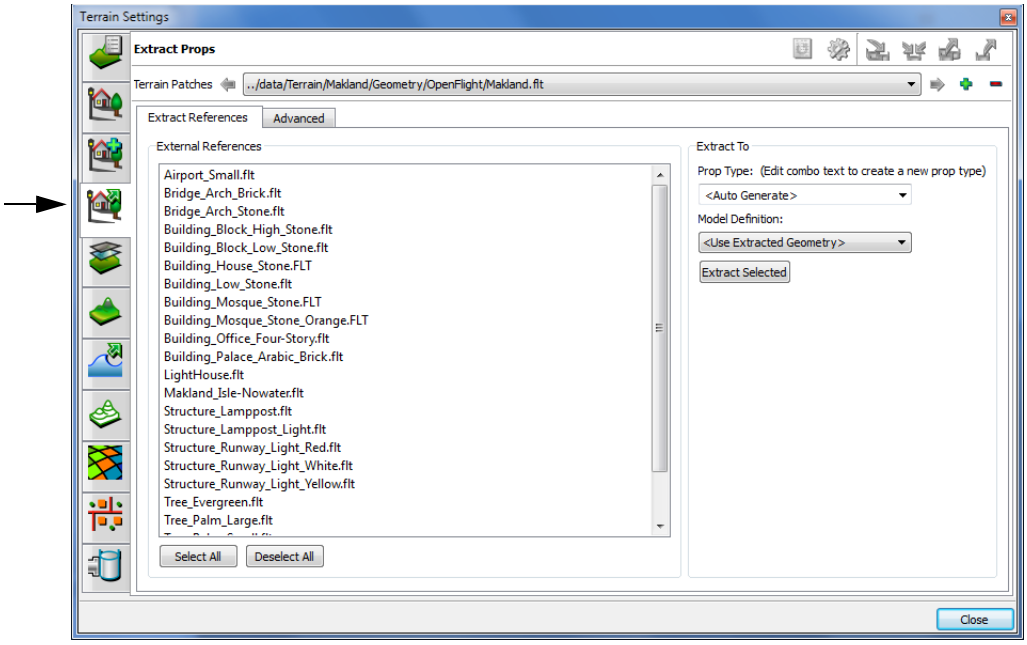


Figure 5-22. Extract props page

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 5-23). 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 5-23. Selected props

5.3.3. 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 5-24).

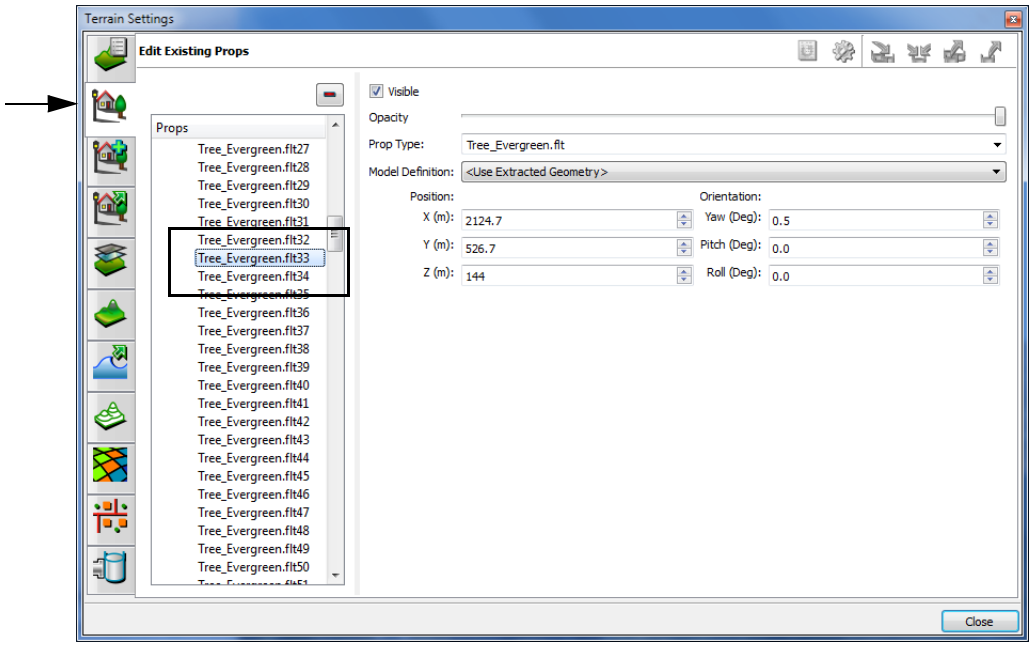


Figure 5-24. Edit Existing Props page

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 5-25).

Figure 5-25. 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.

6. Processing MetaFlight Files

To display MetaFlight files in VR-Vantage applications, you must first process them. This chapter explains how to do so.

6.1. Processing MetaFlight Files for Use in VR-Vantage

Before you can load a MetaFlight file in a VR-Vantage application, you must process it as described in this chapter. If you try to load an unprocessed MetaFlight file, VR-Vantage 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-Vantage 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.

6.2. 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).

6.3. 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.

6.3.1. 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-Vantage. 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 6-1 describes the command-line options.

Table 6-1: 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 6-1: 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-Vantage applications. 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 6-1: 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 to 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.

6.3.2. 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.

6.3.3. 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 9-7.

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.

