RadarFX

Users Guide

JRM Technologies
Real Physics • Real Sensors • Real-time

VT MÄK
A company of VT Systems

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Preface

This manual is for persons who will install RadarFX and use it to view simulations. 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 RadarFX.

MÄK Products

RadarFX 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.
- RadarFX. RadarFX is a client-server application that can simulates synthetic-aperture radar (SAR). The server application, which is based on VR-Vantage and SensorFX, loads a terrain database and, optionally, connects to simulations. A client application requests SAR images from the server. RadarFX includes a sample client application.

How to Contact Us

For RadarFX 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 RadarFX home directory. For example, the directory *radarfx1.0/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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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/.

1. Using RadarFX

This chapter intoduces RadarFX, explains how to install it, and explains how to use it.

1.1. Introduction to RadarFX

RadarFX is a client-server application that can simulates synthetic-aperture radar (SAR). The server application, which is based on VR-Vantage and SensorFX, loads a terrain database and, optionally, connects to simulations. A client application requests SAR images from the server. RadarFX includes a sample client application.

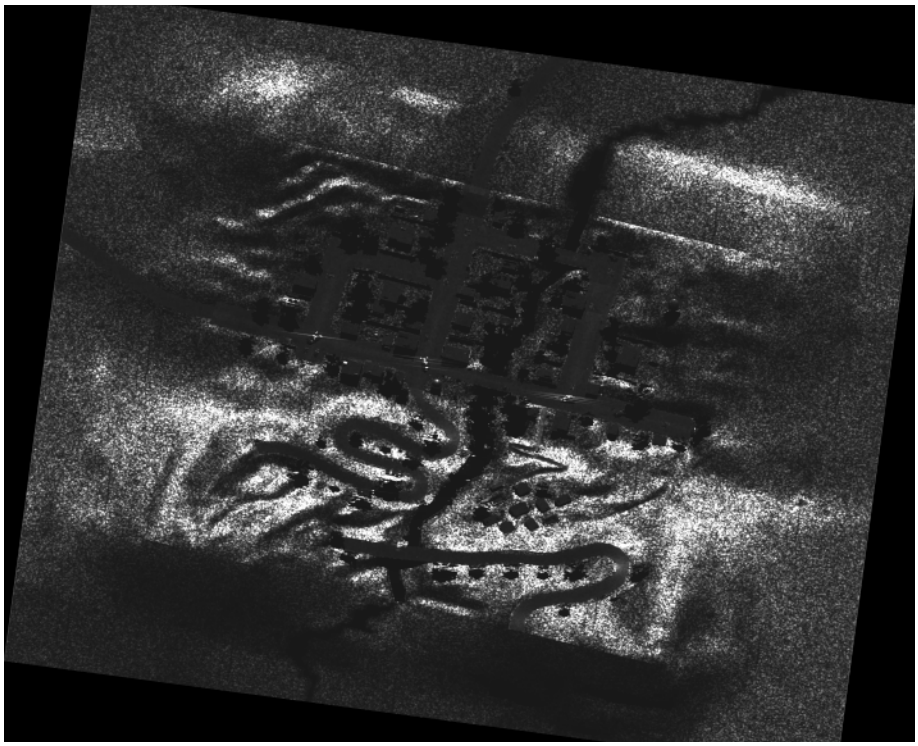

Figure 1-1. RadarFX image

RadarFX includes the documentation for VR-Vantage and SensorFX, which completely explain how to use those products. This manual provides only enough information about those applications to allow you to use RadarFX.

1.2. Installing RadarFX

RadarFX is provided as two standard Windows installers, an application installer and a data installer. To install it, run the application installer. Then run the data installer.

1.2.1. Installing the RadarFX License

RadarFX is licensed separately from VR-Vantage. The client and any software using the client library is not licensed.

The license is provided as a registration file that modifies the Windows registry. The server finds the license file by the system environment variable JRM_LICENSE_FILE. This environment variable needs to be set to the location of the license file you received from your VT MÄK sales representative. To set this environment variable add it to your system settings through the Windows Control Panel

➤ To install the RadarFX license on Windows, in the Windows Explorer, double-click the registration file.

1.3. Starting RadarFX

To use RadarFX, you run the server and a client application. The client could be embedded in any third party application. In this manual we use the sample client application provided with RadarFX.

To start RadarFX server

1. On the Start menu, choose **All Programs** → **MÄK Technologies** → **RadarFX 1.0** → **RadarFX Server**. RadarFX starts and the Choose a Terrain dialog box opens.
2. Select a terrain to load. RadarFX loads the terrain and displays it in the window (Figure 1-2).

