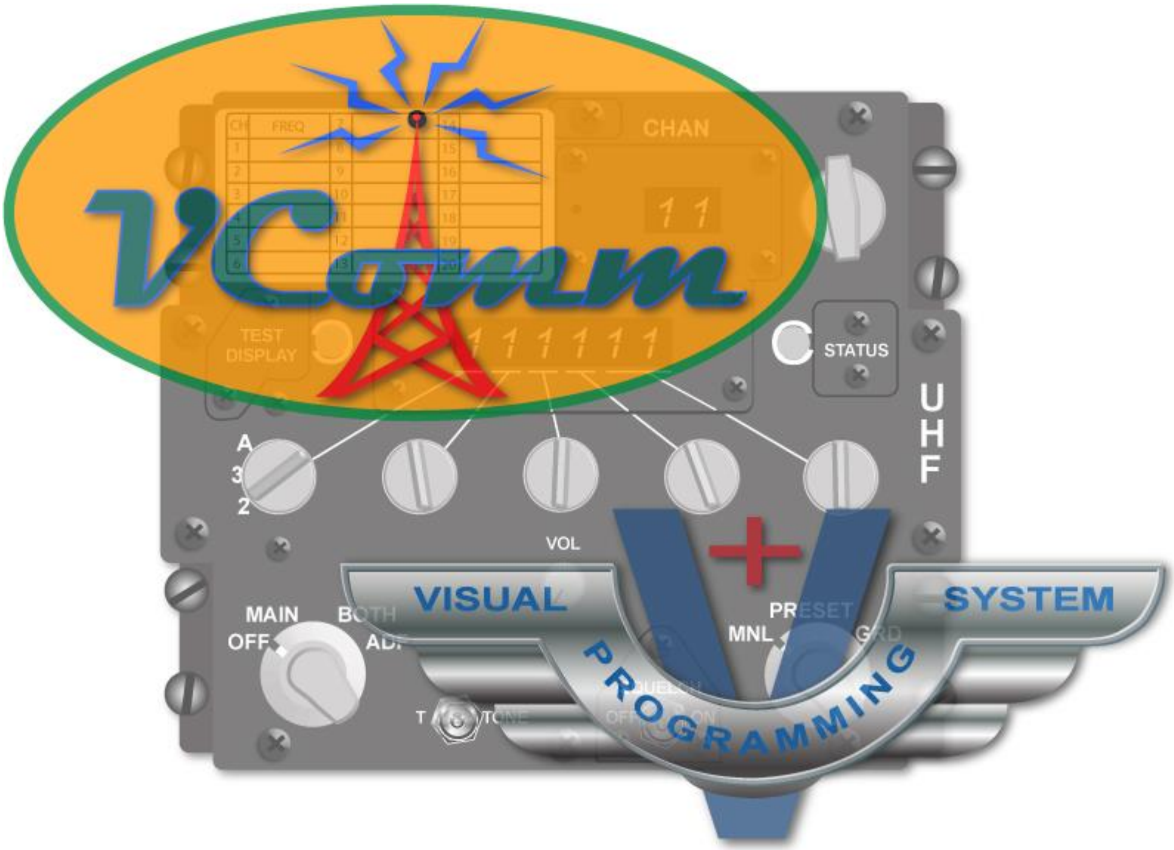
VComm User Manual



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1 Preface

This document was authored using Microsoft Word and is maintained at the SimPhonics web site in .docx format.

1.1 Trademarks and Copyrights

1.2 Revision History

Ensure you have the latest release of this document before relying on this information. Versions less than 1.0 are unreleased, unofficial versions. Table 1 provides the revision history of this document.

Table 1, Revision History

Version	Description	Date
1.0	Initial Internal Preliminary Release	November 20, 2005
1.1	Interim version	December 14, 2005
1.2	Formatting changes; Reorganization; Table of Contents	March 1, 2006
1.3	Clarification of HLA RTi installation and minor editorial changes.	March 14, 2006
1.4	Added Duplex Modes	March 23, 2006
1.5	Added network information and setup sections	April 6, 2006
1.6	Added interoperability note Entity Attach.	April 20, 2006
1.7	Added interoperability note for Capture Buffer; Added note on Number of Transmitters for First Radio performance counter; Added a section discussing sidetone.	May 10, 2006
1.8	Added VComm Terrain Server usage information.	May 30, 2006
1.9	Added VComm architecture diagram with description.	June 1, 2006
1.10	Added Hardware Limitations section.	July 7, 2006
1.11	Updates for VOX and Stereo Devices; Further explanation of DIS Heartbeat provided.	July 30, 2006
1.12	Added big endian mode for the PCM-16 CODEC and added encoder enumeration of 100 for little endian.	July 31, 2006
1.13	Added HAVE QUICK.	September 25, 2006
1.14	Added Audio processing examples.	January 3, 2007
1.15	Added more HAVE QUICK discussion.	February 9, 2007
1.16	Updated compressor limiter and band pass filter section.	March 14, 2007
1.17	Updated network section for TTL description.	March 26, 2007
1.18	Added Radio Entity Kind section.	April 9, 2007
1.19	Added a section describing Waveform Audio Transmission; Added a figure describing the VComm SINCGARS object.	April 30, 2007
1.20	Updated HLA section.	July 25, 2007
1.21	Added Registry key for heart beat.	October 4, 2007
1.22	Embellished the Free Space Propagation Loss section. Updated the DIS Heartbeat sections. Updated registry settings.	January 8, 2008
1.23	Updated HLA sections.	March 26, 2008
1.24	V+ Build 354 Release	July 8, 2008
1.25	Added new objects and Radio Entity Type Discussion as well as the receiving behavior of the DIS Signal Encoding class.	November 23, 2008
1.26	Added a Secondary socket capability to VComm, Build 357 Release	February 19, 2009
1.27	Update networked audio configuration, Build 358 Release	February 25, 2009
1.28	Change DIS timestamp control from registry to runtime configuration parameter.	March 6, 2009