6.4. 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
```

6.5. 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 any VR-Vantage application.
2. Add each MetaFlight terrain as a terrain patch.
3. Save the terrain as an MFT terrain.

7. Model and Element Definitions

In Section 4.5, "Introduction to VR-Vantage Object Modeling,", in *VR-Vantage Users Guide* , we describe the interplay of schemas, model definitions, element definitions, and model mapping. This chapter explains how to create and edit model definitions, element definitions, and model schemas. "Adding a Model to VR-Vantage," on page 8-2 walks you through the process of adding a model.

7.1. 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-Vantage 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 3.5, "Managing VR-Vantage Settings," in *VR-Vantage Users Guide*.
- If you are connected to an exercise, changes to element definitions do not take effect until you disconnect and reconnect.

Model definition schemas define the elements that can be displayed in a scene. The model definition schemas provided with VR-Vantage 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.

7.1.1. 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 7-1).

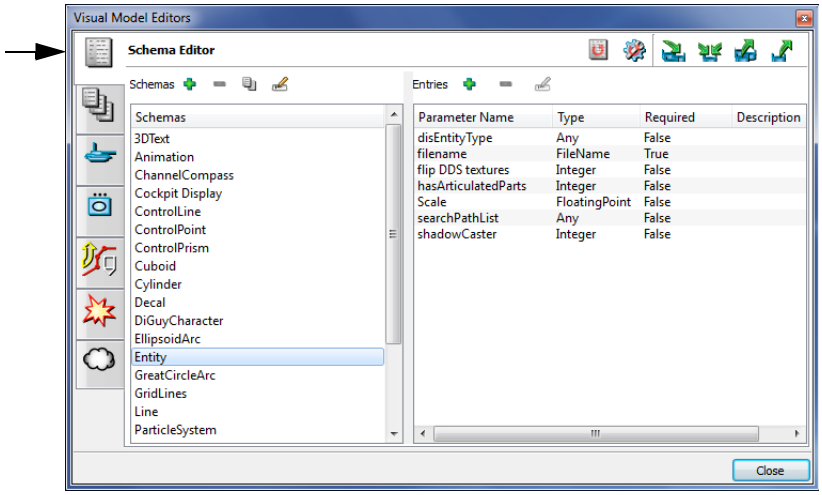


Figure 7-1. Schema Editor page

3. Click the Add button (+) next to the Schemas label. The Create Instance dialog box opens (Figure 7-2).

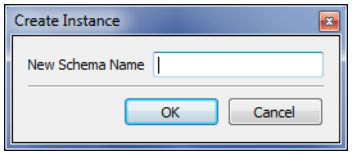


Figure 7-2. Create Instance dialog box

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 7-6.

7.1.2. 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 7-1).
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.

7.1.3. 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 7-1).
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 7-7.

7.1.4. 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 7-1).
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 7-3).

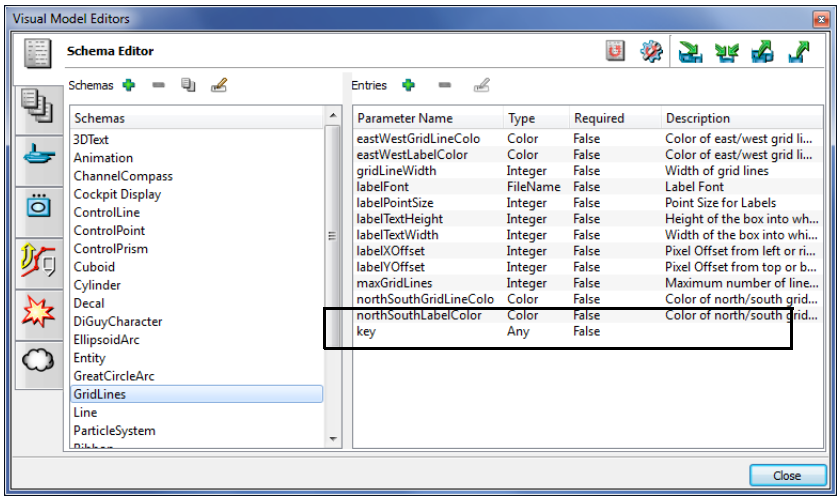


Figure 7-3. New schema parameter

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.

7.1.5. 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 7-1).
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.

7.1.6. 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 7-1).
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.

7.2. 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 7-3.) For most VR-Vantage 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-Vantage, you will probably have to create a new model definition for each one.

VR-Vantage 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 7-4).

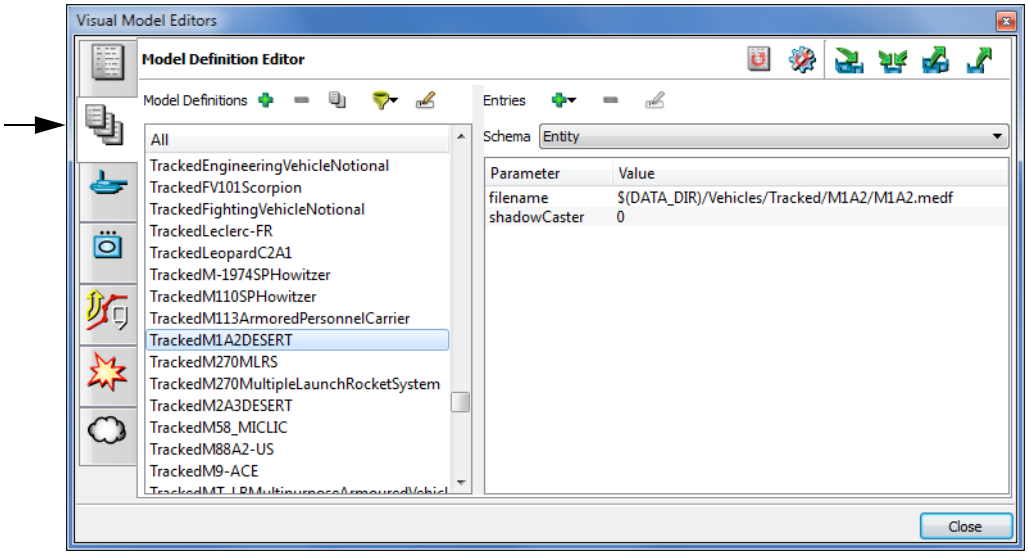


Figure 7-4. Model Definition Editor page

7.2.1. 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 7-4).
3. Optionally, filter the model definitions in the list. (For details, please see "Filtering the List of Model Definitions," on page 7-11.)
4. Click the Add button (+) next to the Model Definitions label. The Add Model Definition dialog box opens (Figure 7-5).

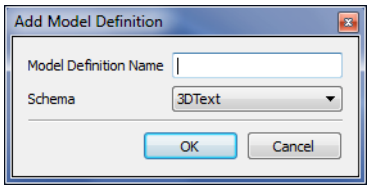


Figure 7-5. Add Model Definition dialog box

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 7-12.

7.2.2. 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 7-4).
3. Optionally, filter the model definitions in the list. (For details, please see "Filtering the List of Model Definitions," on page 7-11.)
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.

7.2.3. 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 7-4).
3. Optionally, filter the model definitions in the list. (For details, please see "Filtering the List of Model Definitions," on page 7-11.)
4. Select the model that you want to copy.
5. Click the Duplicate button ( ). The Duplicate Model Definition dialog box opens (Figure 7-6).

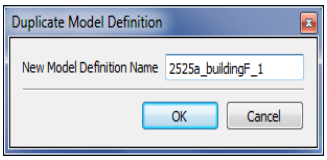


Figure 7-6. Copy model definition

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 7-12.

7.2.4. Filtering the List of Model Definitions

By default, the Model Definition Editor page lists all models that VR-Vantage 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.

7.2.5. 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 7-4).
3. Optionally, filter the model definitions in the list. (For details, please see "Filtering the List of Model Definitions," on page 7-11.)
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 7-7).

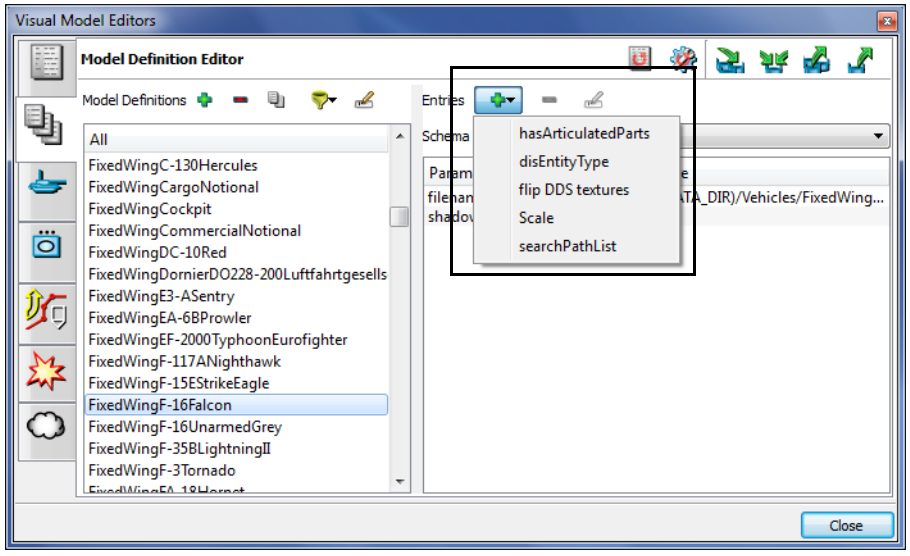


Figure 7-7. Add parameter list

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 7-8).

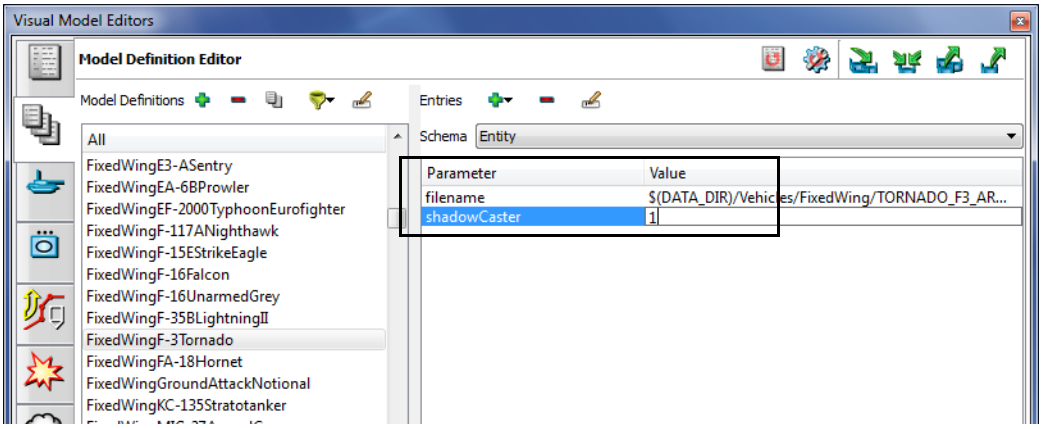


Figure 7-8. Editable parameter

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 7-4).
3. Optionally, filter the model definitions in the list. (For details, please see "Filtering the List of Model Definitions," on page 7-11.)
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 7-8).
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 7-4).
3. Optionally, filter the model definitions in the list. (For details, please see "Filtering the List of Model Definitions," on page 7-11.)
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.

7.2.6. Saving Model Definitions

Like all VR-Vantage 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 3.5, "Managing VR-Vantage Settings," in *VR-Vantage Users Guide*.

7.3. Creating and Editing Element Definitions

Element definitions define how VR-Vantage renders scene elements (entities, tactical graphics, interactions, aggregates, 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.

If you are connected to an exercise, changes to element definitions do not take effect until you disconnect and reconnect.

7.3.1. 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 7-9).

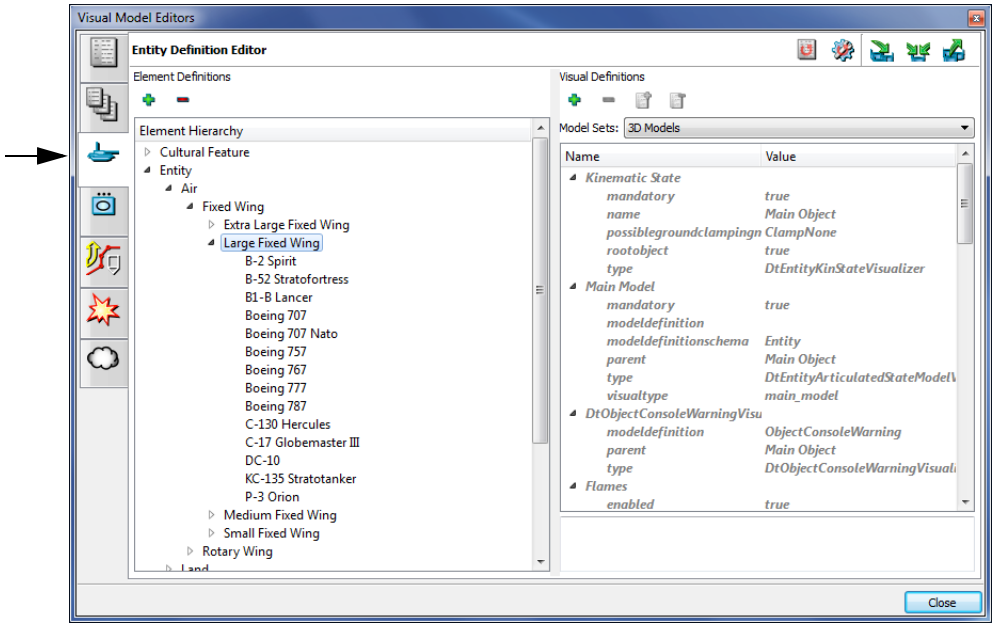


Figure 7-9. Entity Definition Editor page

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 7-17.
8. Optionally, add a visual definition to the element. For details, please see "Adding a Visual Definition," on page 7-16.
9. Optionally, save the element to a file. For details, please see "Saving Element Definitions," on page 7-20.

7.3.2. 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 7-9).
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. (VR-Vantage Stealth only.)
5. Click the Add button (✚) next to the Visual Definitions label. The Create Visualizer Definition dialog box displays a list of available visual definitions.

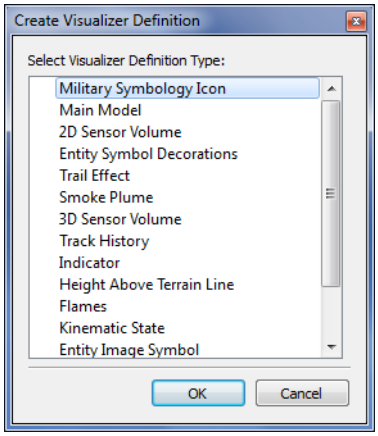


Figure 7-10. Create Visualizer Definition dialog box

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 7-17.

Editing a Visual Definition

Visual definitions and their attributes are displayed either as grey italicized text or as black text (Figure 7-11). 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.)

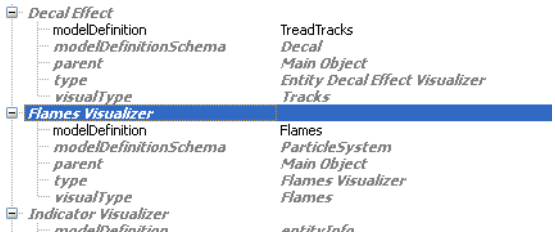


Figure 7-11. Visual definition entry

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 7-9).
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 7-12), or the field becomes editable.

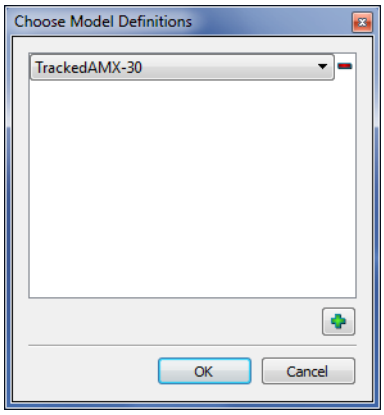


Figure 7-12. Choose Model Definitions dialog box

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-Vantage 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 7-9).
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 7-13).

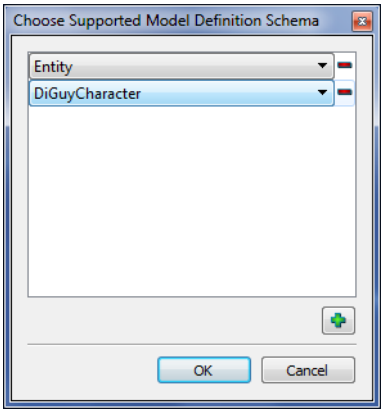


Figure 7-13. Parameter with multiple values

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 7-14).

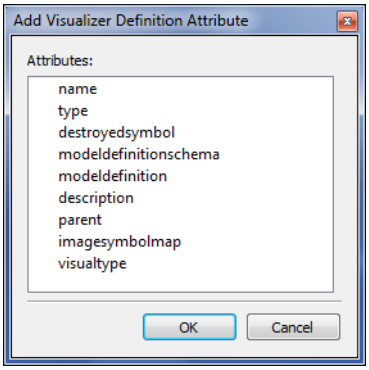


Figure 7-14. Add Visualizer Definition Attribute window

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 ( ).

7.3.3. 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 7-9).
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.

7.3.4. Saving Element Definitions

Changes to element definitions get saved automatically. You can also save element definitions using the standard VR-Vantage options for saving settings. For details, please see "Managing VR-Vantage Settings," on page 3-21, in *VR-Vantage Users Guide*.

7.4. Configuring 2D Icons

The 2D icons in VR-Vantage PVD and the Plan View mode of VR-Vantage Stealth 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.

7.4.1. 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 7-9).
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 7-15).

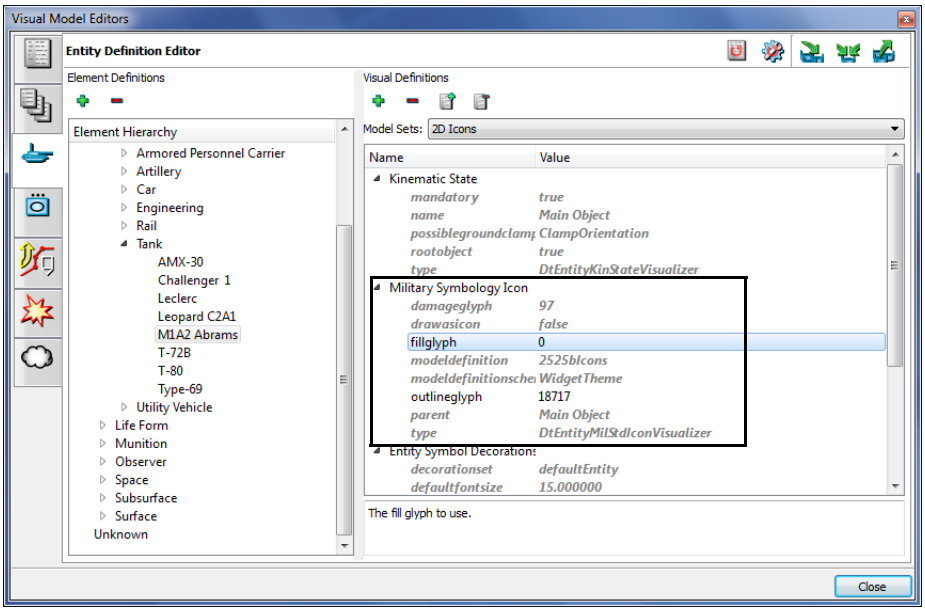


Figure 7-15. Military Symbol Icon visual definition

b. Click the value in the Value column. The Choose Font Glyph dialog box opens (Figure 7-16).

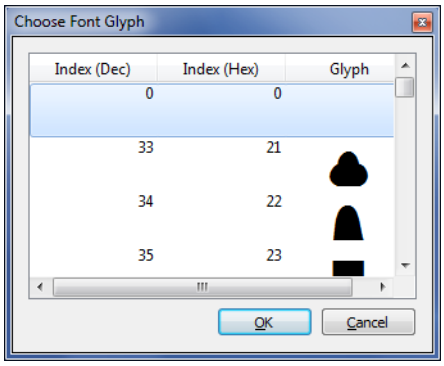


Figure 7-16. Choose Font Glyph dialog box

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.

7.4.2. Using Images for 2D Icons

By default, VR-Vantage 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 7-9). (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 7-17).

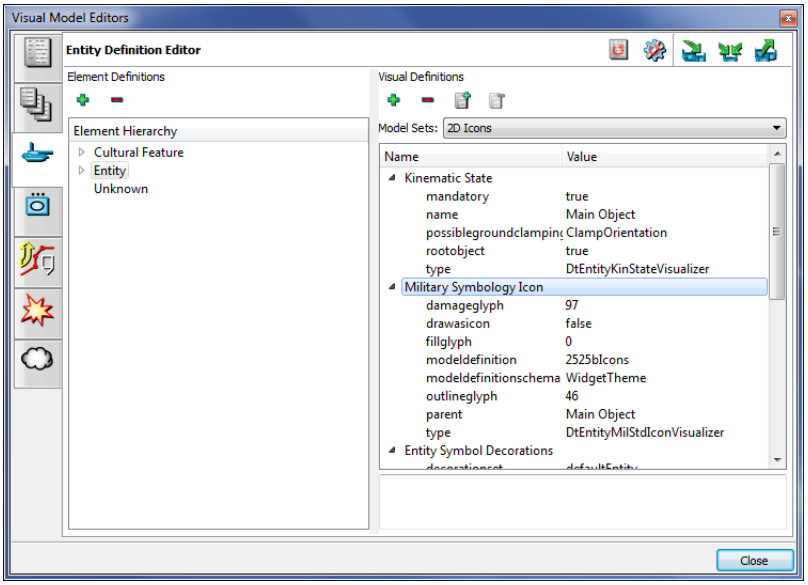


Figure 7-17. Entity element definition with Military Symbology Icon visual definition

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 7-18).

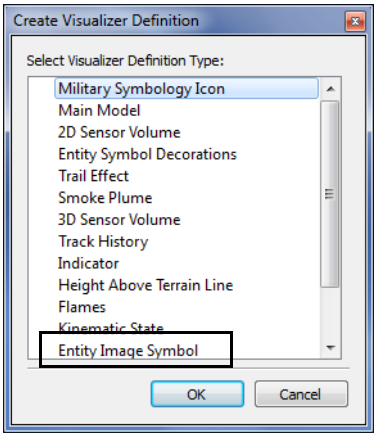


Figure 7-18. Create Visualizer Definition window

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 7-19).

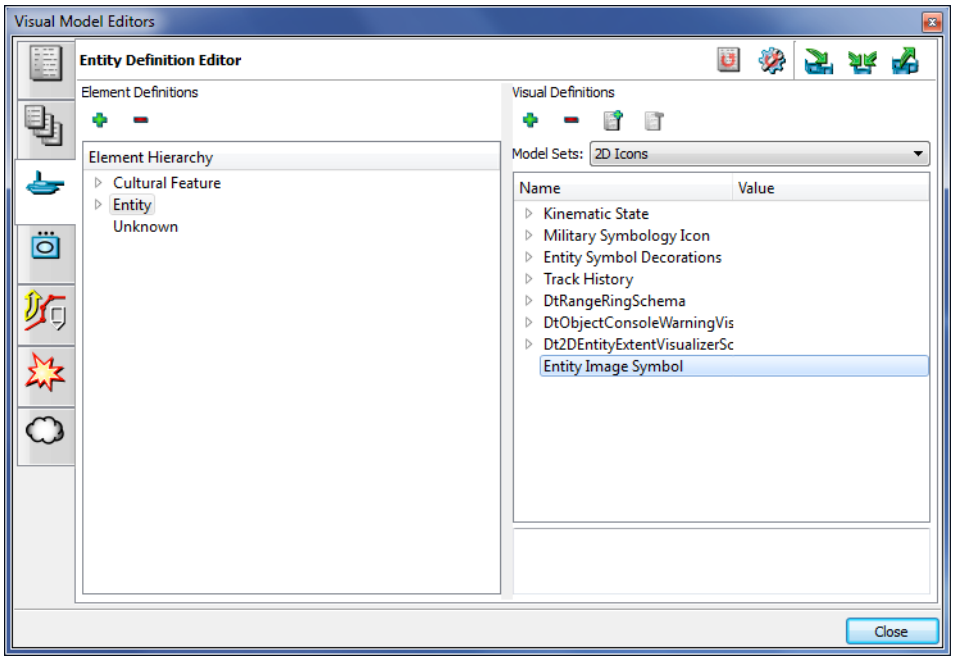


Figure 7-19. Entity element definition with Entity Image Symbol visual definition

11. Click the Add Attribute button (). The Add Visualizer Definition Attribute window is displayed (Figure 7-20).