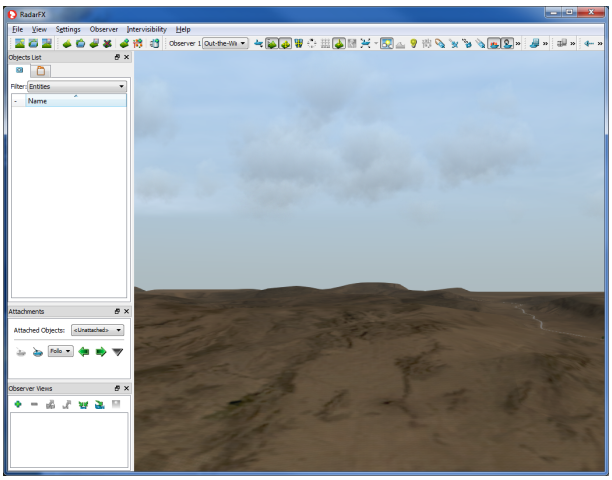

Figure 1-2. RadarFX Server

Since RadarFX uses SensorFX, you will get best results with a terrain that has been materially classified for its use, or which supports material classification on demand. For details about material classification, please see *SensorFX Users Guide*. A materially classified terrain, *VR-VillageSensorFX.mtf* is included with RadarFX.

To start RadarFX Simple Client:

1. On the Start menu, choose **All Programs** → **MÄK Technologies** → **RadarFX 1.0** → **RadarFX Simple Client**. RadarFX Simple Client opens and the Connect to RadarFX Server dialog box opens.
2. In the Connect to RadarFX Server dialog box, accept the default values. Click OK. The RadarFX Simple Client opens (Figure 1-3).

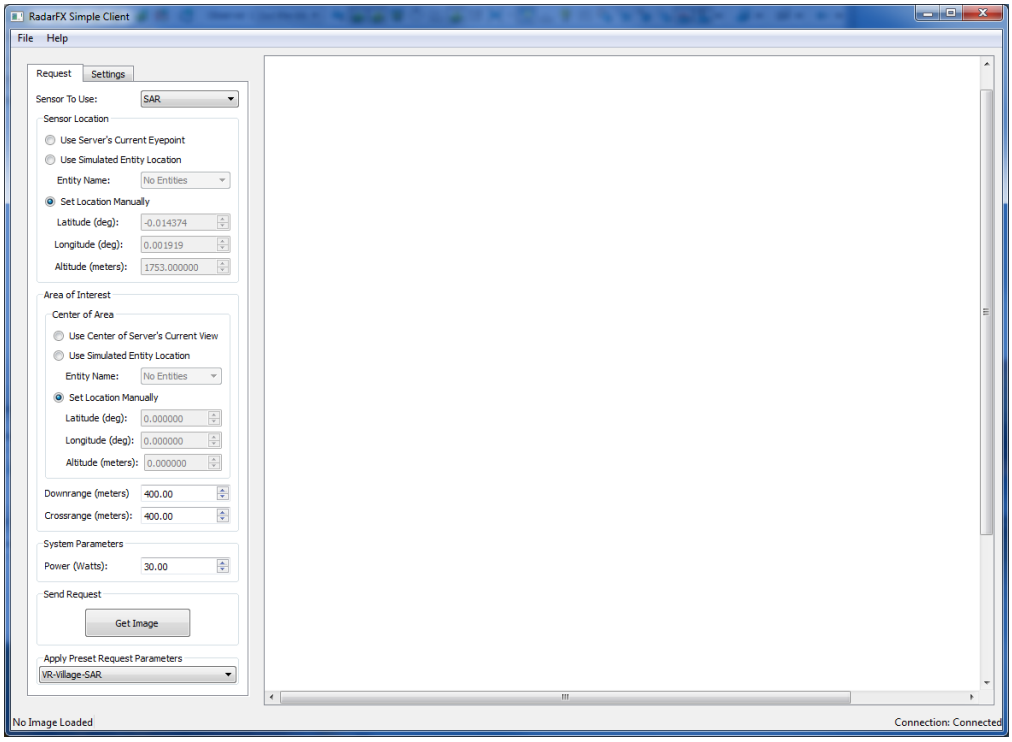

Figure 1-3. RadarFX Simple Client

1.4. Opening a Terrain

The previous section explained how to load a terrain from the Choose a Terrain dialog box when RadarFX starts up. However, if you choose not to load a terrain immediately, or want to load a different terrain at any time after startup, you can do so. For details, please see Section 3.3, "Opening a Terrain,"in *VR-Vantage Users Guide*.