Table 1, Revision History

Version	Description	Date
1.29	Added a RID Filename edit box in the V+ run time Configure dialog to override the HLA installed RTI_RID_FILE installation. Added a new section, 28.4 Known Problems informing users of known issues with VComm. These issues are also published in an online database at simphonics.com. This change is part of the V+ Build 358 release. Added a noise level attenuation adjustment to the registry. (radioNoiseAtten). Changed HLA Enable switch to HLA Join at Startup Switch. Added the registry value UseSignalQualityService to the MISC key.	2009-03-08
1.30	Added HF model and Radio Recording.	2009-04-27
1.31	Added Minimum and Maximum Antenna Range.	2009-05-09
1.32	Minor Document Cleanup	2009-08-05
1.33	Added troubleshooting items, corrected paragraph numbering enhanced the radio noise section.	2009-08-19
1.34	Added information on Signal Quality Service.	2009-08-24
1.35	Enhanced the Crypto Model in VComm. Incorporated several waveforms directly into the VComm DLL resource for KY-58 and KYV-5 ANDVT. Added PTT hold-off for the crypto gear. Added crypto gear turn on tones. Modified the No Fill tone sequence.	2009-10-07
1.36	Revised DIS Radio Identifiers section.	2010-03-29
1.37	Added Remote Desktop Warning	2010-04-07
1.38	Remove TerrainServerProtocol registry entry	2010-05-13
1.39	Updated VComm DLL Build 366 which includes a number of new V+ objects and new modulation objects and material.	2010-07-24
1.40	Add transmission events to Radio Recording	2010-07-28
1.41	Added the modulation sections. Significant cleanup of the document, added several interoperability notes. Clarified the HlaEnableSwitchDefault registry entry. Stephen Jones	2010-08-07
1.42	Modifications to Transmit Wavefile Player description and Automatic Radio Id item in Troubleshooting. RF	2010-09-24
1.43	Add VTP record section. RF	2010-09-27
1.44	Modified the RID Filename (RTI_RID_FILE) user interface.	2010-10-16
1.45	Updated the recording sections to show all of the current means to record radios.	2010-10-24
1.46	Added Index	2010-12-31
1.47	Add Signal Dithering	2011-11-11
1.48	Added Troubleshooting item 13.	2012-28-01
1.49	Added sleep Mode Information – SWJ	2013-03-13
1.50	Update VTP record description – RF	2013-04-25
1.51	Updated propagation less mode and entity attach having no relationship. – SWJ	2013-06-06
1.51	Removed legacy radio sections, major cleanup - MG	2013-06-08
1.52	Added sections in the introduction – SWJ	2013-06-20
1.53	Updated registry section adding a few entries and clarifying which ones are installed by default.	2013-07-31
1.54	Document cleanup, fonts changed – SWJ	2013-09-05

Table 1, Revision History

Version	Description	Date
1.55	Basic Fidelity HAVEQUICK update based on inputs from MAF DMO, CAF DMO and Northrop Grumman JSTARS - SWJ	2014-04-06
1.56	Clarification of VTP records – SWJ	2014-06-19
1.57	Updated KY-58 Device – SWJ	2014-06-20
1.58	Updated for HLA Update - SWJ	2014-07-27
1.59	Added note for VTP record byte orientation – SWJ	2014-09-02
1.60	Corrected potential problem for Signal PDU padding at end of signal payload. – SWJ	2014-10-04
1.61	Moved the MISC registry section to a Vdx datapool, VCommInitData.xml. – SWJ	2014-11-19
1.62	Separated frequency filters into DIS and HLA filters. – SWJ	2014-11-26
1.63	Clarified VTP Records removed references to the registry and changed to datapool. - SWJ	2015-09-15
1.64	Add description of how radio frequencies are rounded. – RGF	2019-09-03
1.65	Add Transmitter Name Prefix for HLA	2020-11-16

2 Before Reading This Document

The reader should be familiar with the modeling and simulation interoperability standard, Distributed Interactive Simulation (DIS), also referred to as IEEE 1278.1 and to a lesser degree, High Level Architecture (HLA) or IEEE-1516. A basic knowledge of networking principles is important, as well as an understanding of the V+ Visual Programming System as well as intermediate computer skills.

3 Referenced Documents

Table 2 provides a list of publications referenced within this document.

Table 2, Referenced Documents

Version	Description	Date
IEEE 1516.1-2000	IEEE Standard for Modeling and Simulation (M&S) High Level Architecture (HLA). Federate Interface Specification	September 21, 2000
IEEE 1278.1-2012	IEEE Standard for Distributed Interactive Simulation – Application Protocols	
SISO-REF-010	Enumeration and Bit Encoded Values for Use with Protocols for Distributed Interactive Simulation Applications	May 12, 2006
Latest version is installed with V+	V+ Visual Programming System User Manual	
Latest version is installed with SMx	SMx Audio System User Manual	
Latest version is installed with V+	VPLus Release Notes	
Latest version is installed with V+	VPLus On-line Object Help System	
Latest version is installed with VTS	VComm Terrain Server User Manual	
Latest version is installed with V+	VComm Signal Quality Service Specification	
AN/ARA to AN/ARC - Equipment Listing http://www.designation-systems.net/usmilav/jetds/an-ara2arc.html		
Radio Propagation Modeling Tutorial http://www.mike-willis.com/Tutorial/PF4.htm		

4 Introduction

VComm is a network based DIS/HLA/VoIP radio communications simulation software application designed to simulate various voice communications systems.

1. LVCcom – Standalone software application

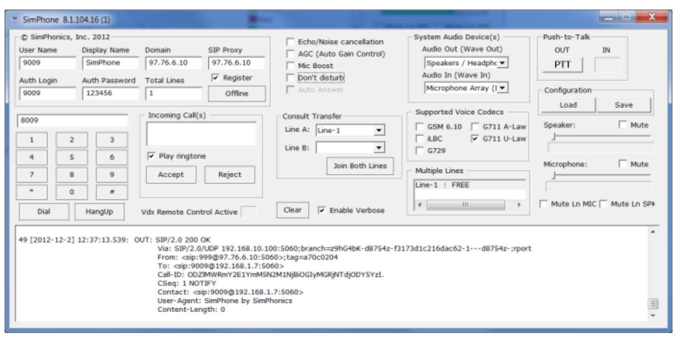
    a. LVCcom uses VComm in a software application for applications needing DIS/HLA based voice communication on a PC or laptop. LVCcom uses

    b. This application uses onboard sound cards, SimPhonics USB ATC Style Jack Box or USB PTT Headsets.



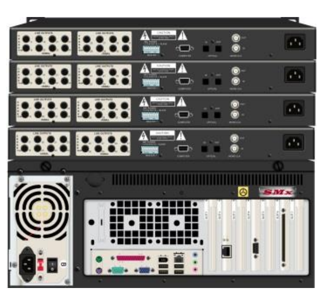
2. SimPhone – Also called VBridge in system form, bridges VoIP and DIS/HLA

    a. SimPhone is a complete VoIP phone, with its functionality exposed to V+ for manipulation by VComm.