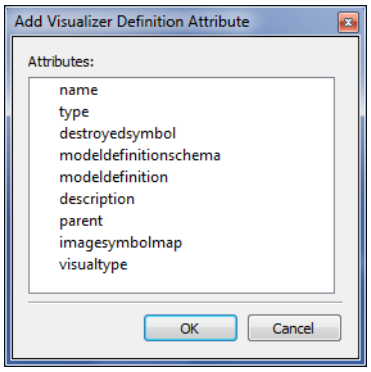


Figure 7-20. Add Visualizer Definition Attribute window

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 7-21).

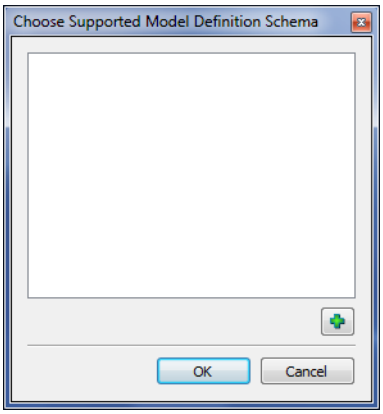


Figure 7-21. Choose Supported Model Definition Schema dialog box

20. Click the Add button. A list is added to the dialog box.
21. In the list, select **WidgetTheme** (Figure 7-22).

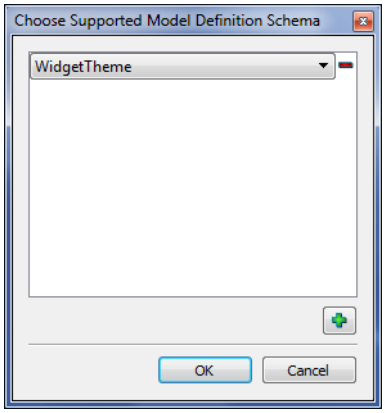


Figure 7-22. Completed Choose Supported Model Definition Schema dialog box

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 7-23).

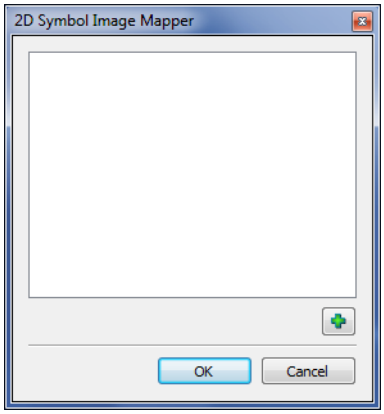


Figure 7-23. 2D Symbol Image Mapper dialog box

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 7-24).

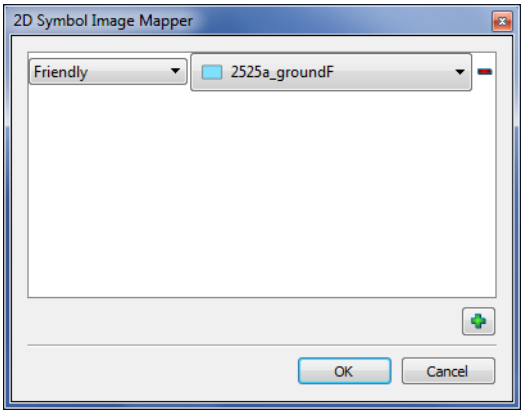


Figure 7-24. 2D Symbol Image Mapper dialog box with force chosen

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 7-25.

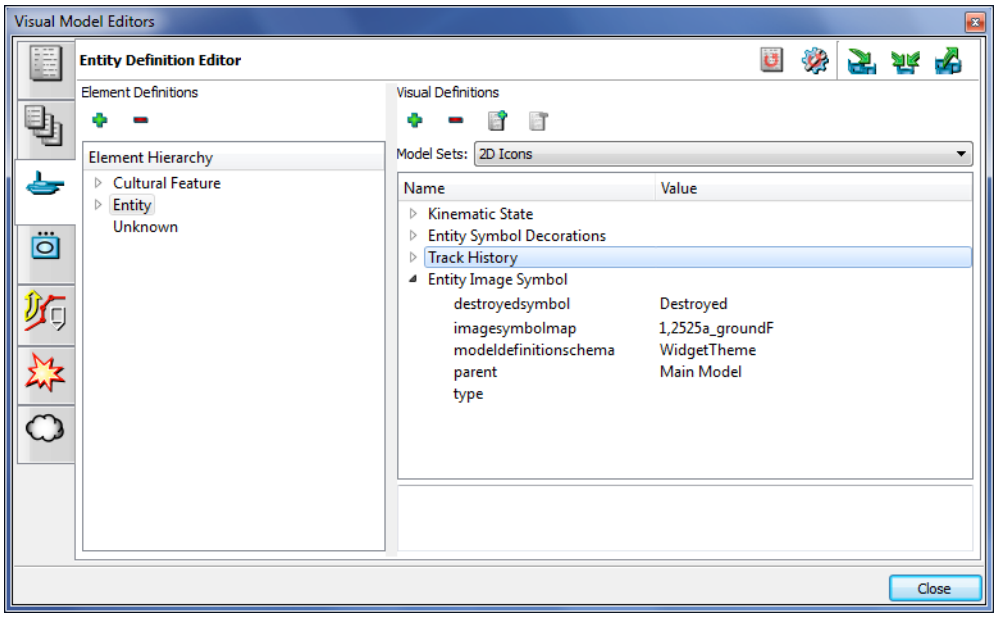


Figure 7-25. Entity Image Symbol visual definition

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.

7.4.3. Adding Images for Entities

VR-Vantage 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 7-4).
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 7-8. 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.

7.5. Adding New Cockpit Display Models

VR-Vantage 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 7-26 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-Vantage 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-Vantage only covers the cockpits delivered with the product. If you add your own cockpits, you will need GL Studio run-time licenses.

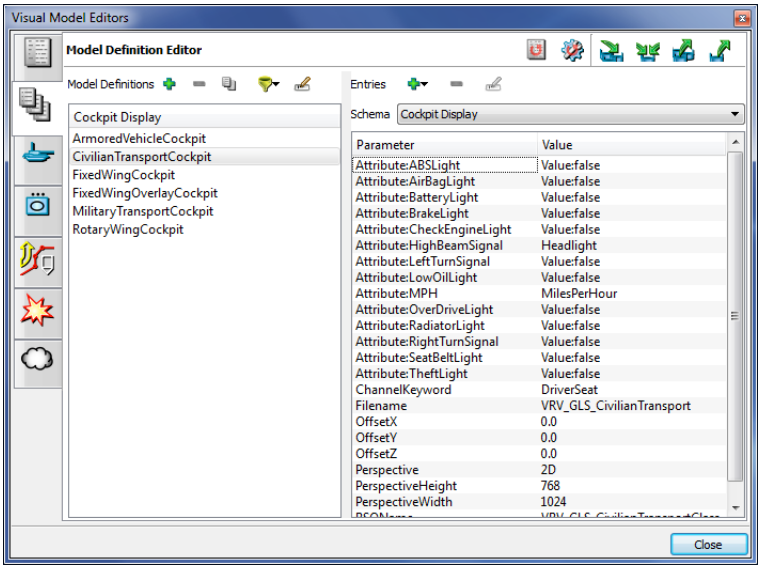


Figure 7-26. Cockpit model definition

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 9-2.

7.5.1. Installing a Cockpit DLL

If you create your own cockpit, it is implemented as an RSO DLL that you must add to the VR-Vantage file structure.

➤ To install a new cockpit, place the DLL for the cockpit in *./data/Huds* and create a model definition for it.

7.5.2. Creating a Model Definition for a Cockpit

Cockpit models are configured using schemas and model definitions, just like any other model in VR-Vantage. 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 7-9. Be sure to select Cockpit Display as the schema. A new model definition is added to the display (Figure 7-27). The message window lists the parameters that you must add. These are the parameters defined by the schema.

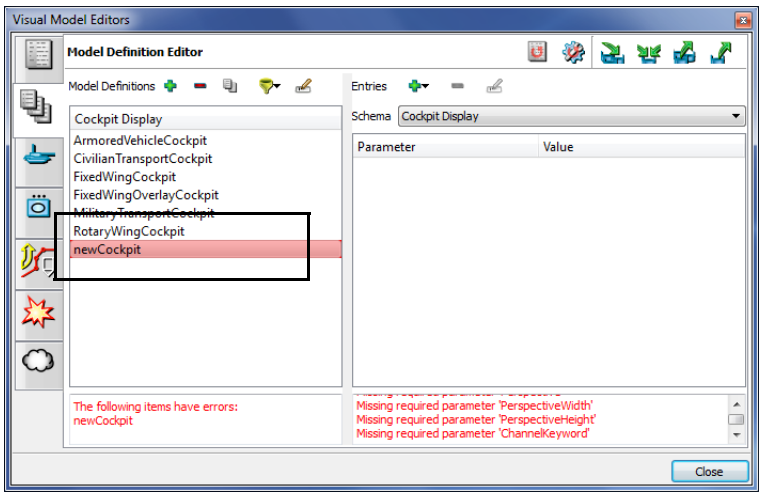


Figure 7-27. New cockpit model definition

2. Add the required parameters, as described in "Adding Parameters to a Model Definition," on page 7-12. Table 7-1 describes the required parameters.

Table 7-1: 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 7-1: 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-Vantage.
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 7-12.
   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-Vantage, as described in Table 7-2.
4. Map an entity type to your definition, as described in "Adding an Entity Type Mapping," on page 9-2.

Table 7-2: 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 7-2: 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.

7.6. Configuring Wakes

When dynamic ocean is enabled, VR-Vantage 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 7-28).

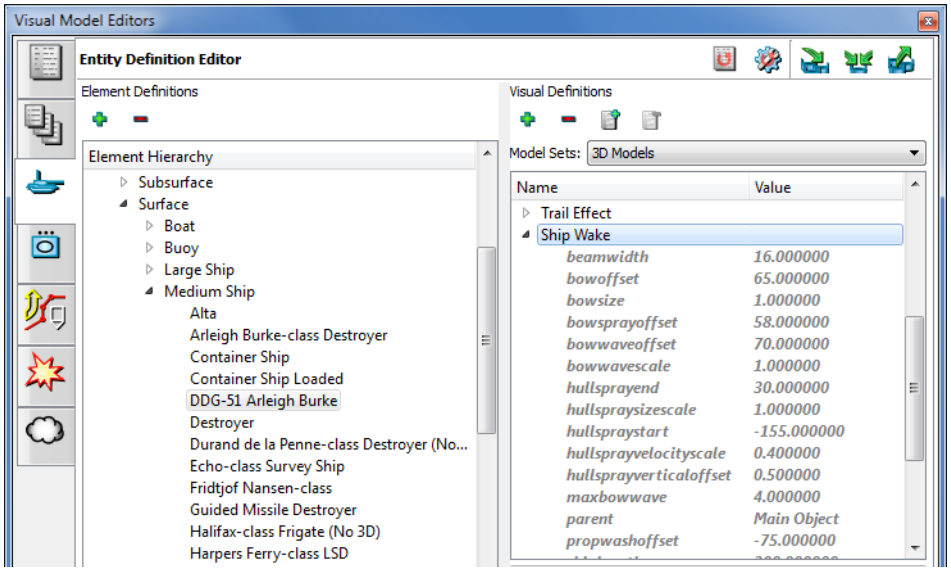


Figure 7-28. Ship Wake visual definition

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 7-3 describes each parameter.

Table 7-3: 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.

Table 7-3: Ship Wake visual definition attributes

Parameter	Description
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.

7.6.1. Configuring Tidal Stream Wakes

Tidal stream wakes are supported as stand-alone models and are automatically attached to streamed buoys and beacons. Model definitions for wakes to be used with each of the supported buoy and beacon models are included (BuoysPillarWake, BeaconsLattice-Wake, and so on). You may want to edit them. We recommend wake lengths of at least 20m for best results. (Some of the model definitions specify values less than that.)

By default, VR-Vantage starts with a tidal stream current speed of 0. To see tidal stream wakes, change the speed on the Scene Settings dialog box, Environment Conditions Settings page. For more information, please see "Configuring Marine Conditions," on page 5-20, in *VR-Vantage Users Guide*.

You can also change the speed and direction of the tidal stream current using a CIGI Component Control or Short Component Control message. The message uses a component class of Regional Sea Surface(4), a component ID of 1, and two float component data fields - the first is the tidal stream current speed (m/s), and the second is the current direction (0-2PI radians, clockwise from North). The Region ID is ignored.

7.7. Adding Wind-based Controls to Models

VR-Vantage can simulate the movement of flags and windsocks based on the current simulated wind speed and direction on terrains. It can also simulate movement of flags and windsocks on models added through connections or programatically (this is not supported for props or external references). These features require models with appropriate switches and articulations, as well as model-specific or terrain-specific meta files.

A meta file is associated with a terrain or model in one of the following ways:

- Place it in the same directory as the terrain or model's MEDF file. The meta file must have the same name as the MEDF file, but with a *.meta* extension.
- Specify it in the **metaFileName** parameter of the model definition used to import the model.

Meta files are user-editable, but require understanding of the annotations and naming conventions in the model file itself.

The meta files are JSON configuration files. They have sections that configure wind control of nodes, as follows:

- Control switch nodes based on wind speed.
- Control the heading (Z-Axis) of articulating (degree of freedom) nodes based on wind direction.

Each section has a `Linkage` entry and a `FeatureData` entry. The `Linkage` entry specifies an OSG node that should have the feature specified in the `FeatureData` entry.

Linkages can be specified by node name or WRM Specification comment (for example, @dis articulated_part 7872). When a model or terrain file is loaded and a meta file is associated with that file, the model or terrain file is searched for any node or nodes specified in any `Linkage` entries in that meta file and the necessary instances to implement the `FeatureData` indicated in that `Linkage`/`FeatureData` pair are created.

`FeatureData` sections indicate a **FeatureName** (which is mapped to a creator that will instantiate the appropriate object to manage that feature) and any additional parameters needed to manage the feature. The meta file used for wind features supports two features - WindSwitchPart and WindDirPart.

WindSwitchPart. The WindSwitchPart feature is used to change the state of a switch node based on the current wind speed. The flag models used by MÄK include a switch with three states. The **WindSpeed** parameter is a list of wind speeds (in km/h) and the **WindState** parameter is a list of the switch state values that correspond to the values in the **WindSpeed** parameter. The number of items in each list should be the same (and only contain switch states supported by the node specified in the `Linkage` entry.

WindDirPart. The WindDirPart feature is used to modify the heading value (Z-Axis) of an articulation (degree of freedom) node based on wind direction. It has the following parameters:

- **RotOffsetDeg**. Allows a rotation offset to be applied.
- **RotDir**. Indicates if the node should be rotated in a clockwise or counterclockwise direction.

For information about adding new meta files or new meta file features, please see section 8.6, Transforming Nodes Programmatically, in VR-Vantage *Developers Guide*VR-Vantage *Front-End Developers Guide*.

7.8. Flipping DDS Textures for a Model

If a model is displayed upside down because its DDS textures are not what VR-Vantage expects, you can specify that the model be flipped. (For more information about DDS textures, please see "Displaying DDS Textures Correctly," on page 3-35.)

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 7-4).
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.

7.9. 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 1-12. Table 7-4 describes the settings you can change.

Table 7-4: SpeedTree settings

Parameter	Description
Clipping distance	The distance at which trees are clipped out of the scene.
Fade from High LOD to Lod LOD	The range (near to far) in which high LOD trees are gradually replaced with low LOD trees.
Fade from Low LOD to Billboard	The range (near to far) in which low LOD trees are gradually replaced with billboard trees. This range is usually greater than the range for high LOD to low LOD.
Ambient Scalar	Multiplies the built-in ambient lighting value in each SpeedTree by the specified amount.
Diffuse Scalar	Multiplies the built-in diffuse lighting value in each SpeedTree by the specified amount.
Specular Scalar	Multiplies the built-in specular lighting value in each SpeedTree by the specified amount.