1.5. Connecting to a Simulation

You do not need to connect to a simulation to use RadarFX client with the RadarFX Server. However, if you do not connect to a simulation, you will not be able to view any entities in the server or use them as the viewpoint from which to capture an image.

To connect to a simulation, follow the instructions in Section 3.4, "Connecting to a Simulation Network," in *VR-Vantage Users Guide*.

1.6. Configuring RadarFX Server

You can configure:

- Server Listen Port. The port that the server is listening on for incoming connections from clients. Changing this value restarts the server immediately.
- Save Image Directory. The default directory to save images.
- Default Observer Mode Name. The default observer mode to use for image captures
- Default Sensor Mode Name. The default sensor mode for image captures.

RadarFX server settings are saved automatically when the application exits.

To configure RadarFX Server:

1. Choose **Settings** → **Application**. The Application Settings dialog opens.
2. Select the RadarFX Server Settings page (Figure 1-4).

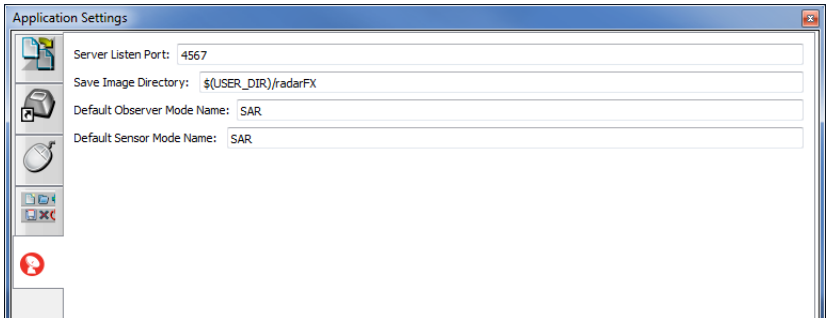

Figure 1-4. RadarFX Settings page

3. Change parameter settings as desired.

1.7. Configuring Sensors

For general details about configuring sensors, please see Section 1.5, "Configuring SensorFX Sensors," in *SensorFX Users Guide*. The parameters for the SAR and MMW sensors are described in Table 1-1.

RadarFX Server uses SensorFX sensors. The discussion of CameraFX sensors in *VR-Vantage Users Guide* does not apply.

Table 1-1: Parameters for SAR and MMW sensors

Parameter	Description
AGC	A means of Automatic Gain Control. With AGC on, the max received power (and thus Saturation Ratio) will be computed as the power estimated to be returned by a surface of unit less areal RCS = 0.25 at the boresight range, disregarding atmospherics, but including system noise. ON or OFF. Default: OFF
Doppler Coloring	(MMW only) A display parameter that color-codes returns according to their perceived velocity relative to the sensor. The intensity of the return is not altered, but the color shifts to red (away from sensor) or blue (toward sensor) by an amount proportional to the position of the return in the detectable Doppler scale, the maximum velocity of which is governed by the wavelength and PRF, and the minimum of which is determined by the wavelenth and time-on-target. ON or OFF. Default: OFF
Toggle Image Orientation	(SAR only) Rotates the image orientation by 180 degrees.
Region of Interest Down-range	(SAR only) The desired downrange extent of the section of terrain to be mapped, relative to the current boresight terrain intersection point. Nominal values in range 100-1000.
Region of Interest Cross-range	(SAR only) The desired cross range extent, in meters, of the section of terrain to be mapped, relative to the current boresight terrain intersection point. Nominal values in range 100-1000.