3. V+ Software add-on for the V+ Visual Programming System

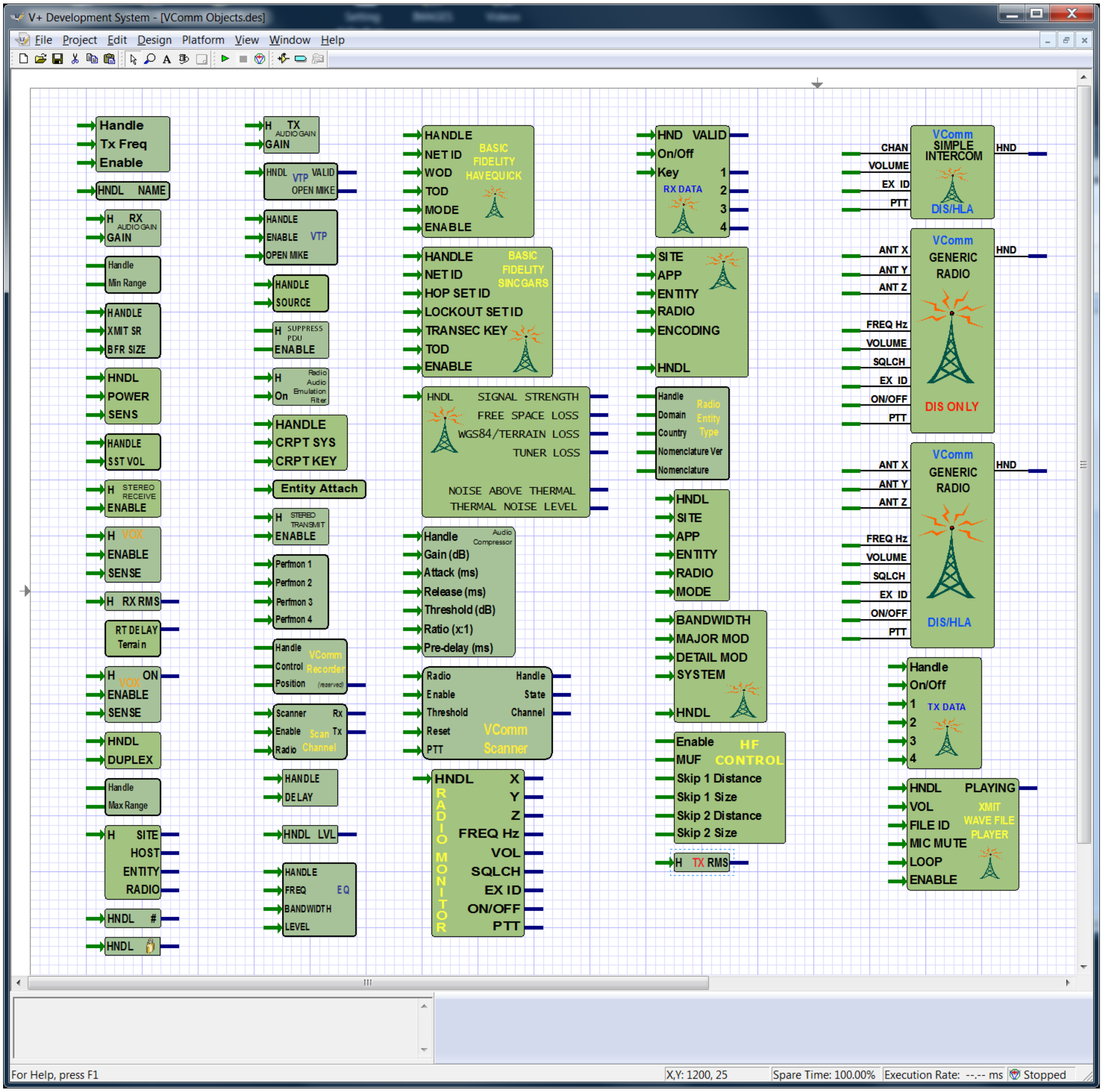
    a. V+ is a powerful and flexible Visual Programming Language (VPL) development environment. V+ can utilize any of the audio devices above as well as the SimPhonics SMx audio system.



4.1 V+

V+ deserves a special section here as most systems use V+ for developing systems for flight simulation and even workstation-based systems. V+ utilizes all of VComm's functionality through V+ objects. The following figure lists the current V+ objects.

Figure 1, V+ VComm objects



4.2 Use Any Sound Device

VComm can utilize virtually any sound card or sound input/output mechanism such as Bluetooth, USB headsets, sound cards, etc. since VComm audio I/O is wrapped around the latest Microsoft DirectSound Application Programming Interface (API). VComm extends DirectSound and underlying structures by adding additional CODECs, improved sample rate conversion, and support for additional hardware such as SimPhonics multi-channel SMx system. At the simplest level, if a laptop computer is equipped with VComm, a sound card and a network card is all you need to communicate over a DIS or HLA network. DIS plays a critical role in military simulation interoperation. VComm provides the networked audio portion of DIS/HLA systems. This networked audio usually is in the form of intercoms and simulated radios.

5 Overview

VComm is a 32 bit Dynamic-Link Library (DLL) exposing an API for use by a client application (see Figure 2). The DLL API is utilized by V+ and VRAD products and is loaded at run-time. In addition to the API and the DIS/HLA network sockets, VComm exposes additional interfaces described below. The VComm Remote Management Interface (VCRMI), shown in blue, is a TCP/IP server interface for use by networked clients to monitor and control VComm. Once the DLL is loaded, VCRMI clients have the ability to create and destroy radios on their own without the need for the API. Typical clients are Hand Held Terminals (HHTs) and web servers. VComm can also connect to a VComm Terrain Server (VTS). The VTS is a stand-alone Windows XP radio terrain server designed to seamlessly interface with VComm 8.0 Build 331 and later. The software can be installed locally or on any machine of a given simulation network. A VComm system can then remotely access VTS via a TCP/IP server/client protocol. Using advanced propagation loss algorithms (Fresnel, Diffraction, WGS84, etc.), VTS accurately calculates loss/gain due to terrain on any part of the earth using DTED or DEM data. A graphical interface is also included to plot a single-shot solution of a user provided antenna pair.