Transmission Scalar	Multiplies the built-in transmission lighting value in each SpeedTree by the specified amount.
Alpha Scalar	Multiplies the built-in alpha value in each SpeedTree by the specified amount.

To configure SpeedTree trees:

1. Choose **Settings** → **Display**. The Display Settings dialog box opens.
2. Select the SpeedTree Settings page (Figure 7-29).

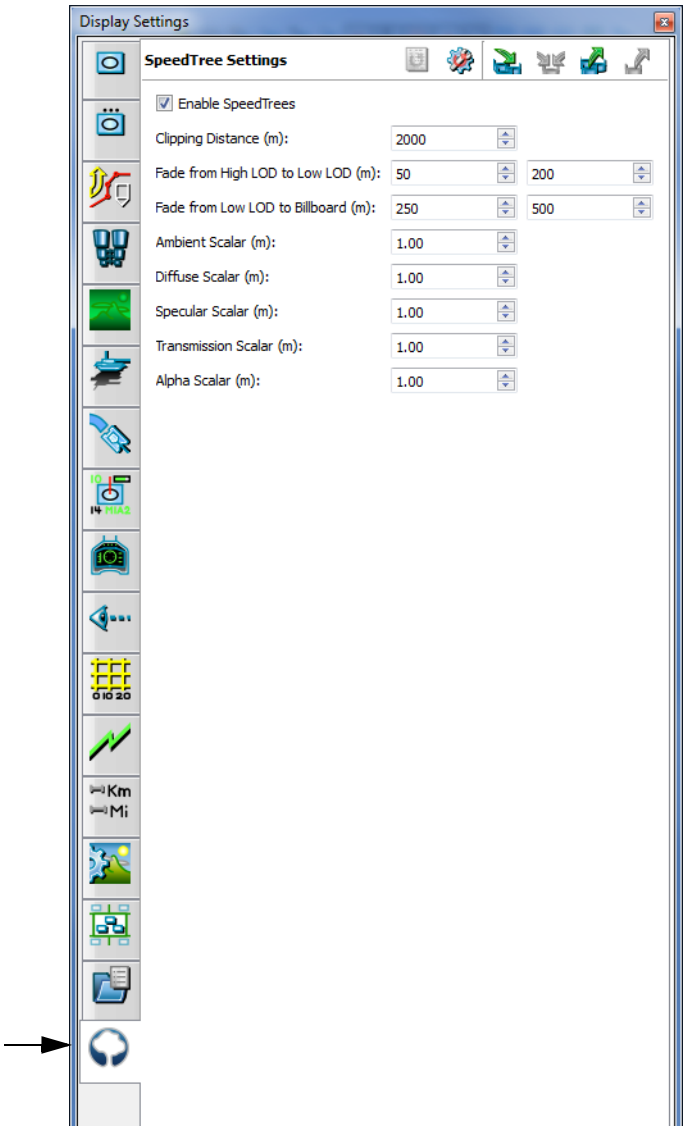


Figure 7-29. SpeedTree Settings page

3. Update parameters as desired.
4. Click Close.

7.10. Best Practices for Creating Models for VR-Vantage

If you build your own models for use in VR-Vantage, 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.

8. 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 chapter contains tutorials that demonstrate how to combine various procedures to add models.

8.1. Adding a Model to VR-Vantage

This tutorial shows how to add a new model to a VR-Vantage application. To help you with the tutorial, VR-Vantage includes a model of an F/A-18 Hornet that is not mapped to any entities.

To see a set of brief videos that demonstrates this tutorial, choose **All Programs** → **MÄK Technologies** → **VR-Vantage 2.0** → **Documentation** → **VR-Vantage Video Tutorials** or run *./doc/vrvantage_tutorialvideos.htm*.

The basic steps are:

1. Create a model definition ("Create a Model Definition," on page 8-2).
2. Add an element definition ("Add an Element Definition," on page 8-5).
3. Map the new model to an entity or object type enumeration ("Add a Model Mapping," on page 8-8).
4. Test the new model ("Test the Model Mapping," on page 8-10).

8.1.1. 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 8-1).

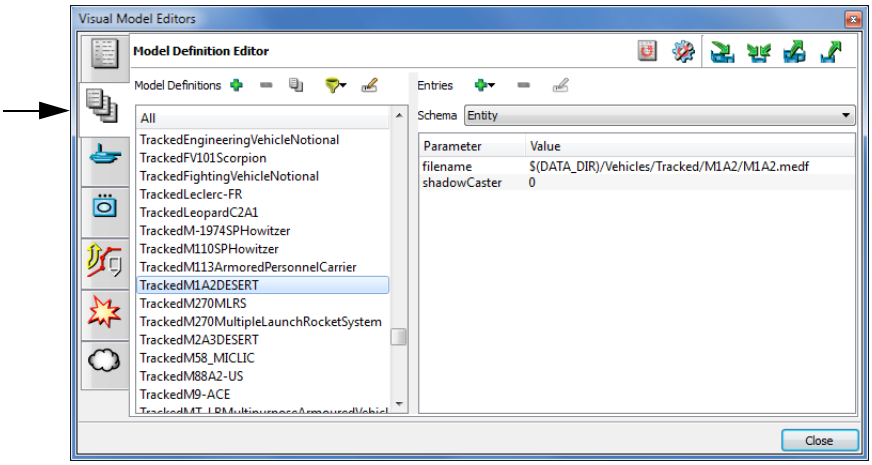


Figure 8-1. Model Definition Editor page

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 7-11.)
4. Click the Add button (+) next to the Model Definitions label. The Add Model Definition dialog box opens (Figure 8-2).

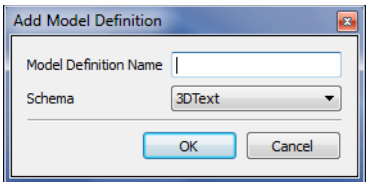


Figure 8-2. Add Model Definition dialog box

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 8-3.

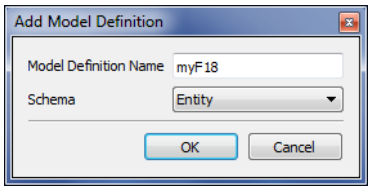


Figure 8-3. New model definition

7. Click OK. The new definition is added to the list (Figure 8-4). It does not have any parameters specified yet, so VR-Vantage prints an error message. Now you must specify the model file for this model definition.

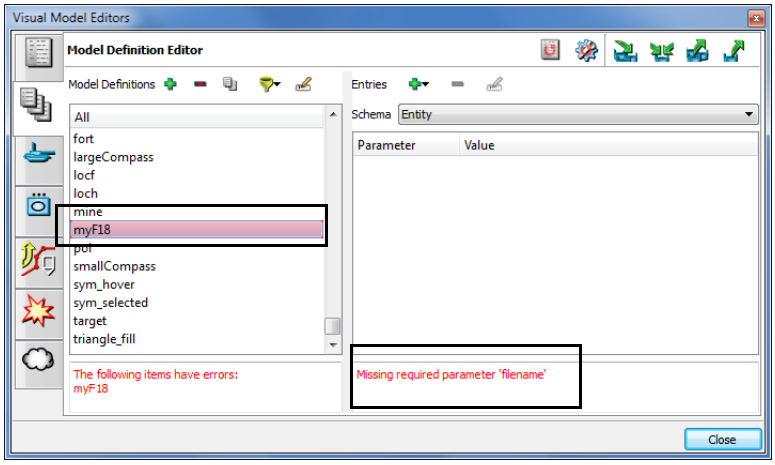


Figure 8-4. New model definition in list

8. Select the new model definition.
9. Click the Add Parameter button (). A list of parameters is displayed (Figure 8-5).

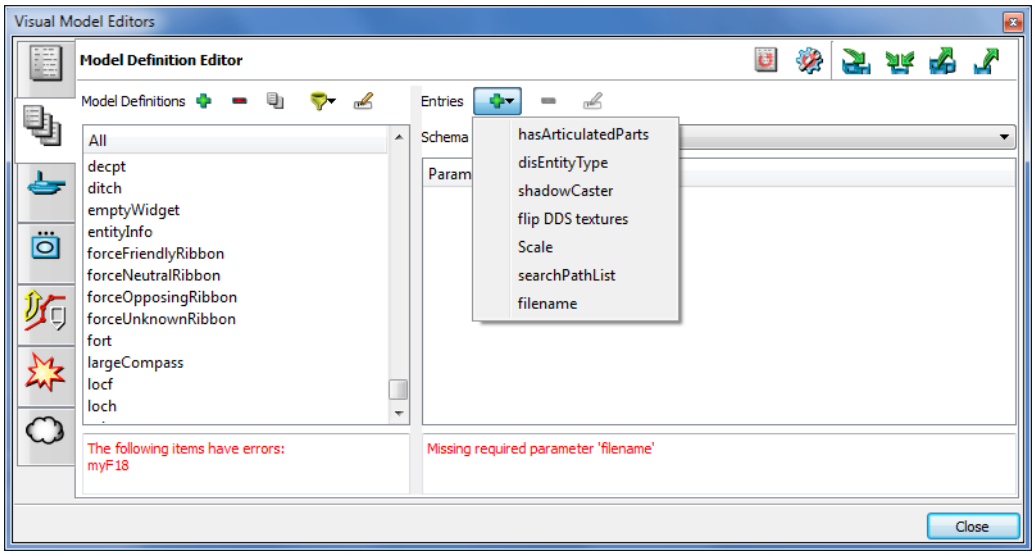


Figure 8-5. List of parameters

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 8-6).

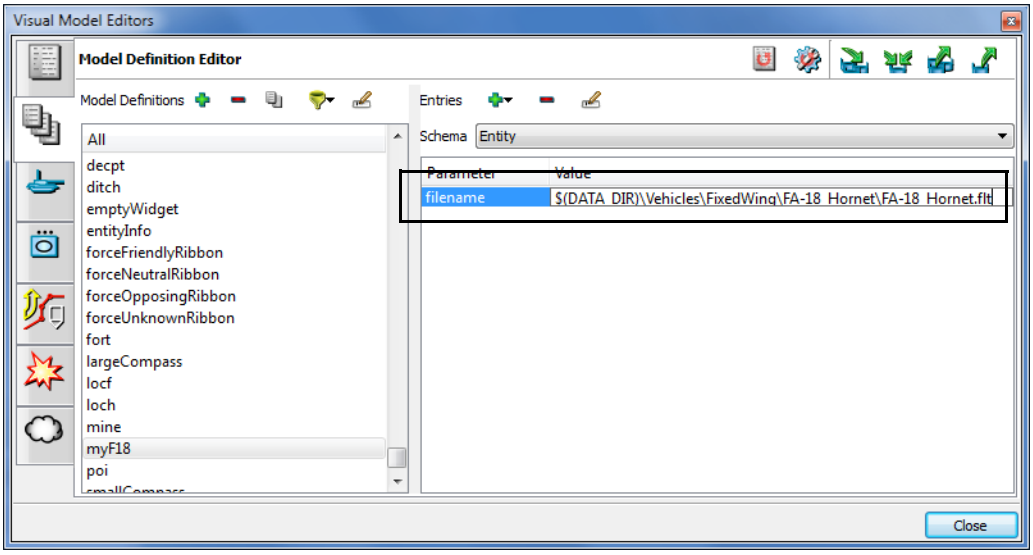


Figure 8-6. Model definition parameter

8.1.2. 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 8-7).

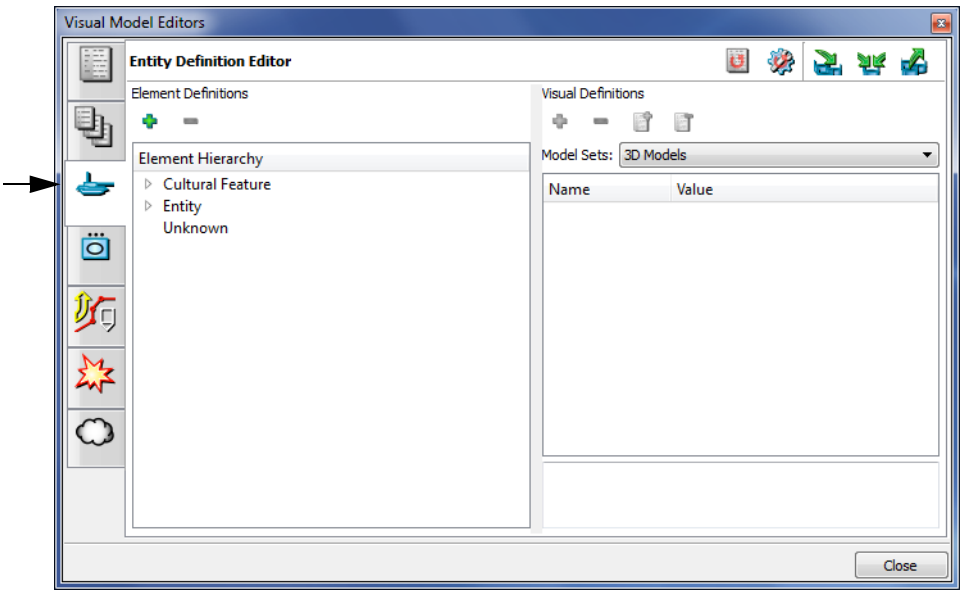


Figure 8-7. Entity Definition Editor page

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 8-8). It has the same list of visualizers as the fixed wing parent level.

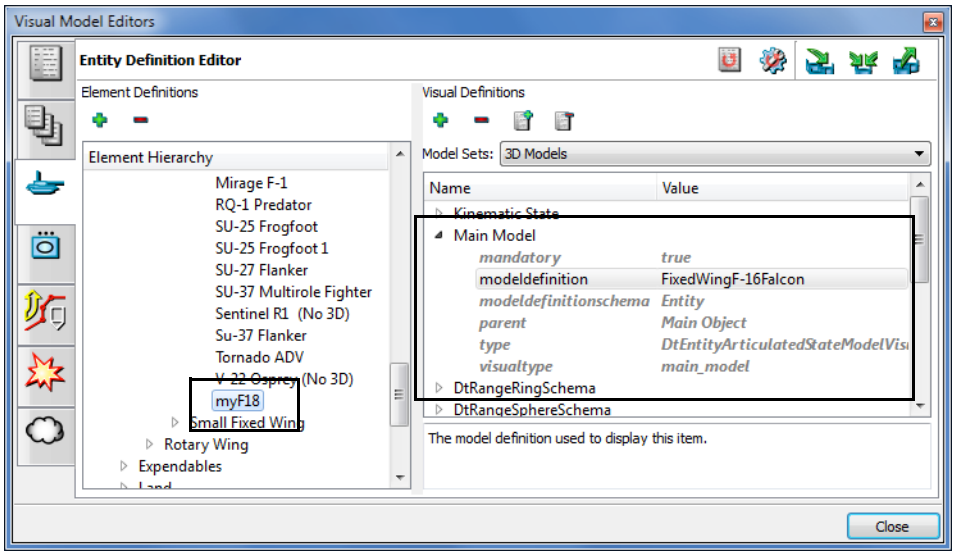


Figure 8-8. New entity definition

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 8-9). It shows the current model definition as a selection in a list.

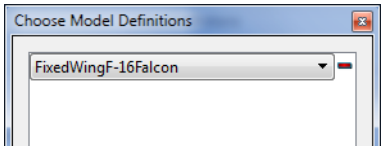


Figure 8-9. Choose Model Definitions dialog box with list of definitions

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 8-10).

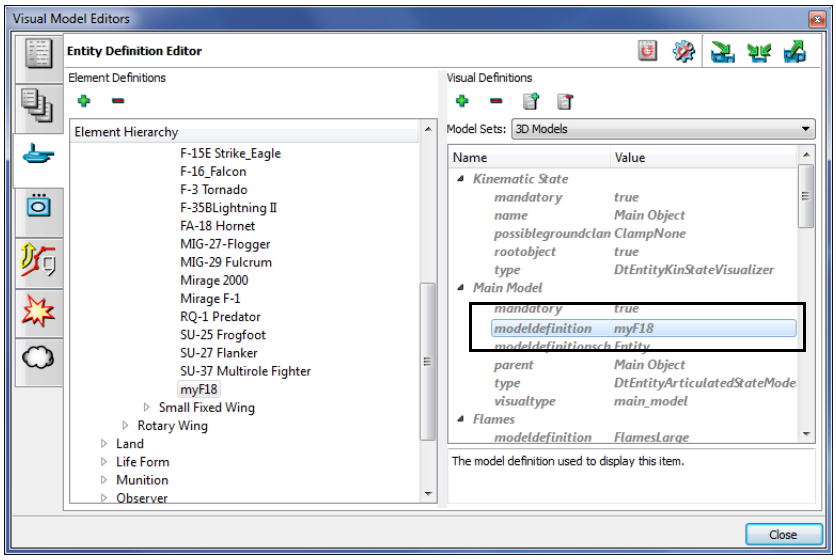


Figure 8-10. Model Definition for Model Visualizer

13. Close the Visual Model Editors dialog box.

8.1.3. 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 8-11).

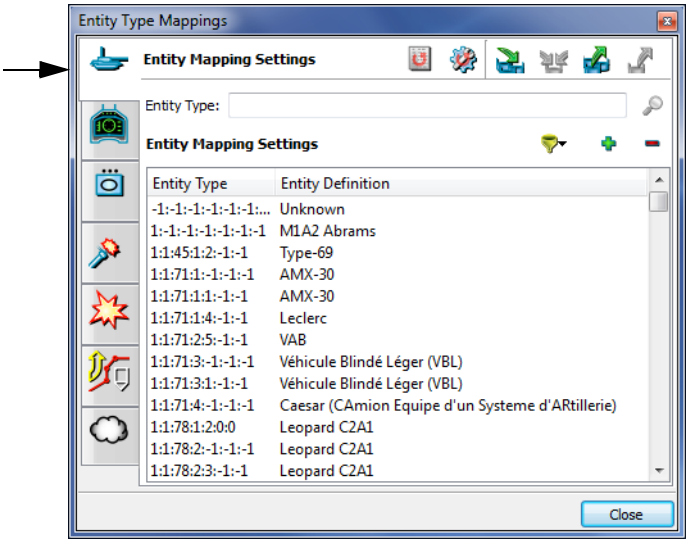


Figure 8-11. Entity Mapping Settings page

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 8-12). It lists a default entity type enumeration.

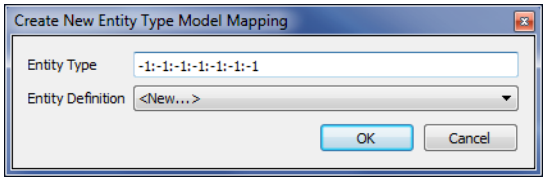


Figure 8-12. Create New Entity Type Model Mapping dialog box

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-Vantage 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-Vantage 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 8-13).

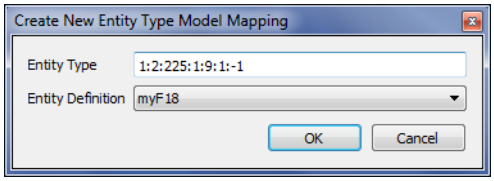


Figure 8-13. Create new model mapping

8. Click OK.
9. The new model mapping is added to the list.

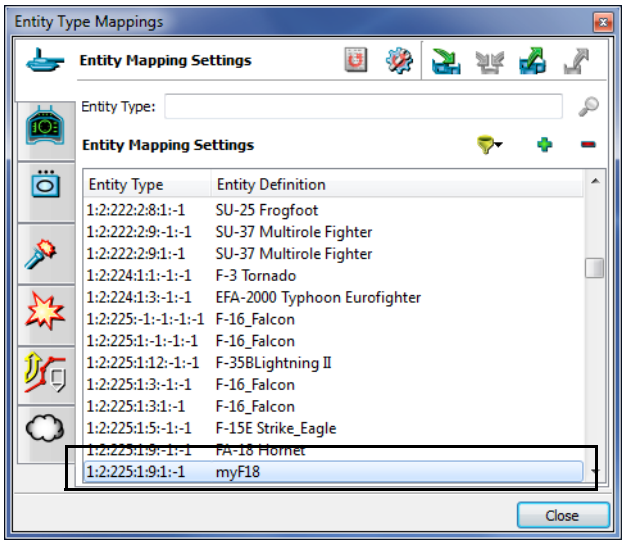


Figure 8-14. New model mapping

10. If you are connected to an exercise, disconnect and reconnect. Changes to model definitions and mappings do not take effect until you reconnect.

8.1.4. 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-Vantage 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 8-15).

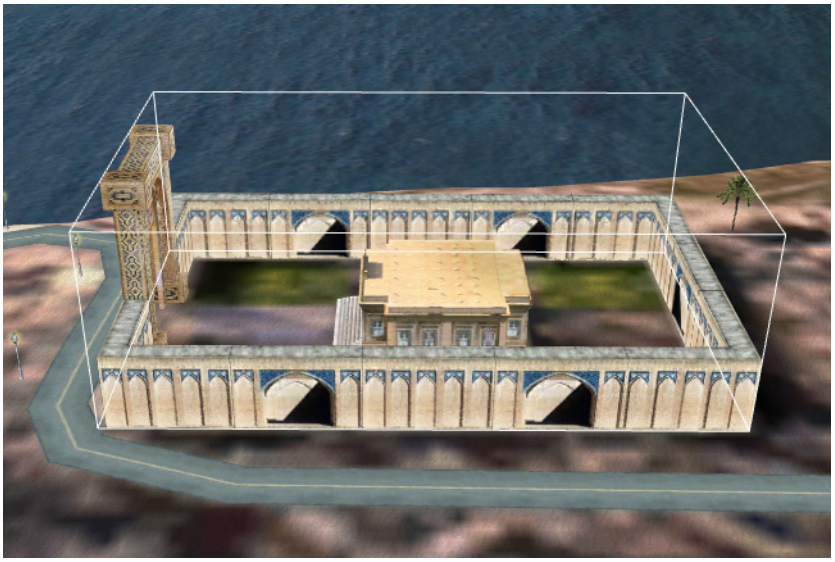


Figure 8-15. Palace

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 8-16).

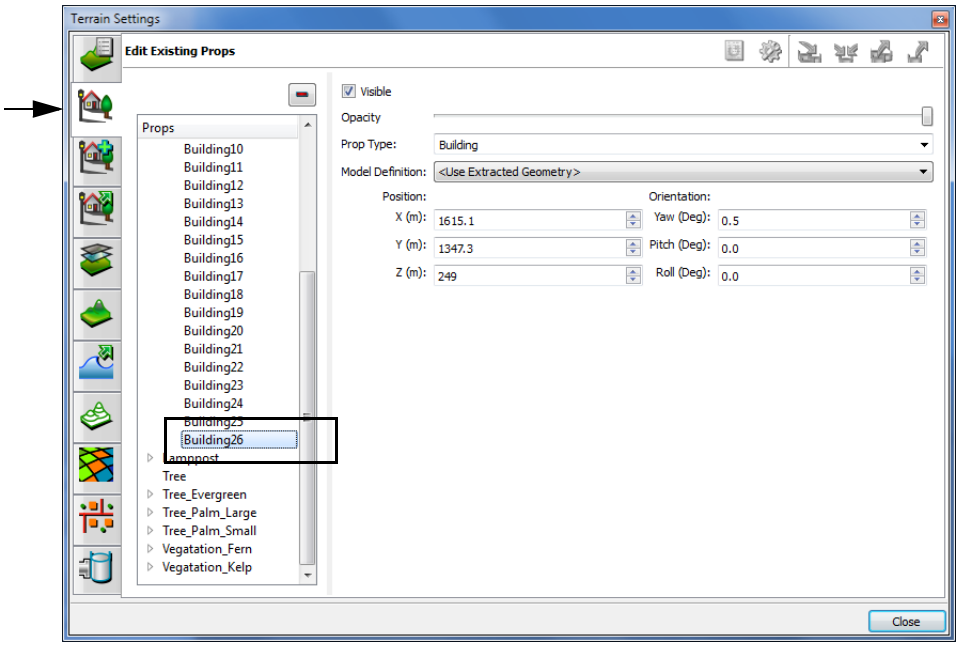


Figure 8-16. Edit Existing Props page

6. In the Model Definition list, select the model definition that you added earlier in this tutorial (Figure 8-17). The model of the palace is replaced with the model for the F/A-18 (Figure 8-18). 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.

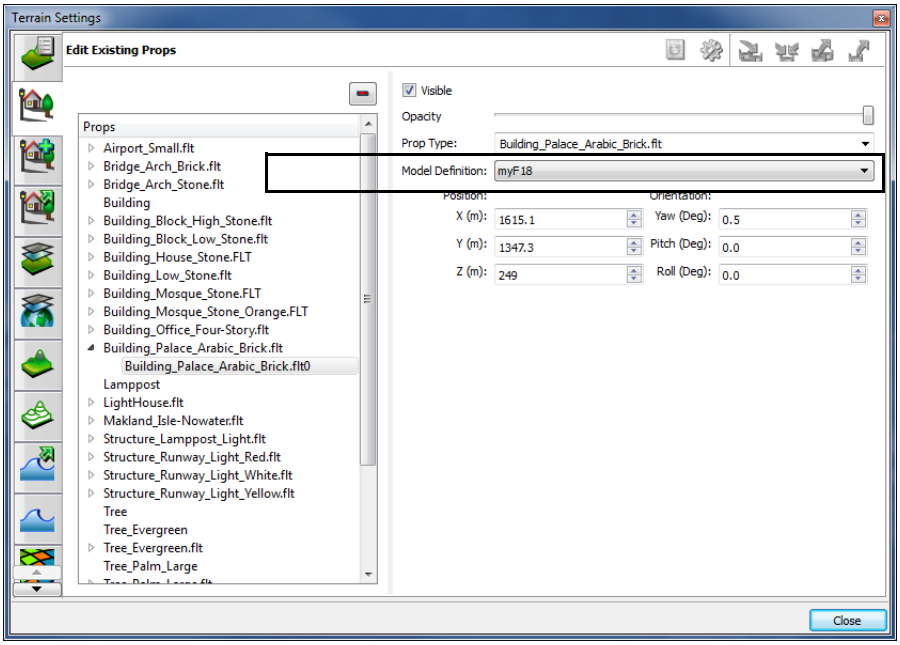


Figure 8-17. Changed model definition

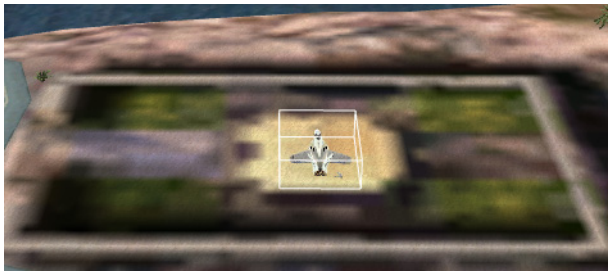


Figure 8-18. F/A-18 replaces the palace

7. If you are going to use this terrain for simulations, change the model definition back to Use Extended Geometry.

9. Mapping Entity Types to Element Definitions

This chapter explains how to map element definitions to DIS and HLA entity types. For information about how to create element definitions, please see Chapter 7, *Model and Element Definitions*. For information about mapping CIGI models and components, please see Chapter 11, *Mapping CIGI Models and Components*. Chapter 8, *Model Tutorials* walks you through the process of adding a model.

9.1. Introduction to Entity Type Mapping

In order to visualize a scene element (entity, aggregate, detonation, and so on), VR-Vantage must map its entity type enumeration to an element definition. This section explains how to do that. For conceptual background, please see Section 4.5.3, "Mapping Entity Types to Element Definitions," in *VR-Vantage Users Guide*.

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-Vantage randomly assigns one of the element definitions to the entity.
- You can map an element definition to more than one entity type.

9.1.1. 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 9-1). 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.

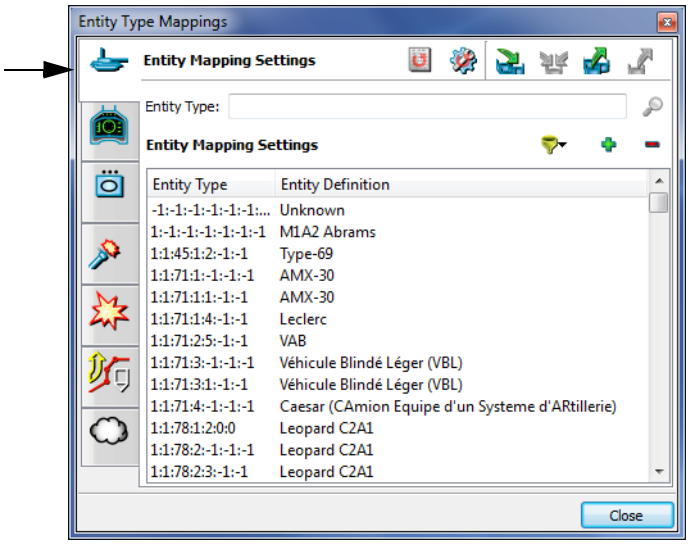


Figure 9-1. Entity Mapping Settings page

3. Click the Add button (+). The Create New Entity Type Model Mapping dialog box opens (Figure 9-2). It lists a default entity type enumeration.

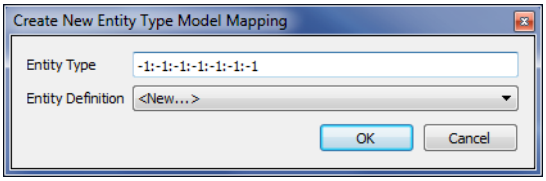


Figure 9-2. Create New Entity Type Model Mapping dialog box

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.

9.1.2. Editing an Entity Type Mapping

This procedure describes how to edit an entity type mapping for an entity. 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 9-1).
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-Vantage 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 9-5.)
   b. In the Entity Definition column, click the element definition to make it an editable list (Figure 9-3)).
   c. Select the new element definition from the list.
   d. Click someplace else in the window.

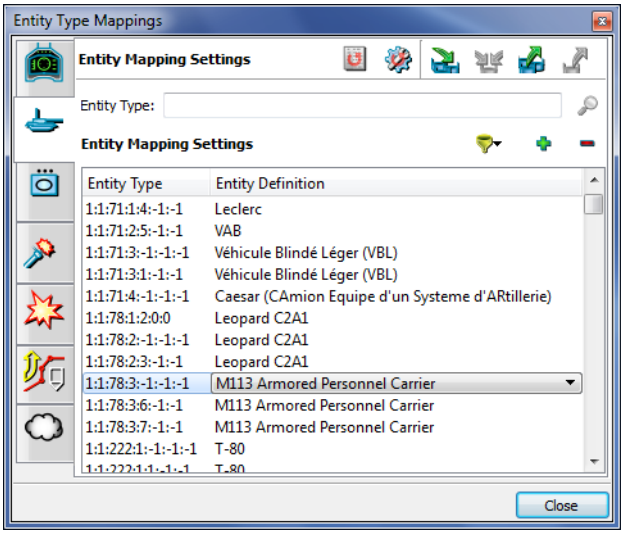


Figure 9-3. Editable entity definition

9.1.3. Filtering the Element Definition List

You can filter the list of element definitions that are available in the Entity Definition (Figure 9-3) 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.

9.1.4. 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 9-1).
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-Vantage highlights the entry for that enumeration if it is present.
4. Click the Delete button (▬).

9.1.5. How VR-Vantage Maps DI-Guy Models

When VR-Vantage discovers a lifeform entity on the DIS or HLA networks, it chooses the animations to play for a DI-Guy based on the lifeform's speed, position, and similar attributes. However, if VR-Vantage receives a special DI-Guy state message (PDU) that dictates the lifeform's character, appearance, or animation, VR-Vantage will no longer try to guess and will expect to be told how to render that lifeform for the remainder of the simulation.

9.2. Clearing the Model Instancing Cache

VR-Vantage 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 9-4).

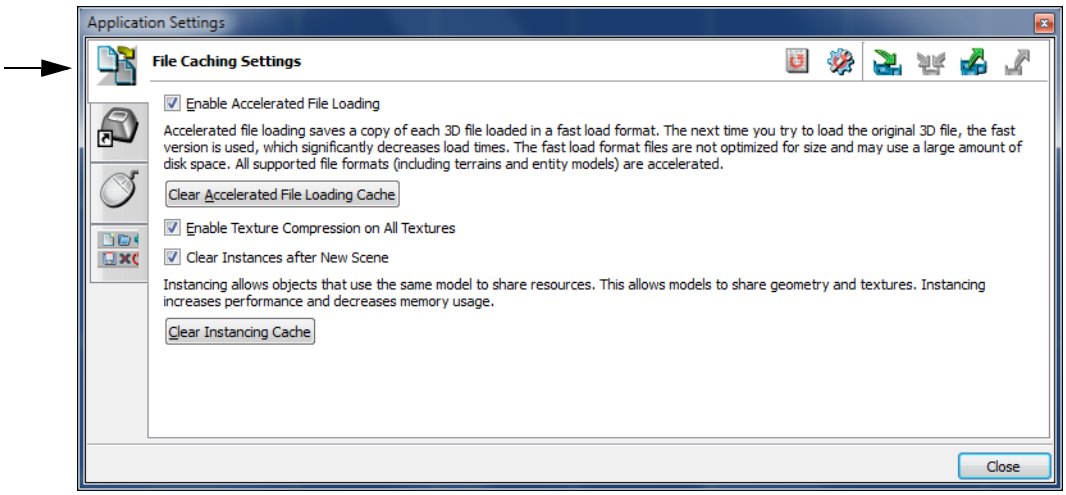


Figure 9-4. File Caching Settings page

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 9-4).
3. Click Clear Instancing Cache.

9.3. Compressing Model Files

The models and image files provided with VR-Vantage 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-Vantage, such as OpenFlight, 3DS, and OBJ, and raster formats such as RGB and PNG.

When VR-Vantage 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 9-1 describes the arguments.

Table 9-1: 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 9-1: 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 are 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 that 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*:

```
%MAK_IGDIR%/bin64/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.

```
%MAK_IGDIR%/bin64/medfTool.exe
  --directory %MAK_DATADIR%/Lifeforms --norecurse
  --extensions flt --image_extensions rgb
  --image_extensions rgba --image_extensions png
  --image_extensions dds
```

10. Configuring Emitter Volumes

This chapter explains how to configure display of emitter volumes.

10.1. Configuring Emitter Volumes

You can configure how VR-Vantage 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.

10.1.1. 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 10-1 describes the emitter volume visualizer attributes that affect emitter volume color.

Table 10-1: 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.

10.1.2. 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-Vantage 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-Vantage Calculates the Radius

VR-Vantage 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 );
```

10.1.3. Configuring Emitter Volume Segments

VR-Vantage 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-Vantage draws one segment. Figure 10-1 shows segments set to 10° (the default) and 30°.

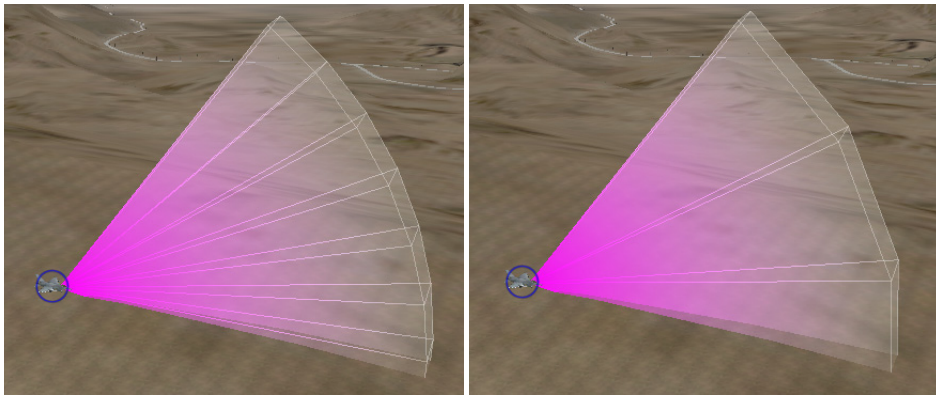


Figure 10-1. Emitter volume segments

Emitter volume segments are managed by the EllipsoidArc schema and model definitions based on it. VR-Vantage 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 10-2).

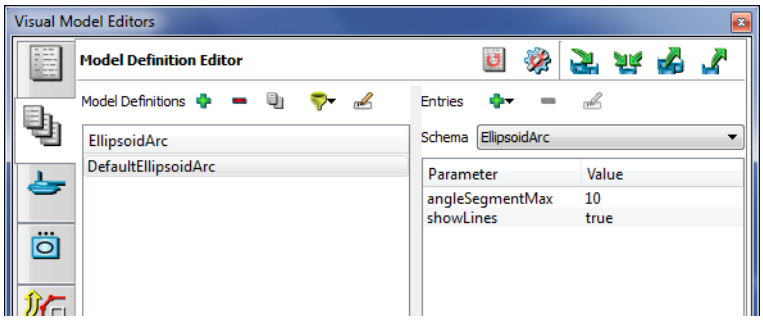


Figure 10-2. EllipsoidArc model definition

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

Displaying Segment Outlines

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

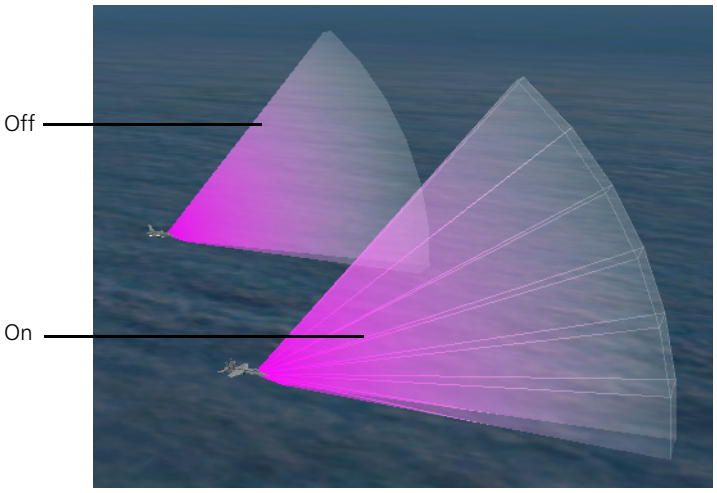


Figure 10-3. Segment outlines

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.

11. Mapping CIGI Models and Components

Unlike DIS or HLA, CIGI does not have a standard set of entity type mappings. Therefore, a CIGI connection cannot use the entity type mappings described elsewhere in this manual. VR-Vantage provides a set of mappings (MAK CIGI Mappings) for the entity models it includes. These mappings work with the CIGI host emulator provided with VR-Vantage. You can add new mappings, and you can edit the default mappings to work with other hosts. This chapter provides a minimal introduction to CIGI and the VR-Vantage CIGI driver and explains how to map CIGI components.

11.1. Introduction to CIGI

CIGI (Common Image Generator Interface) is an interface that allows an image generator (IG) to receive messages from a host to control what is drawn by the IG. CIGI defines packets that are sent between the host and the IG. CIGI is an open source project. It provides an interface control document and an open source library to send and receive CIGI messages: the CIGI Class Library (CCL). The VR-Vantage CIGI driver uses the CCL. VR-Vantage ships with the open-source CIGI Host Emulator. The host emulator and CCL are available at http://cigi.sourceforge.net. Chapter 12, *CIGI Host Emulator Tutorial* describes how to use the host emulator to control VR-Vantage.

11.1.1. The VR-Vantage CIGI Driver

The VR-Vantage CIGI driver supports best-effort (UDP) and reliable (TCP) communication between the CIGI driver and the host. When VR-Vantage uses a best-effort connection, it opens a UDP socket to the host port and tries to exchange data with the host. When it uses a reliable connection, the CIGI driver can act as a TCP client or TCP server. If it runs as a client, on connection the CIGI Driver tries to connect to a TCP server port on the host. If the connection fails, the driver returns to the disconnected state. If it runs as a server, it opens a TCP server socket on the listen port, and it accepts any connections made to that port. Data is then sent on that connection.

CIGI supports two modes of operation: synchronous and asynchronous. In synchronous mode, the IG sends a CIGI Start of Frame packet to the host, which prompts the host to send it data. The data is processed by the IG and is rendered; then the next frame starts. In asynchronous mode, the host sends data at any point and the IG renders the data. Since data may not be received every frame, the IG usually uses dead-reckoning and smoothing to update the positions of the entities until it receives an update.

The VR-Vantage CIGI driver supports synchronous and asynchronous modes. Synchronous mode can be run in single-threaded or multi-threaded mode, as follows:

- In single-threaded mode, the driver runs in the same thread as VR-Vantage, so its rate is bound by the VR-Vantage frame-rate. For example, if the driver is set to run at 60 Hz, but VR-Vantage has a frame rate of 20, the driver will only be able to run at 20 Hz. However, if the driver rate is set to 30 Hz, and VR-Vantage is running at 60, the CIGI Driver will only process CIGI messages at 30 Hz.
- In multi-threaded mode, the driver and VR-Vantage run in separate threads. The driver tries to maintain the desired rate. It sends start of frame messages, processes received messages, and sends messages to the main application to be rendered. Although this is not a true synchronous mode, it is the recommended synchronous mode for performance reasons.

11.1.2. CIGI Packet Support

VR-Vantage can receive the following CIGI packets:

- IG Control.
- Entity Control. Collision Detection is not supported.
- Component Control.
- Short Component Control.
- Articulated Part Control.
- Short Articulated Part Control.
- Rate Control.
- Celestial Sphere Control. Only date/time is supported.
- Weather Control. Only rain and snow are supported.
- View Control.
- View Definition. Mirror, Pixel Replication, and Orthographic projection are not supported.
- HAT/HOT Request.
- Line of Sight Segment Request.
- Line of Sight Vector Request.
- User-defined packet. VR-Vantage supports a user-defined packet for CIGI. For details, please see *DtCigiDiGuyCtrl.h*.

VR-Vantage can send the following packets:

- Start of Frame.
- HAT/HOT Response.
- Line of Sight Response.

For a complete list of supported and unsupported fields for each packet type, please see Appendix B, *CIGI Packets Supported*.

11.1.3. Mapping CIGI Input to VR-Vantage

You map CIGI input to VR-Vantage models and other data files in the CIGI Mappings dialog box. You can map the following objects and components:

- CIGI entity models.
- CIGI entity components.
- CIGI system components.
- CIGI view components.
- CIGI model states.
- CIGI model animations.
- CIGI database mappings.
- CIGI regional sea surface components.
- CIGI observer mode mappings.
- CIGI active sensor regions.

11.2. Mapping Entity Models for CIGI

To view entity models using CIGI, you must map the visual models to the entity types known to the CIGI host. You can also map articulated parts for entities.

To map an entity model to a CIGI entity type:

1. Choose **Settings** → **CIGI Mappings**. The CIGI Mappings dialog box opens.
2. Select the CIGI Entity Models page (Figure 11-1).

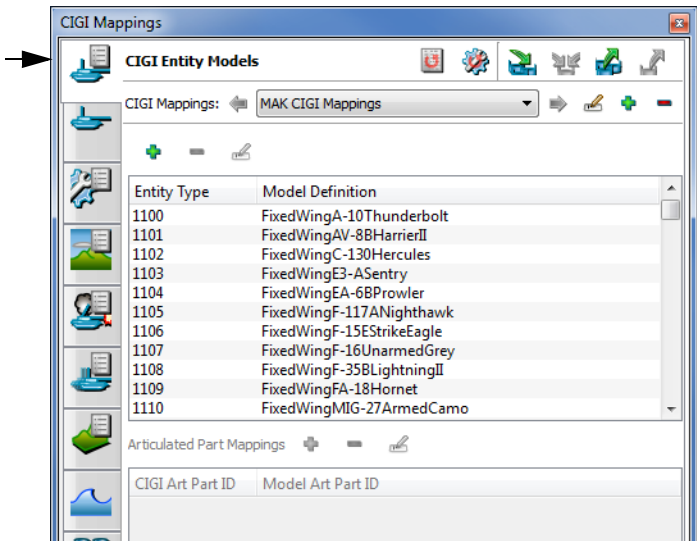


Figure 11-1. CIGI Entity Models page

3. Click the Add button (+) above the list of entity types. The Create New Entity Type Model Mapping dialog box opens (Figure 11-2).

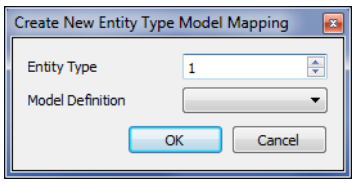


Figure 11-2. Create New Entity Type Model Mapping dialog box

4. Type an integer in the Entity Type box.
5. Select a model definition in the Model Definition list.
6. Click OK. The mapping is added to the list.

11.2.1. Adding an Articulated Part Mapping to an Entity Model

You can map articulated parts to an entity.

To add an articulated part mapping to an entity:

1. Choose **Settings** → **CIGI Mappings**. The CIGI Mappings dialog box opens.
2. Select the CIGI Entity Models page (Figure 11-1).
3. In the list of entity types, select the entity to which you want to add an articulated part. The Articulated Part Mappings window becomes active.
4. Click the Add button (+) next to the Articulated Part Mappings label. The Create New Art Part Mapping dialog box opens (Figure 11-3).

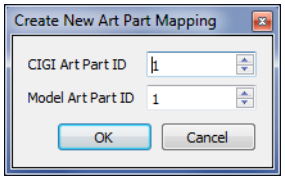


Figure 11-3. Create New Art Part Mapping dialog box

5. In the CIGI Art Part ID box, type an integer. This is an arbitrary number that must match whatever value the CIGI host uses.
6. In the Model Art Part ID box, type an integer. This value is the DIS comment node in the model.
7. Click OK.
8. The mapping is added to the Articulated Part Mappings window.

11.3. Mapping CIGI Components

VR-Vantage can process the following CIGI control messages:

- Entity component control message. Lets you specify model state, animation frame, animation range, and animation speed.
- View component control message. Lets you specify wireframe and whether or not to display the performance statistics overlay.
- System component control message. Lets you specify display of shadows.

The various component pages in the CIGI Mapping Settings dialog box let you specify the component IDs for these messages. The model state mappings specify the data for entity component controls.

For each type of component, if there are two or fewer data fields being used, you can use a component control or short component control message to set the component data. If there are more than two data fields in use, you cannot use a short component control. If there are more than two data fields in use, you cannot use a short component control.

The process for mapping components is similar for each component type.

To map a component ID:

1. Choose **Settings** → **CIGI Mappings**. The CIGI Mappings dialog box opens (Figure 11-1).
2. Select the page for the type of component you want to map.
3. Click the Add button (+) above the mapping window. The Create New Component Mapping dialog box opens (Figure 11-4).

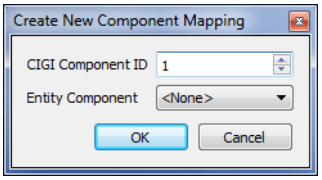


Figure 11-4. Create New Component Mapping dialog box

4. Type an integer value for the component ID. This is the value that will be used in the Component ID field of a component control message.
5. Complete the dialog box as follows:
   - For entity, view, or system components, select the component type from the list. The options vary for the different component types.
   - For animation controls, type the name of an animation.
   - For model state, select an appearance from the list.
6. Click OK. The mapping is added to the window.

11.3.1. Component Control Message Formats

This section describes the fields of the component control messages that VR-Vantage supports.

Entity Component Controls

You can use entity component controls to set the state in entity models and manipulate animations that are built into the model.

Model State

Model states are the equivalent of DIS appearance states. A model state component control message takes a component ID for a model state as configured on the Entity Components page and a model state mapping as configured on the CIGI Model State mappings page.

Table 11-1: Model state component control

Component Class	Entity (0).
Instance ID	Entity ID.
Component ID	ID for Model State, as set on the Entity Components Mappings page.
Component State	The value of the state.
Data 1	Model State, as set in CIGI Model State mappings page (int).
Data 2	Model State, as set in CIGI Model State mappings page (int).

Multiple nodes can be set to the same state through multiple data fields. You can set up to two states with a Short Component Control message or up to six with a Component Control Message.

Animation Control

Entity models can contain named animation nodes. You can set the speed, range, and current frame. The animation node in the model is designated by a string. A mapping from an integer to this string must be specified on the CIGI Model Animations page.

Table 11-2: Animation speed component control

Component Class	Entity (0).
Instance ID	Entity ID.
Component ID	ID for animation speed, as set on the Entity Components Mappings page.
Component State	Animation ID, as set on the Model Animations mappings page.
Data 1	Speed (float).
Data 2	Not applicable.

Table 11-3: Animation range component control

Component Class	Entity (0).
Instance ID	Entity ID.
Component ID	ID for animation range, as set on the Entity Components Mappings page.
Component State	Animation ID, as set on the Model Animations mappings page.
Data 1	First frame index (unsigned int).
Data 2	Last frame index (unsigned int).

Table 11-4: Animation frame component control

Component Class	Entity (0).
Instance ID	Entity ID.
Component ID	ID for animation frame, as set on the Entity Components Mappings page.
Component State	Animation ID, as set on the Model Animations mappings page.
Data 1	Frame index (unsigned int).
Data 2	Not applicable.

System Component Controls

You can enable and disable shadows using the Component State field of a System Component Control message. You can change shadow quality by passing an integer value in the Data 1 field of the component control. Table 11-5 describes the fields and values for the shadow component control.

Table 11-5: Shadows component control

Component Class	System (13).
Instance ID	Not applicable.
Component ID	Set in the System Components mappings page.
Component State	0 — Disable shadows. 1 — Enable shadows.
Data 1	Shadow Quality. Valid values are 1 through 4, with 1 being the worst quality and 4 the best.
Data 2	Not applicable.

View Component Controls

You can enable or disable the performance statistics overlay and wireframe mode using View Component Control messages. The component ID of either component can be set through the CIGI View Components page in the CIGI Mappings dialog box.

Table 11-6: Performance overlay component control

Component Class	View (1).
Instance ID	Not applicable.
Component ID	Set in the View Components mappings page.
Component State	0 — Disable performance statistics overlay. 1 — Enable overlay.
Data 1	Not applicable.
Data 2	Not applicable.

Table 11-7: Wireframe mode component control

Component Class	View (1).
Instance ID	Not applicable.
Component ID	Set in the View Components mappings.
Component State	0 — Disable wireframe mode. 1 — Enable wireframe mode.
Data 1	Not applicable.
Data 2	Not applicable.

11.4. Mapping a Database

Similar to mapping components to IDs, in a simulation using CIGI you can map databases to database numbers. If the host sends a control message that specifies a database, VR-Vantage will load it. If a database is not mapped or the host does not send a control message to load a database, you must load the database in VR-Vantage as you normally would for other connection types.

To map a database:

1. Choose **Settings** → **CIGI Mappings**. The CIGI Mappings dialog box opens (Figure 11-1).
2. Select the CIGI Database Mapping page (Figure 11-5).

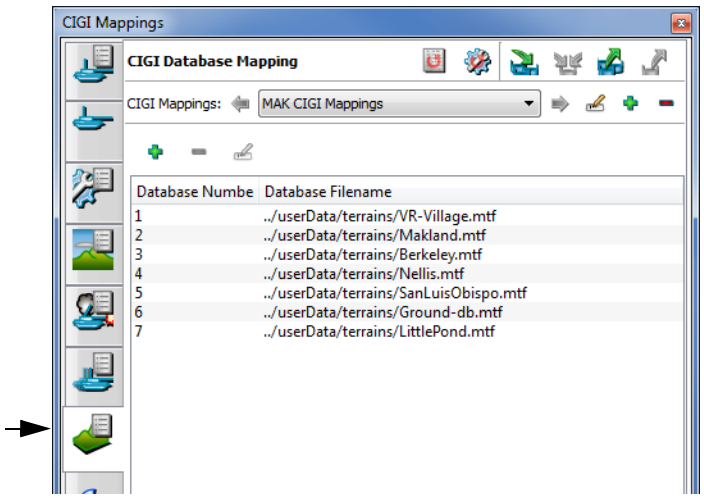


Figure 11-5. CIGI Database Mappings page

3. Click the Add button (+) above the list of databases. A file chooser dialog box opens.
4. Select the database that you want to map to.
5. Click Open. The Create Database Mapping dialog box opens (Figure 11-6).

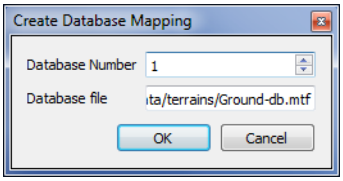


Figure 11-6. Create Database Mapping dialog box

6. Type a number for the database. If you choose a number that is in use, this database will replace the currently mapped database.

7. Click OK.

11.5. Mapping CIGI Views

VR-Vantage associates CIGI views with VR-Vantage channels using channel keywords. (For details about channel keywords, please see "Changing a Channel's Attributes," on page 1-10.) Any channel with keyword cigiView*X* is associated with CIGI view *X*. For example, keyword cigiView2 would map to CIGI view 2.

CIGI view control packets actually affect the observer that is controlling the specified channel or view. VR-Vantage looks up the channel that has the keyword that matches the view ID specified in the view control packet. Then it finds the observer controlling that channel and applies the view control commands to that observer. If multiple channels have the same keyword, then the first channel found with a matching keyword is used.

Multiple channels with the same keyword are fine, as long as they are all controlled by the same observer. This removes the need for CIGI view groups, although VR-Vantage supports them.

11.5.1. Mapping a CIGI View to an Observer Mode

You can map an observer mode to the ViewType parameter in a CIGI view control message.

To map an observer mode to a CIGI view:

1. Choose **Settings** → **CIGI Mappings**. The CIGI Mappings dialog box opens (Figure 11-1).
2. Select the CIGI Observer Mode Mapping page (Figure 11-7).

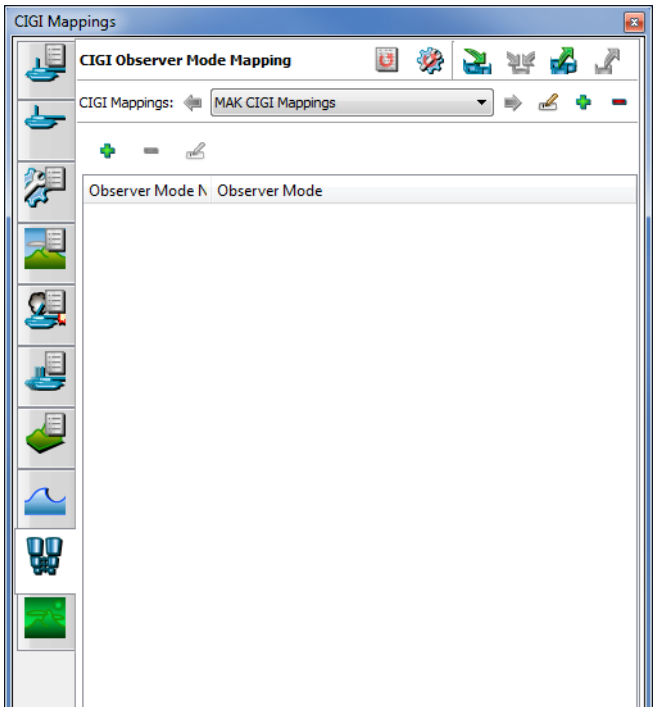


Figure 11-7. CIGI Observer Mode Mapping page

3. Click the Add button (+) above the list of observer mode mappings. The Create New Observer Mode Mapping dialog box opens.
4. Type the CIGI ID or select an ID from the list.
5. Select an observer mode from the Observer Mode list.
6. Click OK.

11.6. Prototypical Host – IG Configurations

This section describes several prototypes for host simulation and image generator configurations. The VR-Vantage CIGI implementation supports the networked IG configuration.

In the classic IG configuration (Figure 11-8), the host simulation connects to the network and filters all the entities and interactions, providing only the relevant ones to the image generator (shown as the VR-Vantage Application) using a protocol like CIGI. The IG renders the scene and presents it to the user on display screens of some sort.

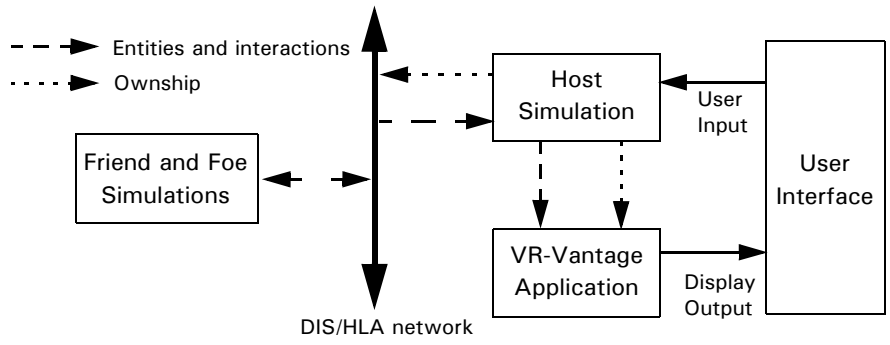


Figure 11-8. Classic IG Configuration

In the networked IG configuration (Figure 11-9), the host simulation communicates only the "ownship" (the one entity the host is simulating) to the image generator, using a protocol like CIGI. The image generator presents all the other entities and interactions in the distributed simulation.

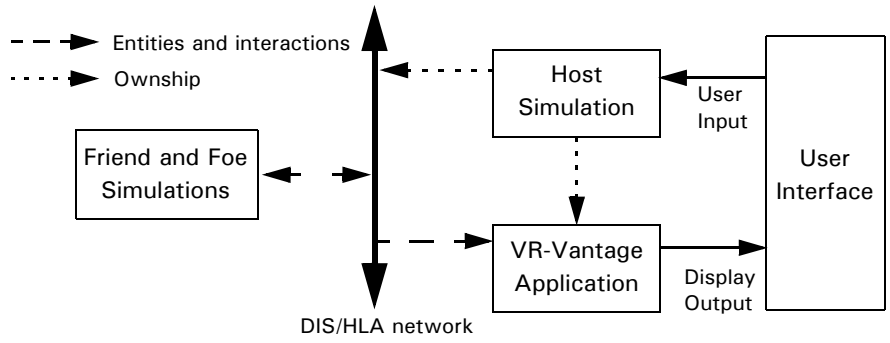


Figure 11-9. Networked IG Configuration

In the distributed visual/simulation configuration (Figure 11-10), the host simulation communicates with the visual application over the DIS/HLA network. (This is the way VR-Vantage connects to any distributed simulation entity.)

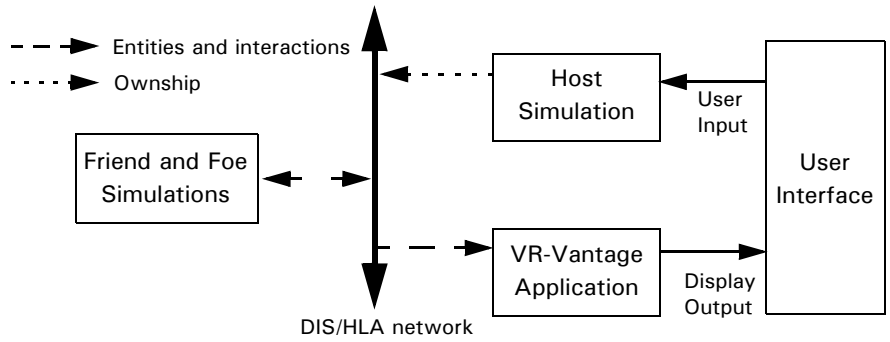


Figure 11-10. Distributed Visual/Simulation Application IG Configuration

In the integrated visual/simulation application (Figure 11-11), the simulation code is embedded in the visual application. This is the way many games are built. You can use the VR-Vantage toolkit to embed simulation code in VR-Vantage or embed VR-Vantage in a simulation application.

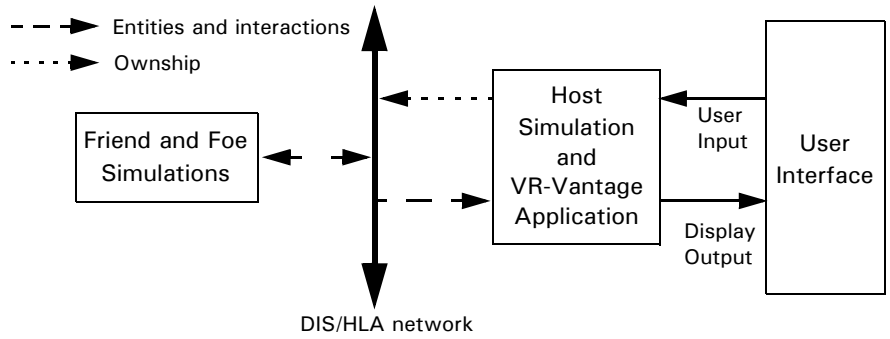


Figure 11-11. Integrated Visual/Simulation Application Configuration

12. CIGI Host Emulator Tutorial

VR-Vantage includes a CIGI host emulator (Windows only). This tutorial explains how to run it and interact with VR-Vantage.

12.1. Using the CIGI Host Emulator (Windows Only)

The Windows version of VR-Vantage includes a CIGI host emulator and a set of mappings that you can use to test your CIGI setup. This section provides a basic introduction to starting the host emulator, connecting VR-Vantage to it, and sending basic control messages to VR-Vantage.

Figure 12-1 illustrates connection settings that must be the same on the host emulator (Section 12.1.1, "Start the Host Emulator") and the CIGI connection in VR-Vantage (Section 12.1.2, "Connect VR-Vantage to the CIGI Host Emulator").