Table 1-1: Parameters for SAR and MMW sensors

Parameter	Description
Center Frequency	The carrier frequency of the radar. Affects atmospheric transmission loss and noise, as well as beam width, Doppler resolution, and wavelength. Higher values improve crossrange positional resolution (beam width), and downrange Doppler resolution, at the expense of a smaller effective receiver area. Typical values are: ◆ L-band: 1-2 GHz ◆ S-band: 2-4 GHz ◆ C-band: 4-8 GHz ◆ X-band: 8-12 GHz ◆ Ku-band: 12-18 GHz ◆ Ka-band: 30-40 GHz ◆ MMW band ~ 40 - 300 GHz ◆ W-band: 90-100 GHz
Pulse Width	The width of the radar transmitter's pulses, in microseconds. Inversely proportional to bandwidth. Lower values improve downrange positional resolution and increase received signal. Higher values reduce system noise. Should be smaller than 1/PRF. Typically 1.E-9 to 1.E-2 [s].
Pulse Repetition Frequency	The frequency, in Hz, with which the transmitter sends pulses of RF power. Lower values increase the maximum unambiguous range and received signal, but decrease maximum detectable Doppler shift. Should be smaller than 1/PW and c/2DR, where c is speed of light and DR is downrange region of interest. Should be greater than about V/L, where V is intended aircraft speed and L is integration path length. Typically 250-300000 Hz
Transmitter Polarization Angle	Linear polarization angle of transmitter gain, in degrees. Typical values: ◆ Horizontal = 0 ◆ Vertical = 90 ◆ Default = 45
Transmitter Directivity	Similar to a lobe-width parameter, in that larger values focus the transmitter gain pattern into a smaller but stronger main lobe centered at the boresight direction. A value of 1 results in no focusing, that is, a Unity gain pattern. Must be greater than zero, but typically set > = 1.

Table 1-1: Parameters for SAR and MMW sensors

Parameter	Description
Receiver Polarization Angle	Linear polarization angle of receiver acceptance pattern, in degrees. Typical values: ◆ Horizontal = 0 ◆ Vertical = 90 ◆ Default = 45
Receiver Directivity	Similar to a lobe-width parameter, in that larger values focus the receiver acceptance pattern into a smaller but stronger main lobe centered at the boresight direction. A value of 1 results in no focusing. Increasing values also increase effective receiver area. Must be greater than zero, but typically set > = 1.
Integration Path Length	(SAR only) The distance over which the radar collects returned pulses, also known as the SAR antenna length. Higher values improve cross range resolution. Should be greater than desired cross range region of interest, and greater than c/(2ðf), where c is light speed and f is center frequency in Hz. The effect of very high values will be limited by terrain texture resolution and/or display resolution. Typically 100-10000
Emitter Power	The power emitted by the radar transmitter. Higher values improve effective image gain. Decreasing power results in a darker image. Must be greater than zero. Typically 50-5000.
System Temperature	Unavoidable internal radar system noise temperature. Higher values degrade signal-to-noise ratio. Must be greater than zero. Typically 270-850 degK.
Saturation S/N Ration	The Signal-to-Noise ratio at which the return pulses saturate the receiver electronics. In other words, this ratio defines the maximum received power of the system, when multiplied by the noise power. Higher values will decrease image intensity. Must be greater than zero, but typically set > = 1.
Gain Pattern	Allows focusing of the emitted or received RF power into lobes. Both the transmitter and receiver share the same gain/acceptance pattern, but can have different directivities. Possible values: ◆ Unity (no lobes). ◆ Lobe (single-lobe). ◆ Rect. Rectangular (main lobe plus side lobes).

Table 1-1: Parameters for SAR and MMW sensors

Parameter	Description
Display Type	Governs to which computed ratio the display is sensitive. ◆ Scaled Power: Ratio of received power to max power. ◆ Scaled Radiance: Ratio of received radiance to max radiance. ◆ Scaled Effective RCS: Ratio of received power to power estimated to be returned by a surface of unit RCS at the boresight range, disregarding atmospherics, but including system noise.
Light Pool Gain	
Intensity Modulation Gain	Together with the geometry-model-specific IMOD files, this governs the extent to which detail variance present in the RGB texture for the entity or terrain models will be translated into additional RCS variance in the radar scene.

1.8. Using RadarFX

The typical use of RadarFX is to embed its functionality into a third-party client application. The client application requests an image from RadarFX Server, which provides an image based on the location in formation sent from the client. The RadarFX Simple Client demonstrates what you can do with the RadarFX API. This section describes how to use the simple client.

You can create presets for frequently used configuration settings so that you do not have to enter them every time you use the client application. For details, please see "Creating a Configuration Preset," on page 1-14.

To request an image from the server, you:

1. Specify the sensor to use.
2. Specify the location of the sensor.
3. Specify the area of interest.
4. Set the power to use.
5. Send the request.

1.8.1. Specifying the Sensor

The client gets a list of sensors from the RadarFX Server. RadarFX users typically use the SAR sensor.