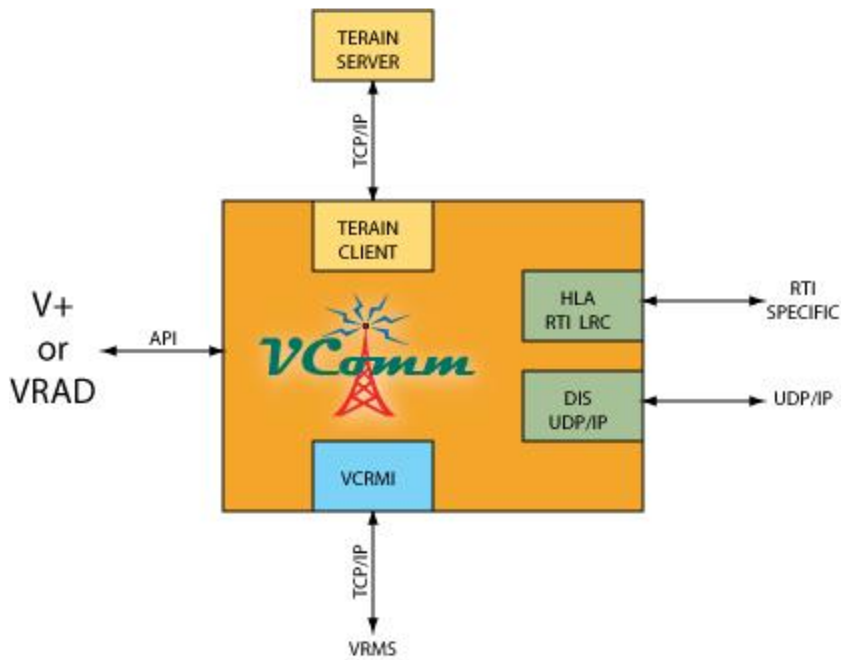


Figure 2, VComm Architecture

5.1 Interoperability Notes

There are only a handful of vendors that offer DIS/HLA voice systems. Of those only two are significant players in this industry and SimPhonics is one of them. Although DIS/HLA is pervasive in the DOD simulation community interoperability remains a problem. VComm incorporates many features that improve interoperability between vendor systems. Listed below are some important interoperability issues.

1. **16 kHz CVSD –** Other vendor systems use 16,000 Hz CVSD, not 8000 Hz. When communicating with these systems that are setup for CVSD, remember to set the transmit sample rate to 16,000 Hz when interoperating with these systems using CVSD, even though the vendor equipment may indicate 8,000 Hz.
2. **Big Endian PCM-16** – SimPhonics implementation of the 16-bit PCM compression scheme outlined in the SISO enumeration document as enumeration (4) has been implemented in Little Endian byte order in the past. This has been changed to Big Endian byte order for future systems. Some of the vendor systems use Big Endian byte order and some use little endian byte order. When using 16-bit PCM and there is loud noise and the audio is unintelligible, try the other mode by setting the appropriate value in datapool.
3. **Non-Standard CVSD Enumeration –** Some systems can be configured to represent various CVSD types at enumeration of 255. This is not compliant with the DIS enumerations but often used. VComm supports 255 as the CVSD MIL-STD-188-113 version which is the same as the enumeration of 2 for signal encoding type.
4. **Sample Rates –** Other systems may not dynamically convert sample rate and compression schemes from what the user has selected, especially in older systems. If an incoming packet contains sample rates of 16,000 Hz, and the system is set to 8000 Hz, the incoming voice will be pitch-shifted resulting in the “Donald Duck” sound effect. This is also true of compression schemes. The same is true in reverse. All VComm systems perform dynamic sample rate and compression scheme conversion on all streams, so that multiple sample rates may be sent to the system, and all will be received properly. This issue is being addressed by the new DIS version that should be out soon, currently referred to as IEEE 1278.1a 200X.
5. **Audio Buffer Size** – VComm will allow an audio buffer to be as small as 80 bytes and as large as 1232 bytes. This may not work with other systems.
6. **Frequency Tuning Model –** Some systems do not consider the effect of bandwidth or receiver selectivity beyond one Hz. If the transmitter is not set to exactly the same frequency as the receiver it will not receive the signal.
7. **Squelch –** Some vendors do not model squelch properly. Do not rely on other systems to accurately generate squelch.
8. **Modulation –** Some systems have no modulation model and will transmit arbitrary modulation enumeration types that should be ignored. For example a transmission may come in that is intended to be AM, when in fact it is FM, since the receiver model on that side has no modulation model and will receive any modulation or even system type.
9. **Simple Intercom –** Most vendors do not and did not use the DIS Intercom Control PDU and Intercom Signal PDU and used the Transmitter PDU and Signal PDU instead for an intercom function. The intercom PDU system provided for state-full modes of operation and SimPhonics had developed an intercom system that used these PDUs in early 1996. However, it became clear that no one else had, so SimPhonics state-full intercom was shelved and an intercom using

the radio PDUs was embraced. However, as a result of this chaos, some rather hacky intercoms have emerged. One of the most prominent intercoms using the radio PDU is the so-called Simple Intercom that has been documented by SimPhonics and others in the SISO Radio tiger Team. The Simple Intercom breaks some of the established rules of DIS, and is also supported in HLA via the RPR_FOM. The intercom features a priority scheme. For more information on the VComm Simple Intercom, refer to section 10.

10. **Beware of the Wildcard –** A vendor has used wildcards as field values that are not documented in the DIS standard. For example, a value of 255 (all bits set in a byte) in the encoding scheme of DIS is an indication of the CECOM CVSD. Therefore, if you see a value of all bits set in a field, beware, it may indicate a value that is intended to be a wildcard. SimPhonics does not address these wildcard numbers simply because the value was never standardized or documented. These vendors has plenty of time to document these values at SISO and incorporate the change into the standard.
11. **Entity Attach –** VComm has a mode that allows a radio to obtain its antenna location from an existing network entity. This is called entity attach mode.
12. **Antenna Gain –** Some vendors use the concept of Antenna Gain in their models, even when the antenna is the enumeration of 0, which is a reference antenna, Omni directional, isotropic. An isotropic antenna has a gain of 1.0 by definition in all directions. Directional antennas are not used large scale exercises including DMO. Therefore the concept of Antenna Gain for unidirectional antennas is meaningless at this point in the DIS world.

5.2 DIS/HLA Network Interoperability

SimPhonics equipment will automatically convert incoming DIS/HLA transmissions in multiple encoding schemes and sample rates during real-time. This is simply done within VComm since the encoding and sampling information is embedded within the DIS Signal PDU. This is a major interoperability benefit when using VComm. Figure 3 portrays how VComm dynamically converts the encoding of incoming Signal PDU packets regardless of what the user has configured for outgoing Signal PDU packets.