- For best results, shut down VR-Vantage before you start this tutorial. Start it when instructed to do so.
- To see a set of brief videos that illustrate this tutorial, on the Start menu, choose **VR-Vantage 2.0** → **Documentation** → **VR-Vantage Video Tutorials**, or open *./doc/vrvantage_tutorialvideos.htm*.

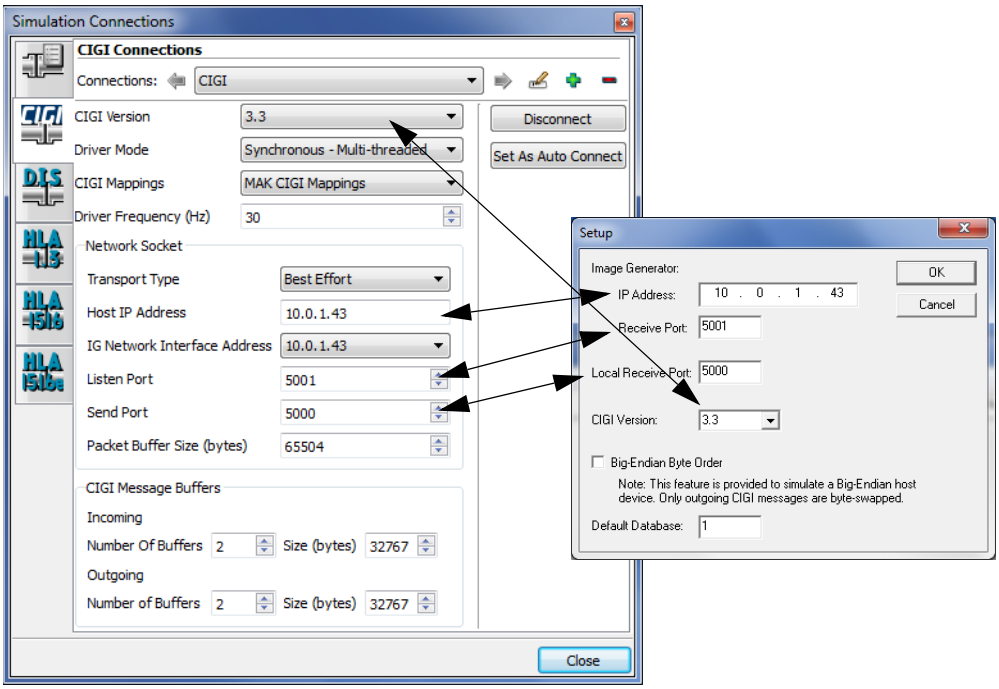


Figure 12-1. Connection settings and host emulator setup

12.1.1. Start the Host Emulator

Running the host emulator on the same computer as VR-Vantage could affect VR-Vantage's performance.

To start the host emulator:

1. On the Start menu, choose **All Programs** → **VR-Vantage 2.0** → **Tools** → **CIGI Host Emulator**. The host emulator starts up (Figure 12-2). The first time you run it, the Setup dialog box opens automatically (Figure 12-3). (Thereafter, to change the setup, in the host emulator, choose **File** → **Setup**.)

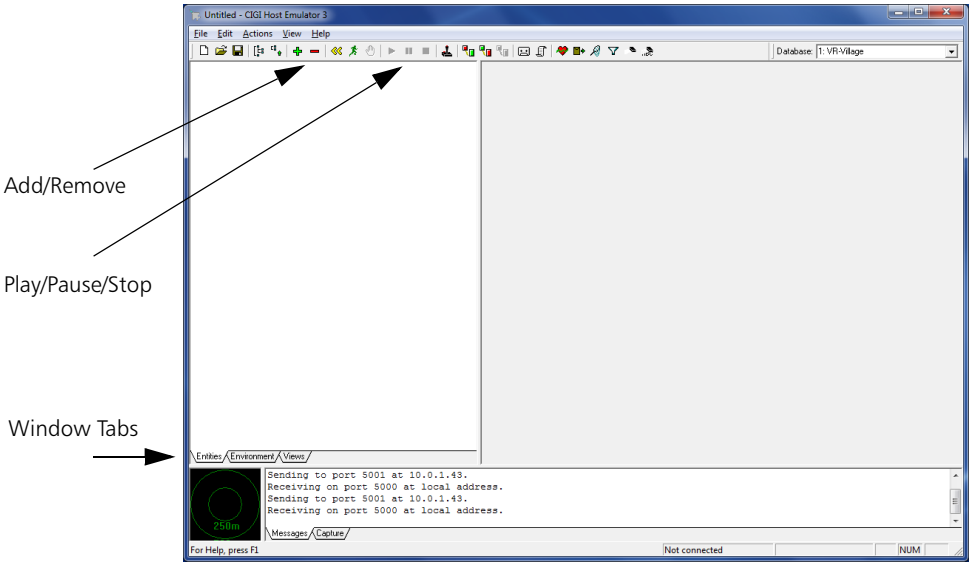


Figure 12-2. CIGI host emulator

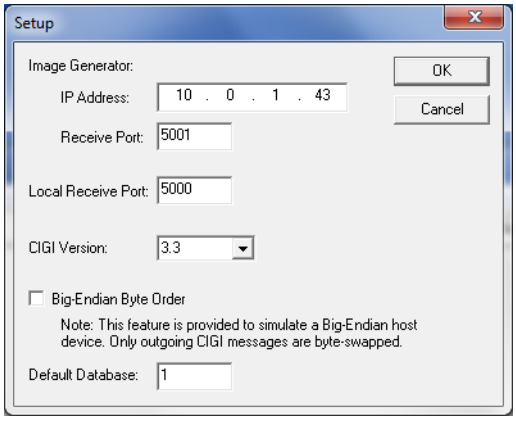


Figure 12-3. Setup dialog box

2. In the IP Address box, type the IP address for the computer on which you are running VR-Vantage.

3. In the Receive Port box, type the port that is configured as the Listen Port in the CIGI Connection that you are using in VR-Vantage. (In other words, this is the port to which the host emulator should send its messages.)
4. In the Local Receive Port, type the port on which the host emulator should receive messages. This must match the Send Port value on the CIGI Connection that you are using in VR-Vantage.
5. Specify the CIGI version that you want to use.
6. Specify the default database that you want to use. This value should match a database mapping in the CIGI Database Mapping page of the CIGI Mapping Settings in VR-Vantage. (Database 1 is VR-Village.)
7. Click OK.

12.1.2. Connect VR-Vantage to the CIGI Host Emulator

To connect VR-Vantage to the CIGI Host Emulator:

1. Start VR-Vantage IG.
2. Choose **Settings** → **Connections**. The Simulation Connections dialog box opens.
3. Select the CIGI Connections page (Figure 12-1).
4. Select a connection or create a new one.
5. Set the CIGI Version to the same CIGI version you specified in the host emulator setup.
6. Set CIGI Mappings to MAK CIGI Mappings.
7. Set the Host IP Address to the IP address of the computer on which the host emulator is running.
8. Set the Network Device Address to the IP address of the computer running VR-Vantage IG. The Image Generator IP Address in the host emulator setup must match this value.
9. Set the Listen Port to the same value as the Image Generator Receive Port value in the host emulator setup.
10. Set the Send Port to the same value as the Local Receive Port value in the host emulator setup.
11. Change any other connection parameters as desired.
12. Click Connect. After a few seconds, VR-Vantage displays the database configured in the host emulator.

12.1.3. Create an Ownship Entity on the Host Emulator

The ownship entity controls the observer in VR-Vantage.

To create the ownship entity:

1. In the CIGI host emulator, select the Entities tab (Figure 12-2). The window is empty because there are no entities.
2. On the toolbar (Figure 12-2), click the Add button (). The New Entity dialog box opens (Figure 12-4).

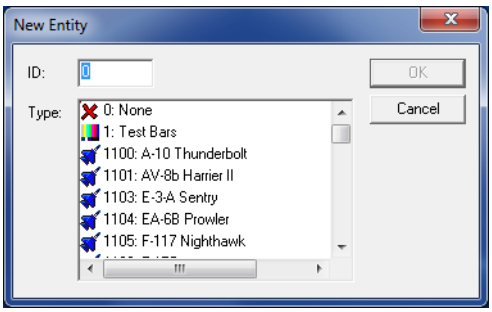


Figure 12-4. New Entity dialog box

3. Select 0: None.
4. Click OK. The Ownship entity is added to the entity list. Its properties are listed in the panel to the right of the entity list (Figure 12-5).

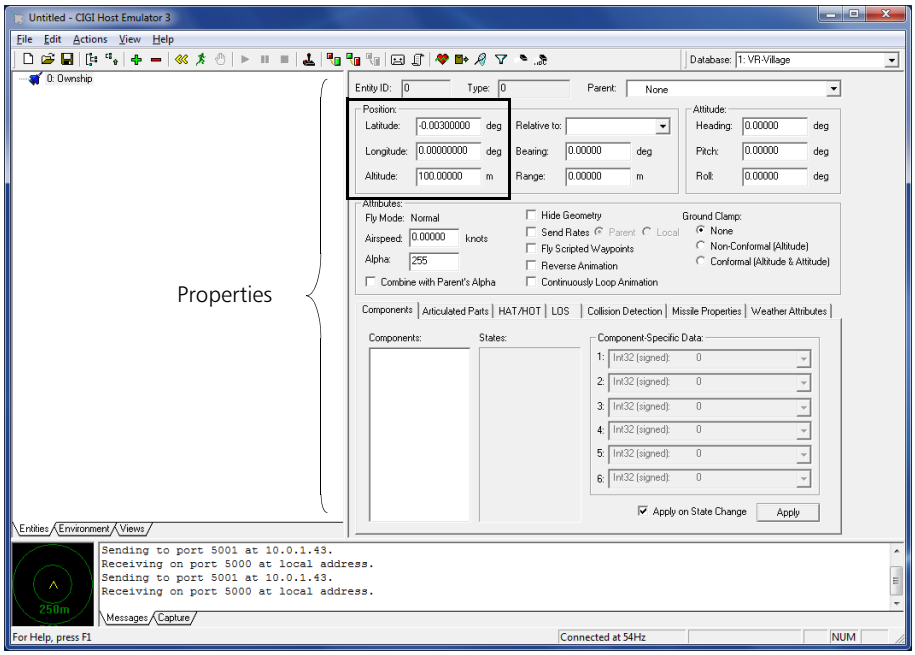


Figure 12-5. Entity properties for ownship entity

5. In VR-Vantage, an entity called CIGI Ownship is added to the entity list.
6. Attach to the entity by sending a view control message from the host emulator:
   a. Choose **Actions** → **Send Packet** → **View Control**. The Send View Control Packet dialog box opens.
   b. Edit the view control attributes as desired.
   c. Click Send. The CIGI host emulator sends a view control with the Position data in the main window. (If you are using database 1 (VR-Village), the view changes to a view of the village.
7. In the Position group box on the host emulator, change the Altitude attribute (Figure 12-5). The view in VR-Vantage changes.

12.1.4. Create a Simulated Entity on the Host Emulator

Creating a simulated entity will let you apply effects and experiment with setting model states and other attributes.

To create a simulated entity:

1. In the CIGI host emulator, select the Entities tab (Figure 12-2).
2. On the toolbar (Figure 12-2), click the Add button (✚). The New Entity dialog box opens (Figure 12-4).
3. Select M1A2.
4. Click OK. The entity is added to the entity list.
5. In VR-Vantage, an entity called CIGI Entity 1 is added to the entity list.

12.1.5. Change an Entity's Model State

To change an entity's model state:

1. In VR-Vantage, attach to the M1A2.
2. Rotate the view so that you can see the rear of the tank.
3. In the host emulator, select the Entities tab.
4. Select the M1A2 entity (Figure 12-6).

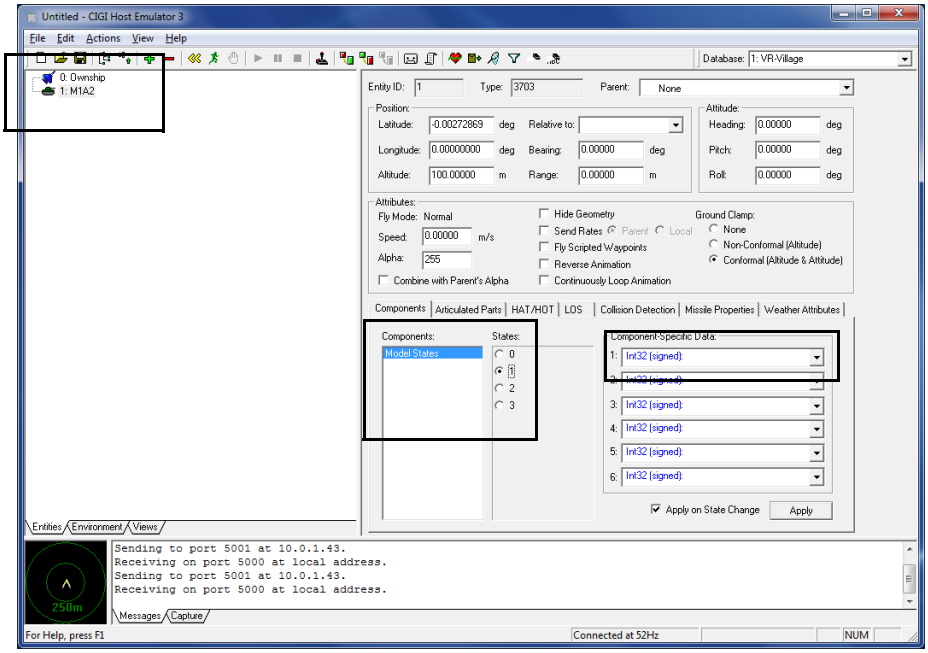


Figure 12-6. Entity attributes

5. In the properties panel, select the Components tab (Figure 12-6).
6. In the States list, select option 1.
7. In the Component Specific Data list, put the cursor in the first box.
8. Type 16.
9. Click Apply. The brake lights on the tank turn on (Figure 12-7).

Figure 12-7. Brake lights

12.1.6. Add an Effect

To add an effect in the MÄK implementation of CIGI, you add the effect and attach it to an entity.

To add an effect:

1. In the CIGI host emulator, select the Entities tab (Figure 12-2).
2. On the toolbar (Figure 12-2), click the Add button (). The New Entity dialog box opens (Figure 12-4).
3. Select Detonation.
4. Click OK. The effect is added to the entity list.
5. On the properties panel, in the Parent list, select M1A2. In the entity list, the Detonation is now subordinate to the M1A2 entity (Figure 12-6).

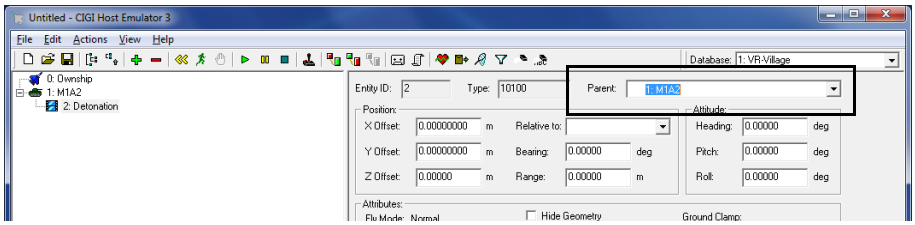


Figure 12-8. Entity attributes

6. To display the detonation, click Play (Figure 12-2).

12.1.7. Change the Weather

You can send control messages to enable and disable precipitation. VR-Vantage supports layer 4 (rain) and 5 (snow).

To change the weather:

1. In the host emulator, choose **Actions** → **Send Packet** → **Weather Control**. The Send Weather Control Packet dialog box opens (Figure 12-9).

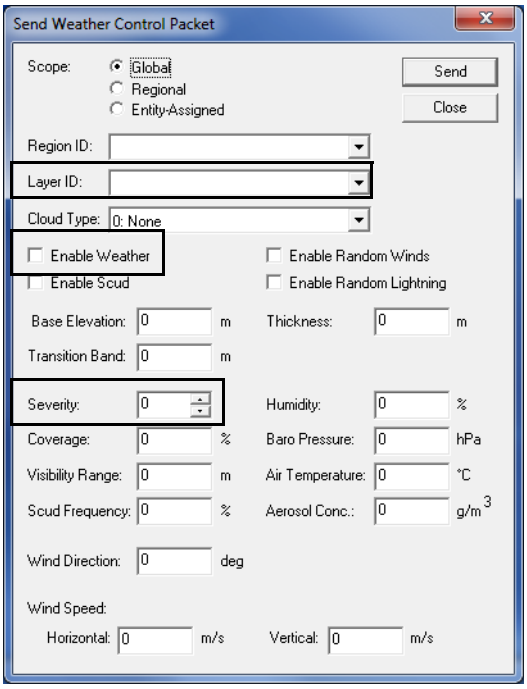


Figure 12-9. Send Weather Control Packet dialog box

2. In the Layer ID box, type 4 (for rain) or 5 (for snow).
3. Select the Enable Weather check box.
4. In the Severity box, select an option greater than zero.
5. Click Send. VR-Vantage displays the selected form of precipitation.

13. Creating and Editing Key Mappings

This appendix explains how to edit key mappings and create new key mappings.

13.1. 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-Vantage comes with key mappings that we think will meet the needs of most VR-Vantage users. However, you can edit the default keyboard mappings and create new mappings of your own with the Key Mapping Editor.

13.2. The Key Mapping Editor

The Key Mapping Editor (Figure 13-1) 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.

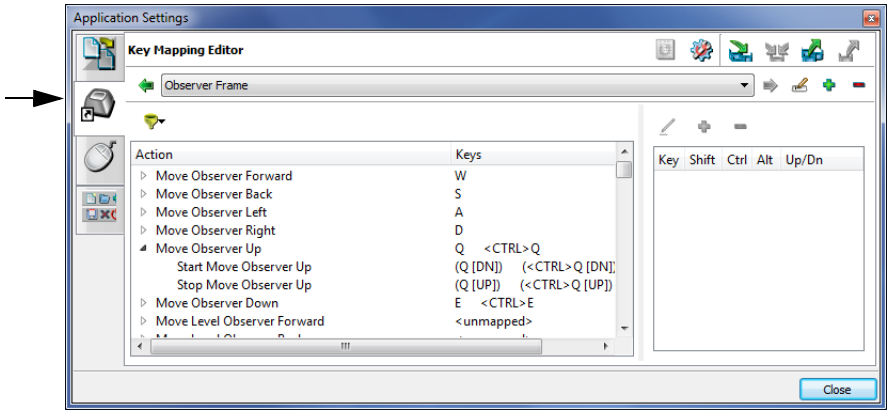


Figure 13-1. Key Mapping Editor

13.2.1. 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-Vantage 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 13-1.

13.3. Editing a Key Map

The Key Mapping Editor lists all of the VR-Vantage 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 13-1).
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 13-4.
   - "Changing a Key Mapping," on page 13-6.
   - "Deleting a Key Mapping," on page 13-6.
5. Optionally, export the key map to a file.
6. Click OK.

13.3.1. 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 13-8.
2. Select the function to which you want to add a key mapping.
3. Click the Add button (+) above the Key Map window (Figure 13-2). The Key Entry dialog box opens (Figure 13-3).

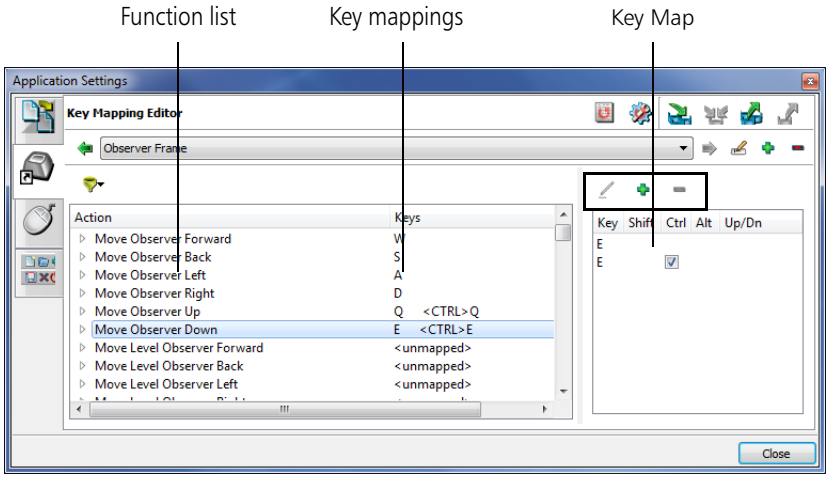


Figure 13-2. Key Mapping Editor

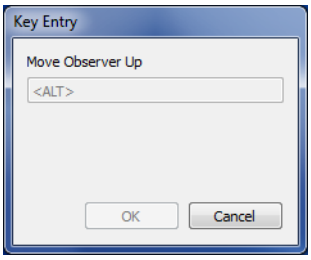


Figure 13-3. Key Entry dialog box

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-Vantage notifies you and asks how to proceed. For details about duplicate key mappings, please see "Using Combined Key Mappings," on page 13-7.) The mapping is added to the function and is listed in the Keys column of the function list and in the Key Map window.

13.3.2. 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 13-2).
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 13-4). It shows the current key mapping.

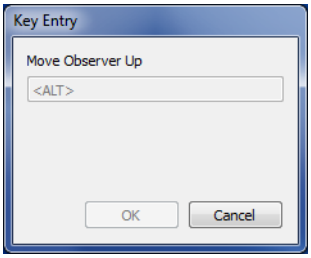


Figure 13-4. Key Entry dialog box

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.

13.3.3. 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 13-2).
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.

13.4. 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-Vantage 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 13-5). It lists the functions that already use this key mapping.

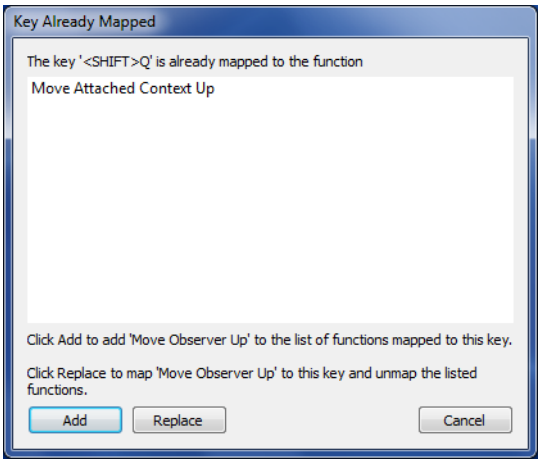


Figure 13-5. Key Already Mapped dialog box

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.

13.5. 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.

13.6. Creating a Key Map

To create a key map:

1. Choose **Settings** → **Application**.The Application Settings dialog box opens.
2. Select the Key Mapping Editor page (Figure 13-1).
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 13-4.

13.7. Deleting a Key Map

To delete a key map:

1. Choose **Settings** → **Application**.The Application Settings dialog box opens.
2. Select the Key Mapping Editor page (Figure 13-1).
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.

A. The WRM Specification (DIS Notes)

Some OpenFlight files contain information specified by the *WRM Entity Model Specification for DIS Interoperability*. This information makes it possible for VR-Vantage 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.

A.1. Introduction

In order for visualization applications such as VR-Vantage 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-Vantage 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-Vantage 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-Vantage, and with visualization applications from other vendors.

A.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.

A.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.

A.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.

A.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.

A.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-Vantage, so spelling counts.

A.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 A-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 A-2.

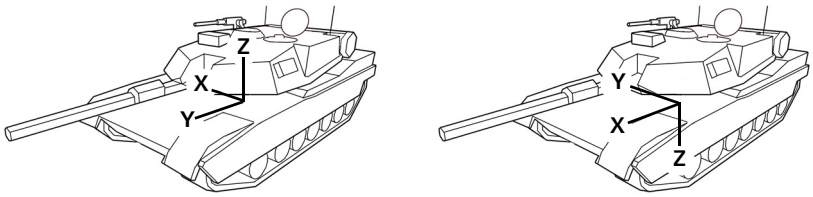
- `state` *`state`*,*`state`*... . Specifies the state of the appearance attribute with a DIS appearance state code. This keyword is placed in a Group node just below the switch node. For a list of supported values, please see Table A-2.

A.3.3. Model Coordinate Systems

OpenSceneGraph (OSG) and the DIS Standard use different right-hand coordinate systems. Table A-1 describes the two systems. Figure A-1 illustrates them.

Table A-1: Model coordinate systems

Coordinate	OpenSceneGraph	DIS
X	Right	Forward
Y	Forward	Right
Z	Up	Down



OSG coordinate system DIS coordinate system

Figure A-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.

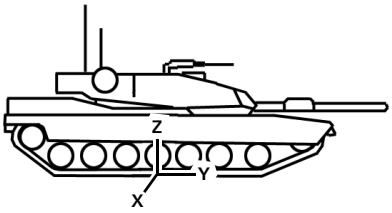
Location of the Origin for Models

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.

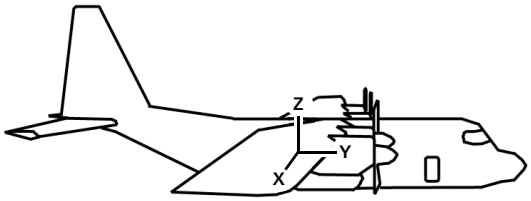
Figure A-2 illustrates the location of a model's origin for each platform domain.

Land



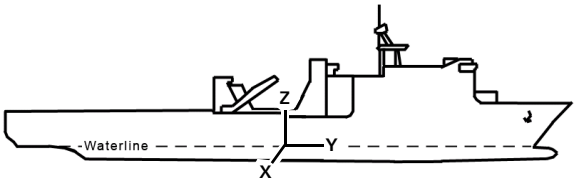
On the plane of ground contact, at the axis of yaw rotation.

Air



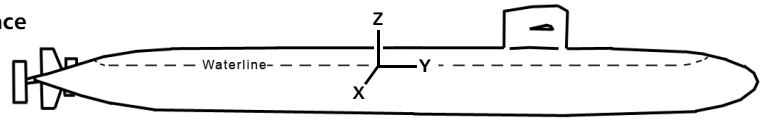
At the center of gravity.

Surface



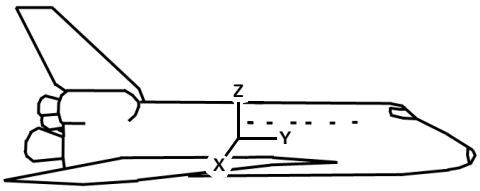
On the axis of the center of buoyancy, in the plane of the waterline for an unloaded ship.

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 A-2. Location of origin by domain

A.4. Articulated Parts

In order for VR-Vantage 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-Vantage 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.

A.5. Entity Appearances

VR-Vantage 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 A-8, lists the attributes you can use with VR-Vantage.

The children of the switch node represent the different portions of a model among which VR-Vantage 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-Vantage 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-Vantage does not support this functionality. To tell VR-Vantage 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 A-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.

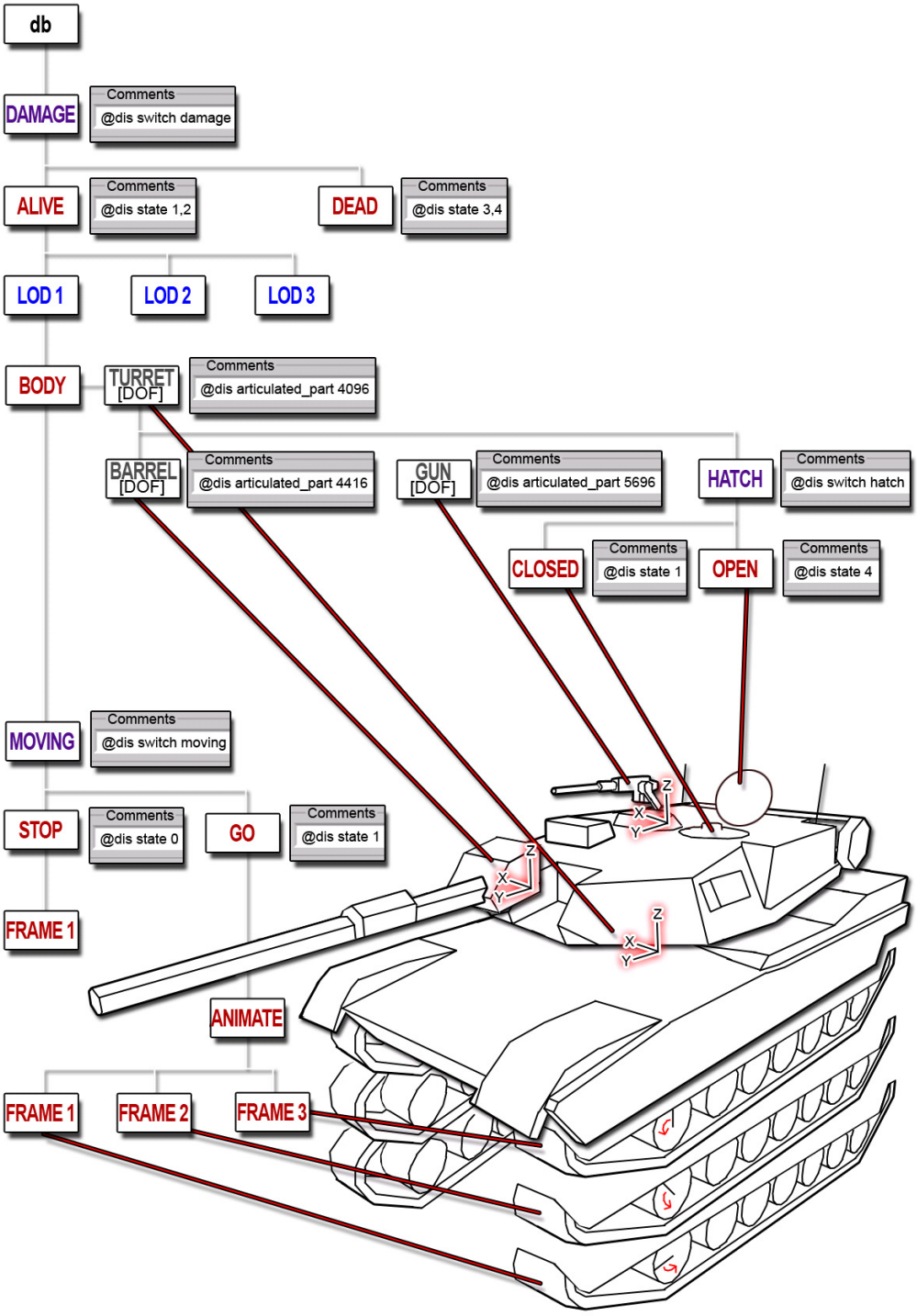


Figure A-3. 3D model structure

A.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-Vantage that animation instructions follow.
- *`num_frames_per_second`* is the rate at which VR-Vantage 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.

A.7. DIS Keyword Values

Table A-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 A-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 A-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 A-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 A-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 A-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 A-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 A-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 A-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 A-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 A-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.

B. CIGI Packets Supported

This appendix lists the various CIGI packets and the fields that VR-Vantage supports.

B.1. CIGI Packet Support

The tables in this section describe VR-Vantage support for the following CIGI packet types:

- IG Control (Table B-1).
- Entity Control (Table B-2).
- Component Control (Table B-3).
- Short Component Control (Table B-4).
- Articulated Part Control (Table B-5).
- Short Articulated Part Control (Table B-6).
- Rate Control (Table B-7).
- Celestial Sphere Control (Table B-8).
- Weather Control (Table B-9).
- View Control (Table B-10).
- View Definition (Table B-11).
- HAT/HOT Request (Table B-12).
- Line-of-sight Segment Request (Table B-13).
- Line-of-sight Vector Request (Table B-14).

Table B-1: IG control packets

Field	Supported	Unsupported
Database Number	X	
IG Mode	X	
Timestamp Valid	X	
Extrapolation/Interpolation Enable	X	
Host Frame Number	X	
Timestamp	X	
Last IG Frame Number	X	

Table B-2: Entity control packets

Field	Supported	Unsupported
Entity ID	X	
Entity State	X	
Attach State	X	
Collision Detection Enable		X
Inherit Alpha	X	
Ground/Ocean Clamp	X (Conformal Only)	
Animation Direction	X	
Animation Loop Mode	X	
Animation State	X	
Linear Extrapolation/Interpolation Enable	X	
Alpha	X	
Entity Type	X	
Parent ID	X	
Roll/Pitch/Yaw	X	
Latitude/Longitude/Altitude or X/Y/Z offset	X	

Table B-3: Component control packets

Field	Supported	Unsupported
Component ID	X	
Instance ID	X	
Component Class	X	
Component State	X	
Component Data	X	

Table B-4: Short component control packets

Field	Supported	Unsupported
Component ID	X	
Instance ID	X	
Component Class	X	
Component State	X	
Component Data	X	

Table B-5: Articulated part control packets

Field	Supported	Unsupported
Entity ID	X	
Articulated Part ID	X	
Articulated Part Enable	X	
X/Y/Z Offset Enable	X	
Roll/Pitch/Yaw Enable	X	
X/Y/Z Offset	X	
Roll/Pitch/Yaw	X	

Table B-6: Short articulated part control packets

Field	Supported	Unsupported
Entity ID	X	
Articulated Part ID 1	X	
Articulated Part ID 2	X	
DOF Select 1	X	
DOF Select 2	X	
Articulated Part Enable 1	X	
Articulated Part Enable 2	X	
DOF 1	X	
DOF 2	X	

Table B-7: Rate control packets

Field	Supported	Unsupported
Entity ID	X	
Articulated Part ID	X	
Apply To Articulated Part	X	
Coordinate System	X	
X/Y/Z Linear Rate	X	
Roll/Pitch/Yaw Angular Rate	X	

Table B-8: Celestial sphere control packets

Field	Supported	Unsupported
Hour	X	
Minute	X	
Ephemeris Model Enable	X	
Sun Enable		X
Moon Enable		X
Star Field Enable		X
Date/Time Valid	X	
Date	X	
Star Field Intensity		X

Table B-9: Weather control packets

Field	Supported	Unsupported
Entity/Region ID		X
Layer ID	X (Only Rain/Snow)	
Humidity		X
Weather Enable	X	
Random Winds Enable		X
Random Lightning Enable		X
Cloud Type		X
Scope		X
Severity	X	
Air Temperature		X
Visibility Range		X
Scud Frequency		X
Coverage		X
Base Elevation		X
Thickness		X
Transition Band		X
Horizontal Wind Speed		X
Vertical Wind Speed		X
Wind Direction		X
Barometric Pressure		X
Aerosol Concentration		X

Table B-10: View control packets

Field	Supported	Unsupported
View ID	X	
Group ID	X	
X/Y/Z Offset Enable	X	
Roll/Pitch/Yaw Offset Enable	X	
Entity ID	X	
X/Y/Z Offset	X	
Roll/Pitch/Yaw	X	

Table B-11: View definition packets

Field	Supported	Unsupported
View ID	X	
Group ID	X	
Near/Far/Left/Right/Top/Bottom Enable	X	
Mirror Mode		X
Pixel Replication Mode		X
Projection Type		X
Reorder		X
View Type		X
Near/Far/Left/Right/Top/Bottom	X	

Table B-12: HAT/HOT request packets

Field	Supported	Unsupported
HAT/HOT ID	X	
Request Type	X (Extended not supported)	
Coordinate System	X	
Update Period	X	
Entity ID	X	
Latitude/Longitude/Altitude or X/Y/Z offset	X	

Table B-13: Line-of-sight segment request packets

Field	Supported	Unsupported
LOS ID	X	
Request Type		X (Extended not supported)
Source Point Coordinate System	X	
Destination Point Coordinate System	X	
Response Coordinate System		X
Destination Entity ID Valid	X	
Alpha Threshold		X
Source Entity ID	X	
Source Latitude/Longitude/Altitude or X/Y/Z Offset	X	
Destination Latitude/Longitude/Altitude or X/Y/Z Offset	X	
Material Mask		X
Update Period	X	
Destination Entity ID	X	

Table B-14: Line-of-sight vector request packets

Field	Supported	Unsupported
LOS ID	X	
Request Type		X (Extended Not Supported)
Source Point Coordinate System	X	
Response Coordinate System		X
Alpha Threshold		X
Entity ID	X	
Azimuth	X	
Elevation	X	
Minimum Range	X	
Maximum Range	X	
Source Latitude/Longitude/Altitude or X/Y/Z Offset	X	
Material Mask		X
Update Period	X	

B.2. User Defined CIGI Packet

VR-Vantage supports a user-defined packet for CIGI. For details, please see *DtCigiDiGuyCtrl.h*.

C. CIGI Utilities

This appendix describes the utilities provided for testing CIGI connections.

C.1. Using asynchHostTest.py

The *./tools/CigiUtilities/asynchHostTest.py* script has two functions. It acts as a simple CIGI host that sends test packets to a socket for test purposes. It also serves as an example of how you can write a script to test your CIGI network.

This script opens a socket and repeatedly sends IGControl and EntityControl messages to the socket until you press **Ctrl**+**c**. The script instructs the IG to load the Ground-DB terrain database and 700 FixedWingA-10Thunderbolt entities from VR-Vantage. It then cycles the roll of the entities at a given frame rate.

To run *asyncHostTest.py* with default values (port 5001, IP 127:0:0:1), use:

```
asyncHostTest.py
```

The script creates 700 entities and changes their roll value. To see the entities in VR-Vantage:

1. Start VR-Vantage.
2. Choose **Settings** → **Connection**. The Simulation Connections dialog box opens.
3. Select the CIGI Connections page. The Listen Port (5001) and Host IP Address match the default values for the host created by the script.
4. Change the IG Network Interface Address to 127.0.0.1.
5. Click Connect. VR-Vantage loads the ground-db terrain and displays the entities (Figure C-1).

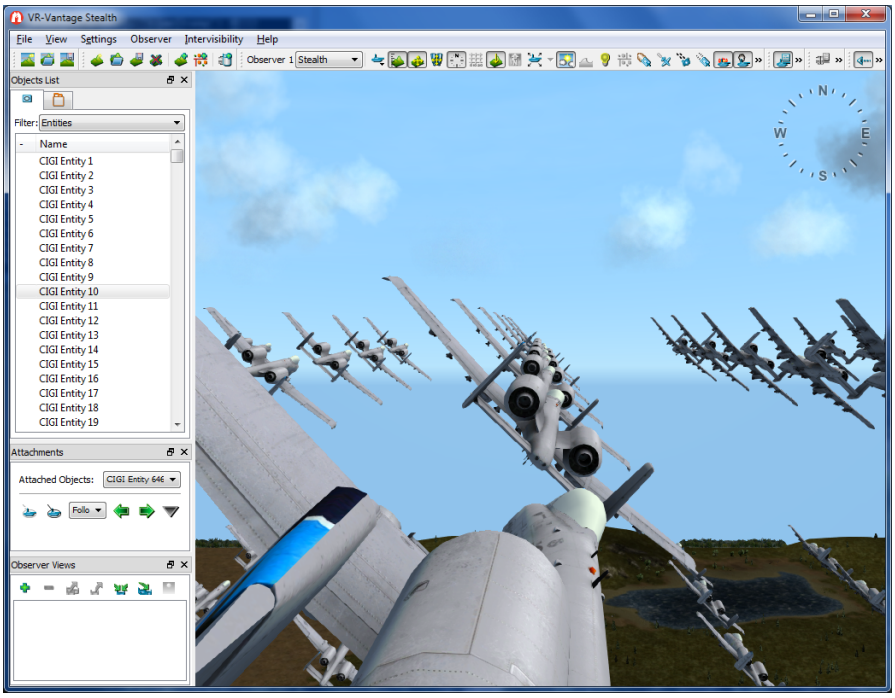


Figure C-1. Entities generated by *asyncHostTest.py*

C.2. Using logger.py

The *./tools/CigiUtilities/logger.py* script listens to a UDP socket (unicast or multicast) and records the packets it receives. It can then play the packets back.

To record:

```
logger.py -r
```

The default log file is *cigiSession.log*.

To play:

```
logger.py
```

The logger records data in a binary format. However, you can convert it to a readable format. To convert the data, run:

```
logger.py -c
```

The default output file is *cigiSession.txt*. The following is an example of converted log entries:

```
<Time(0.000000)>
<IGControl({'lastFrame': 0, 'timeStamp': 0, 'dbNum': 6, 'frameNum': 1})>
<EntityControl({'bits2': 0, 'alt': 140.0, 'parentID': 0, 'lon': -122.988,
  'pitch': 0.0, 'entType': 1100, 'roll': 1.0, 'alpha': 255, 'yaw': 0.0,
  'lat': 36.00827037, 'entID': 1, 'bits1': 1})>
<EntityControl({'bits2': 0, 'alt': 140.0, 'parentID': 0, 'lon': -
  122.9883, 'pitch': 0.0, 'entType': 1100, 'roll': 1.0, 'alpha': 255,
  'yaw': 0.0, 'lat': 36.00827037, 'entID': 2, 'bits1': 1})>
<EntityControl({'bits2': 0, 'alt': 140.0, 'parentID': 0, 'lon': -
  122.98859999999999, 'pitch': 0.0, 'entType': 1100, 'roll': 1.0,
  'alpha': 255, 'yaw': 0.0, 'lat': 36.00827037, 'entID': 3, 'bits1': 1})>
<EntityControl({'bits2': 0, 'alt': 140.0, 'parentID': 0, 'lon': -
  122.98889999999999, 'pitch': 0.0, 'entType': 1100, 'roll': 1.0,
  'alpha': 255, 'yaw': 0.0, 'lat': 36.00827037, 'entID': 4, 'bits1': 1})>
<EntityControl({'bits2': 0, 'alt': 140.0, 'parentID': 0, 'lon': -
  122.98919999999998, 'pitch': 0.0, 'entType': 1100, 'roll': 1.0,
  'alpha': 255, 'yaw': 0.0, 'lat': 36.00827037, 'entID': 5, 'bits1': 1})>
```

When the logger records packets, it does not compress them. The log file can quickly grow quite large.

C.3. Using snooper.py

The *./tools/CigiUtilities/snooper.py* script can connect to the host and the IG at the same time and can record traffic and then play it back. Figure C-2 illustrates the snooper as follows:

- Host/IG interaction without the snooper.
- Host/IG interaction with the snooper mediating. The snooper receives the packets from the host and IG and passes them on. It also records them to a file.
- Snooper playback. The snooper sends the logged packets to the proper destination.

When the snooper records packets, it does not compress them. The log file can quickly grow quite large.

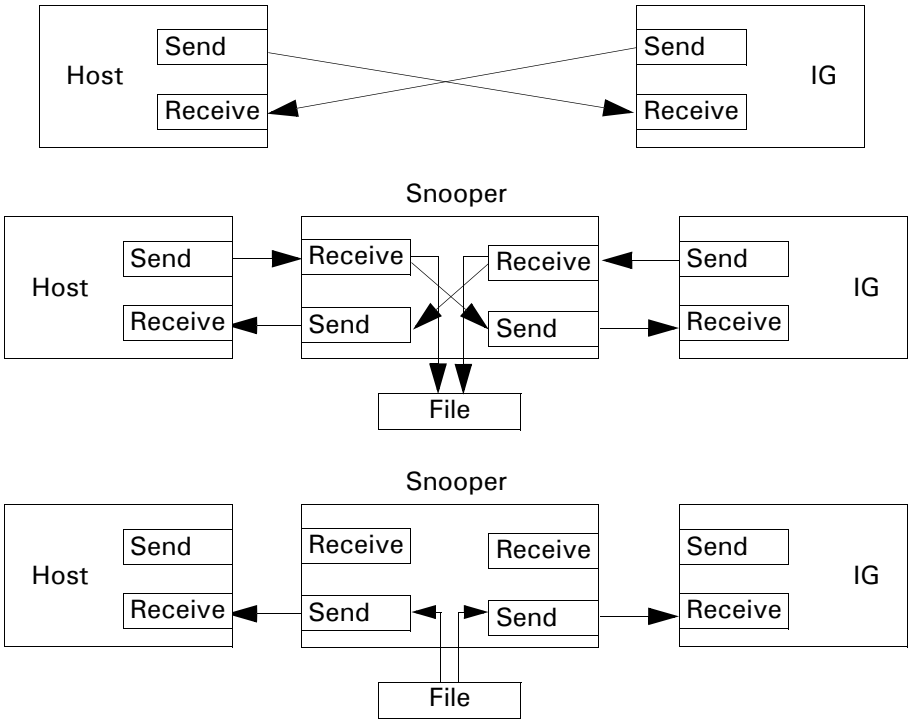


Figure C-2. Using the snooper

To run the snooper you must specify send and receive ports for both the host and IG, for example:

```
snooper.py --host_send_port 5000 --host_recv_port 5001
  --ig_recv_port 5002 --ig_send_port 5003
```

Since this is a long command line, you can save the command line to a configuration file, as follows:

```
snooper.py --host_send_port 5000 --host_recv_port 5001
  --ig_recv_port 5002 --ig_send_port 5003 --save [-f
  myfile]
```

If you do not specify a file with `-f`, the command is saved to *snooper.cfg*.

To load the saved configuration, run:

```
snooper.py --load [-f myfile]
```

C.4. The pyCigi Module

The pyCigi module (*./tools/CigiUtilities/byCigi*) is a package of modules to handle the reading, writing, packing and unpacking of CIGI messages. pyCigi has modules to handle each of the CIGI message types that are supported by VR-Vantage. For a list of supported packets, please see Chapter B, *CIGI Packets Supported*.

Each module within pyCigi is self documented and contains a unit test. The documentation for a module can be seen from inside a Python shell:

```
python
>>> import pyCigiStartOfFrame
>>> help(pyCigiStartOfFrame.StartOfFrame)
```

To run the unit test for a module, run the module as a script from a shell window:

```
pyCigiStartOfFrame.py
```

The script *pyCigiMappings.py* gets information about mappings from *./appData/settings/stealth/MAK CIGI Mappings.mcsx*. Do not move this file or the script will not work.

For complete documentation of the pyCigi module, please see *Readme.txt*.

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