To specify the sensor to use:

1. In the RadarFX Simple Client window, select the Request tab.
2. Select an option in the Sensor to Use list.

1.8.2. Specifying the Location of the Sensor

You must tell the server where the sensor that will take the image is located. You can:

- Use the location of the server's observer. This option is most useful when both the server and the client are running on the same machine and you can manually move the observer into position and then request a radar image.
- Attach to an entity in the simulation (if the server is connected). The client gets a list of entities from the server. The client does not need to be connected to the simulation.
- Enter a location manually in latitude, longitude, and altitude.

To specify a location:

1. In the Sensor Location group box, choose one of the options.
2. If you choose Use Simulated Entity Location, select an entity in the Entity Name list.

   If you choose Set Location Manually, specify Latitude, Longitude, and Altitude.

1.8.3. Specifying the Area of Interest

The area of interest is the area that you want to take an image of. The sensor does not have to be located in the area, although it could be. You can specify the area of interest as:

- An area centered on the server's eyepoint.
- An area centered on a simulated entity.
- An area specified by its latitude, longitude, and altitude.

The cross range and down range values specify the size, in meters, of the area of interest centered on the target location, as illustrated in Figure 1-5.

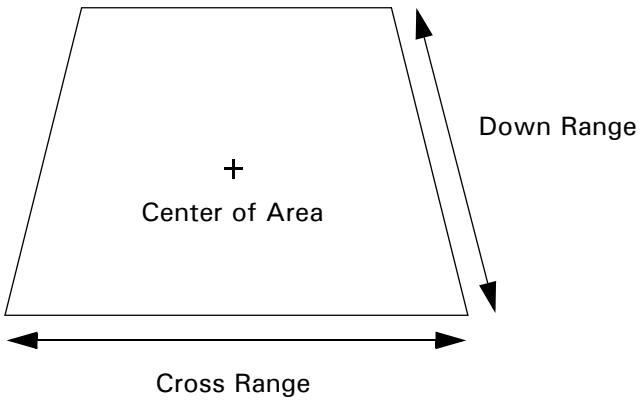

Figure 1-5. Area of interest

To specify the area of interest:

1. In the Center of Area group box in the Area of Interest group box, select an option.
2. If you choose Use Simulated Entity Location, select an entity in the Entity Name list.

   If you choose Set Location Manually, specify Latitude, Longitude, and Altitude.
3. Specify the down range in the Downrange box.
4. Specify the cross range in the Crossrange box.

1.8.4. Specifying the Power

The power value is the amount of power that the SAR system should use to generate the image. Higher power levels increase the image gain. Lower levels result in a darker image.

➤ To specify the power, in the System Parameters group box, enter a value in the Power box.

1.8.5. Requesting the Image

When you request an image, the client sends the request to RadarFX Server. The server returns the image and it is displayed in the client window.

➤ To request the image, in the Send Request group box, click Get Image.

1.8.6. Configuring Image Properties

You can specify the properties of the image that the server returns. You can also specify that the image be saved on the server. You can specify the following properties:

- Image size, in pixels.
- Image Rotation. The image can be rotated so that North is up or the sensor's view is up.
- Image Format. Options are PNG, JPG, BMP, Raw, and NTIF.
- Image Data Type. Byte, short, or float.

To specify image properties:

1. In the Simple Client window, select the Settings tab.
2. In the Image group box, change properties as desired.
3. To save the image on the server, in the Save Options group box, select Save On Server. Specify the directory in which to save images.

1.8.7. Saving and Loading Files on the Simple Client

You can save the images you get from the server. You can load images that you have saved.

➤ To save an image, choose **File** → **Save Image**, and specify a name and location for the image.

➤ To load an image, choose **File** → **Load Image**, and select the image to load.

1.8.8. Creating a Configuration Preset

The client includes several preset configurations for the terrains that are shipped with RadarFX Server. The presets are stored in *./userData/radarFX/defaultClientPresets.json*. You cannot saved configurations through the graphical user interface (GUI). The following is one of the presets included. To create your own, copy a block of code and change the values as desired.

```
{
  "name": "VR-Village-SAR",
  "ownshipLocation": {"lat": -0.014374, "lon": 0.001919, "alt": 1753},
  "targetLocation": {"lat": 0, "lon": 0, "alt": 0},
  "downrange": 400,
  "crossrange": 400,
  "power": 30,
  "sensor": "SAR (SensorFX)",
  "imageRotation": "North Up",
  "imageX": 1280,
  "imageY": 1024,
  "imageFormat": "PNG"
},
```

1.8.9. Loading a Configuration Preset

➤ To load a preset, in the Apply Preset Request Parameters group box, select a preset from the list.

Link - Simulate - Visualize

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