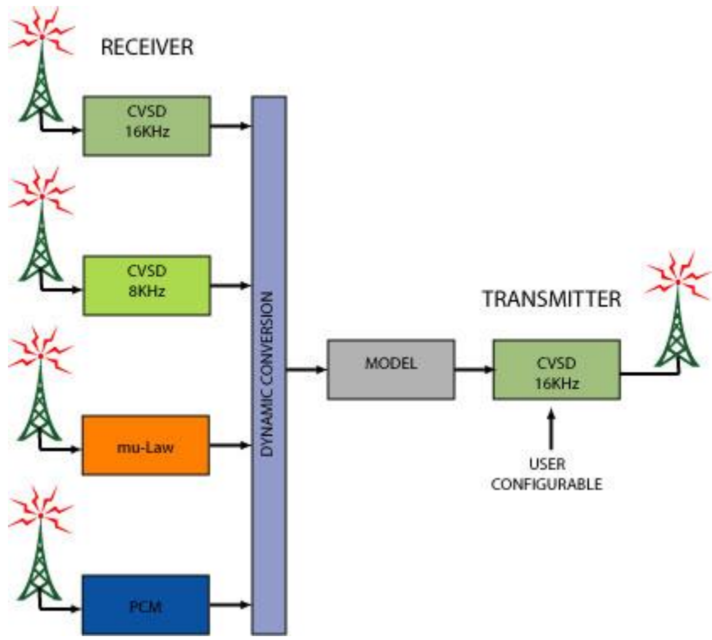


Figure 3, VComm Encoding Conversion During Real-time

There are many other important issues that are not mentioned here, but are vital to interoperability. There is only one other significant vendor of DIS/HLA networked audio systems, and this vendor has ignored interoperability issues like the one described above and this has caused issues in military exercises. SimPhonics is active in the creation of new DIS and HLA networked audio standards to improve interoperability and has played a key role in the development of editing changes to the existing IEEE-1278 standard. Currently the new DIS standard, IEEE-1278.1 200X will most likely be produced sometime in the next year. HLA RPR-FOM and other key FOMs are derived from this standard.

6 Installation

VComm is currently installed with the V+ Visual Development System. See the V+ installation instructions. Future versions may be installed separately.

6.1 System Requirements

VComm requires Microsoft Windows 7. It is recommended that all critical updates be installed along with all security updates including the latest service packs. In order to support networked audio a full duplex sound card with the latest driver that supports DirectX 9.0 or later is required, along with a full duplex PCI 100/10 network card.

6.2 Supported Hardware

Most sound cards will work with VComm including Bluetooth headsets and USB headsets. Note that SimPhonics provides a USB headset with built-in PTT. This headset is especially handy for use with laptops. The SimPhonics H261 is shown in Figure 4. The sound card is part of the headset.

Figure 4, SimPhonics USB PTT Headset

SimPhonics manufactures SMx systems which are used on higher end systems such a full flight simulators. The SMx provides up to 64 channels of high end 24 bit audio. Figure 5 portrays the back of the SMx breakout box. For more information of the SMx system, see the SMx User’s Manual.

Figure 5, SimPhonics SMx Breakout Box

6.3 Hardware Devices and Channels

VComm requires an audio device (sound card, USB headset, Bluetooth headset, etc.) to operate. An audio device is a mechanism for controlling audio input and output into and out of a computer. Traditionally, a computer features a single stereo sound card. VComm can handle up to 32 such devices. Windows regards most sound cards as stereo devices. In other words, each sound card should have two channels, with left being the first and right being the second. A channel is an independent audio input or output of an audio device. VComm looks at this in a slightly different way. It enumerates channels starting with the first device on through the list of devices as specified by the Audio Device Order within V+ (more about Audio Device Order below). Table 3 presents an example of a system configured with a USB PTT Headset Adapter, an onboard Sigma Tel Audio device, and an 8 channel SMx device. In the left-most column we see the device numbering as regarded by Windows. In the right-most column we see how VComm numbers these channels. The shaded channels, 2 and 4, are essentially unavailable to VComm since VComm deals with audio in a monaural manner. All SMx channels can be used by VComm due to the nature of SMx – that of dealing with audio on a single channel basis. Note that SMx must still adhere to the Windows convention of devices in order to work with the DirectSound API, but internally it does not deal with audio in a stereo device manner.

Table 3, Device and Channel Allocations

Device Number		Device Name	VComm Chan Num
1	Left	PTT Headset Adapter	1
	Right		2
2	Left	Sigma Tel Audio	3
	Right		4
3	Left	SMx 01/02	5
	Right		6
4	Left	SMx 03/04	7
	Right		8
5	Left	SMx 05/06	9
	Right		10
6	Left	SMx 07/08	11
	Right		12

If a multiple sound card PC architecture is being used, care must be taken to determine the enumerated order of these devices for a given VComm application. In the configuration section of the V+ Run Time System is a page called **Audio Device Order** (see Figure 6). Use this page to configure the order of multiple sound cards in your application (remember to save this configuration in the .VNE file[1]). When USB headset devices are used in conjunction with a PCI device such as an on-board sound card, the input devices might be listed in reverse order compared to the output devices. You'll need to ensure that the input devices line up with the output devices in the Audio Device Order page.

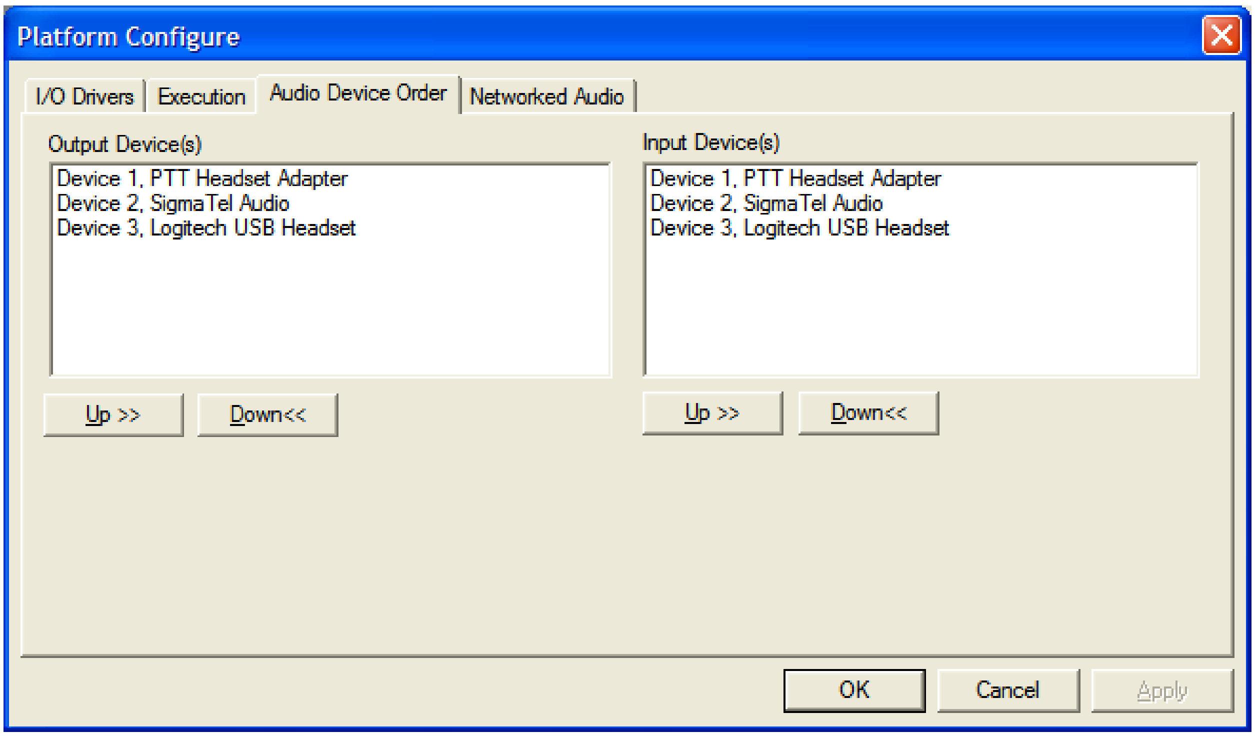


Figure 6, V+ Audio Device Order Configuration

If you plug a monaural headset into a stereo sound card, one of the channels of this device will be unused. VComm associates a radio or intercom with a single channel of a sound card since most radio and intercom communications are monaural. Most commercial sound cards are stereo devices. This can cause problems within a VComm application in that a headset designated as device 1 in the V+ Run Time System will actually have two channels associated with it. VComm radios can only use one of these channels which may result in audio heard only in one side of the headphones. VComm has a solution for this.

Note: *The first device to appear in the list is the default sound device as configured in the Windows Sounds and Audio Devices control panel. If your default sound device is one of the SMx devices, make sure that the SMx Audio System is enabled in the V+ Run Time System configuration page. Otherwise, Signal PDUs will not be transmitted.*

[1] For more information on VNE files, see the V+ - Visual Programming System User Manual.

In order to provide audio into both speakers of monaural headphones, use Object 2047, **VComm Force Stereo RX** (the rightmost object in Figure 7). This will connect the even numbered channel to the odd numbered channel if the radio/intercom designated the odd number channel, and the odd numbered channel even if vice versa. For example, let's say you have a stereo sound card which you've configured as device 2 in the Audio Device Order. In addition, your VComm application has a radio with a channel designation of 3. If you attach object 2047 and enable it, the audio will be heard in channels 3 and 4, which is the same thing as saying Device 2, Left and Right. It works the same way if you have designated channel 4 to your radio.

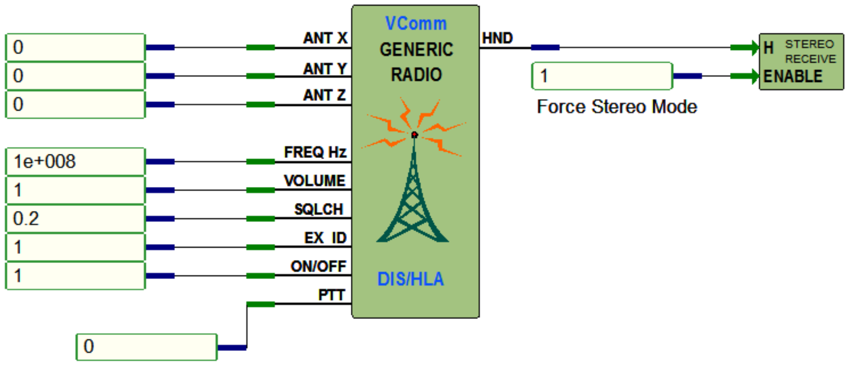


Figure 7, VComm Force Stereo RX Object

This object will also work if you have a microphone input connected to one side of a stereo sound card. However, most microphones with stereo plugs actually route the input signal to both sides of the plug. USB headsets are typically like that. The SimPhonics PTT Headset Adapter's microphone signal is sent to both the left and right channels of the sound device.

6.4 Hardware Considerations

Most sound cards will work with VComm directly with no modifications. The device (sound card) must support full duplex operation and 16000 and 8000 sample rates, which are submultiples of 48000. Most devices support these features.

6.4.1 Device order

Changing the device order in the Windows control panel once you have established a working system may cause problems within VComm. This Windows XP problem may manifest itself as audio being produced on the wrong channel. The network cards that are used with VComm must support full duplex operation at 100 Mbps (megabits per second) or 1000 Mbps speeds. Network interface cards that do not support full duplex will cause problems and possibly audio breakups with only a few radios in the design. Sometimes it is difficult to determine if the card supports full duplex operation. In these cases it is best to replace the card or use another card with gigabit speeds at full duplex. If your computer is configured with more than one network card, make sure you specifically configure one of them for VComm operation. Otherwise, VComm will transmit and receive on all of the network cards available. This may result in distorted or broken audio. See sections 8.1 for more information on how to select a specific network card for VComm.

6.4.2 Volume Controls Linear or Audio Taper?

VComm radios expect their volume inputs to be in linear format since it is converted internally to log format or "audio taper" for proper logarithmic volume control response for the human ear. Most existing volume control potentiometers are logarithmic and are referred to as "audio taper" controls as opposed to "linear taper" controls. If the system is reading from an actual volume control in a simulator for example, and the control is an audio taper control, the control must "linearized". V+ can perform this operation or the host computer can. Contact SimPhonics for a suitable algorithm.

7 VComm User Configuration

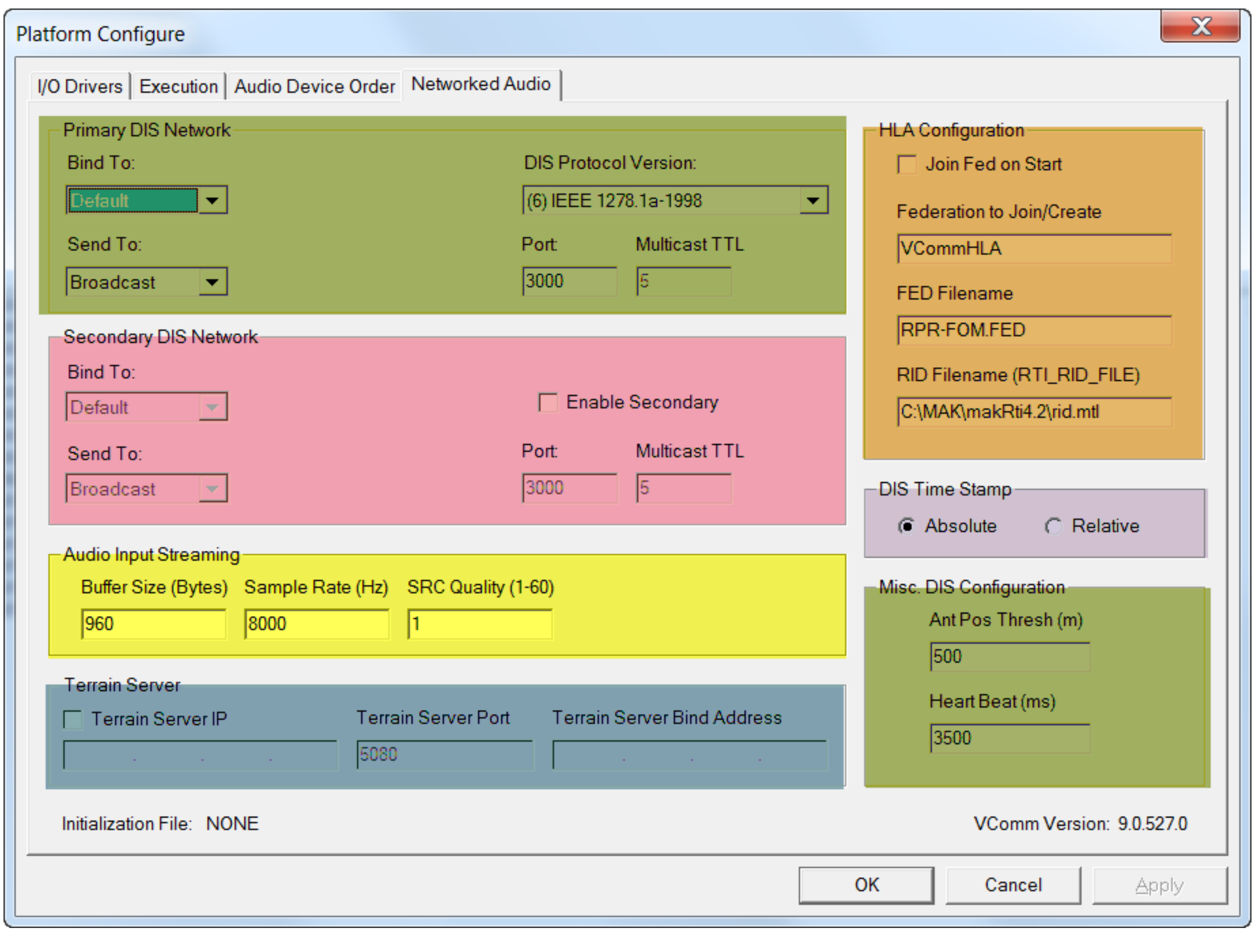
VComm is a software component sold separately but used on several SimPhonics software products listed below and does not appear by itself as a product. The User can control the configuration of VComm for the following use cases:

1. Add-on to V+ for use in V+ high end Simulation applications
2. A software component for SimPhonics Desktop Applications
3. Part of SimPhonics Web Based Applications

7.1 VComm configuration in V+ runtime system

When VComm is purchased with V+ it is shipped and installed as part of the runtime system. The V+ development system always includes the VComm object inventory so that users can design with VComm objects. Aside from the visual program, the user can change VComm parameters via the V+ Runtime Window **Configure menu** followed by the **Network Audio** tab.

Figure 8, Networked audio configuration



7.1.1 V+ Runtime network audio configuration

This window is divided into the following sections:

1. Primary DIS Network
2. Secondary DIS Network
3. Audio Input Streaming
4. Terrain Server
5. HLA Configuration
6. DIS Timestamp;
7. Misc. DIS Configuration

7.2 DIS Time Stamp

This control configures the DIS Transmitter and Signal PDU Timestamp field and is initialized to Absolute. See IEEE 1278.1-2012.

8 Network Configuration

DIS is a UDP connectionless networking technology, while HLA can be either UDP or TCP/IP connection oriented technology. VComm has network configuration for DIS only. HLA networking configuration is managed by the RTI. The V+ Run Time System Networked Audio configuration dialog is shown in Figure 9. This is where most user configurable network settings are located.

8.1 Network Addressing

VComm supports DIS over a primary and a secondary network. By default, only the primary network is enabled. Enabling the secondary network is accomplished by clicking the **Enable Secondary** checkbox as shown in Figure 9. The network settings for the primary and secondary networks are configured on the V+ Run Time System Networked Audio configuration dialog. In general, configuration of the secondary network works the same way as for the primary network. Note that the DIS Protocol version specified for the primary DIS network is inherited by the secondary DIS network (i.e. it is not possible to have a different version on each network).

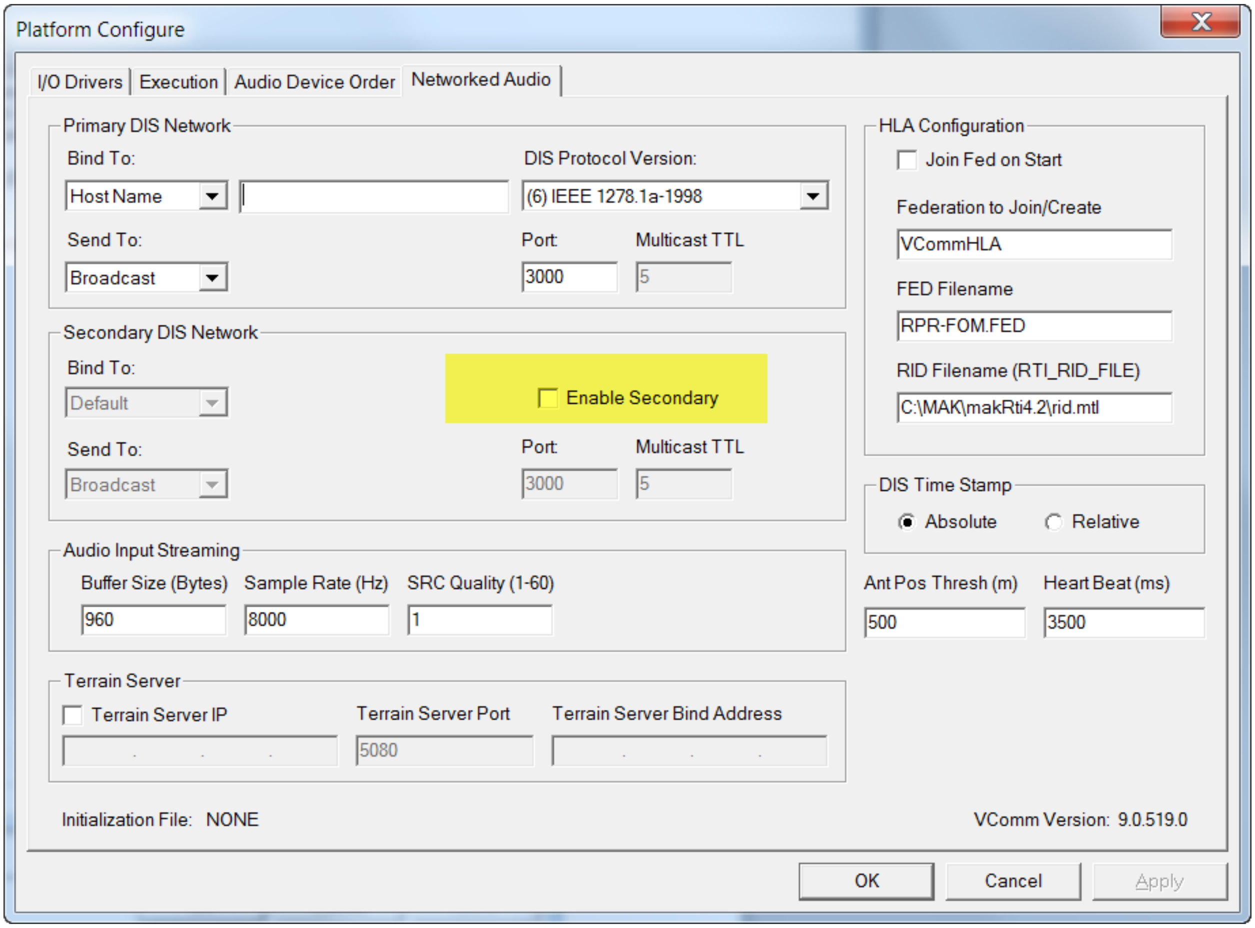


Figure 9, Networked Audio Secondary Network Activation

For each DIS network (primary and secondary), it is possible to specify how VComm should bind to a network adapter. The method of binding to a network adapter is specified using the **Bind To** dropdown list as shown in Figure 10. If there is only one network adapter in your system then it is simplest to select the Default option. Under this option, VComm will automatically bind to that single adapter. If there are multiple network adapters in your system and the Default option is selected, then VComm may attempt to use all the adapters. This may result in distorted or broken audio streams. To bind to a specific network adapter select one of the other options.

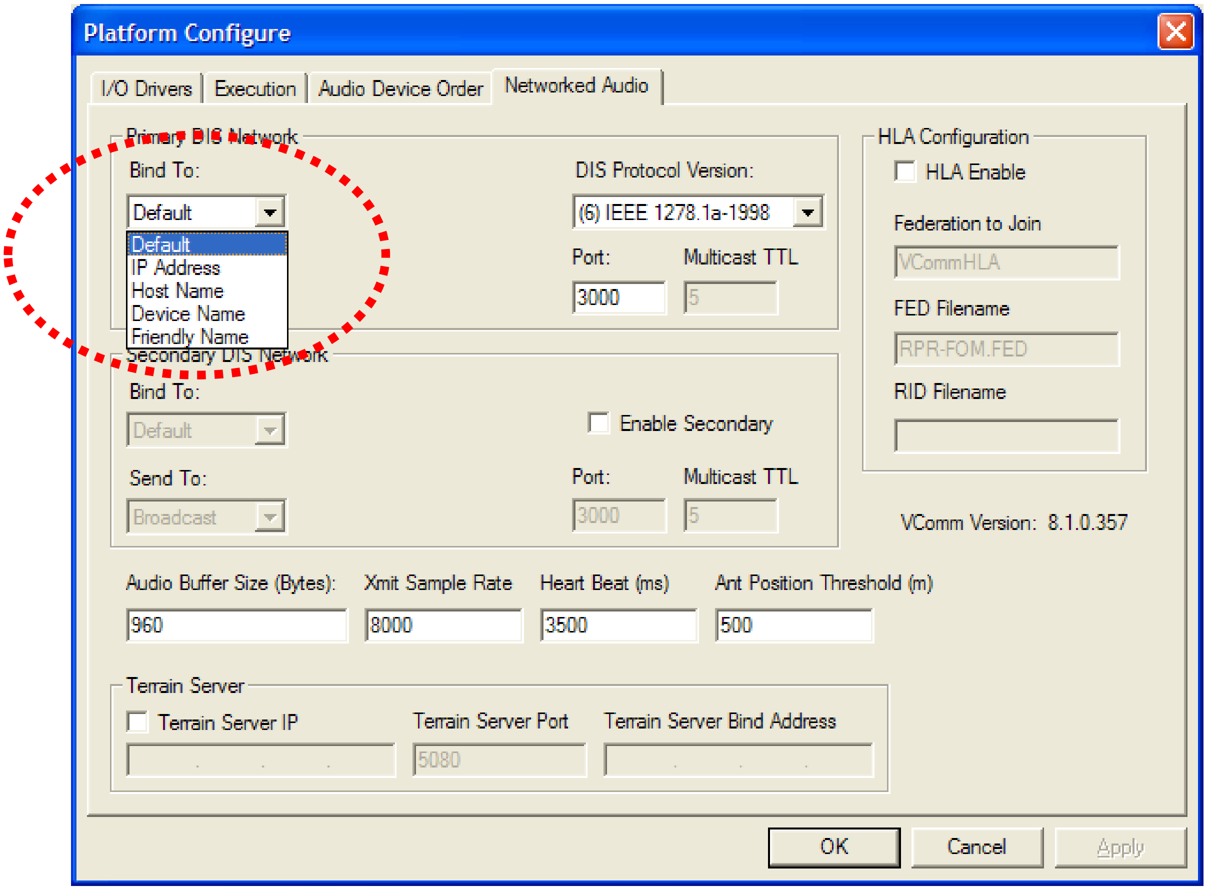


Figure 10, Networked Audio Binding Dropdown

If the network adapter you wish to bind to is configured with a known fixed IP address, then selecting the IP Address option allows entry of that address as shown in Figure 11. VComm will bind to the adapter with the specified IP address.

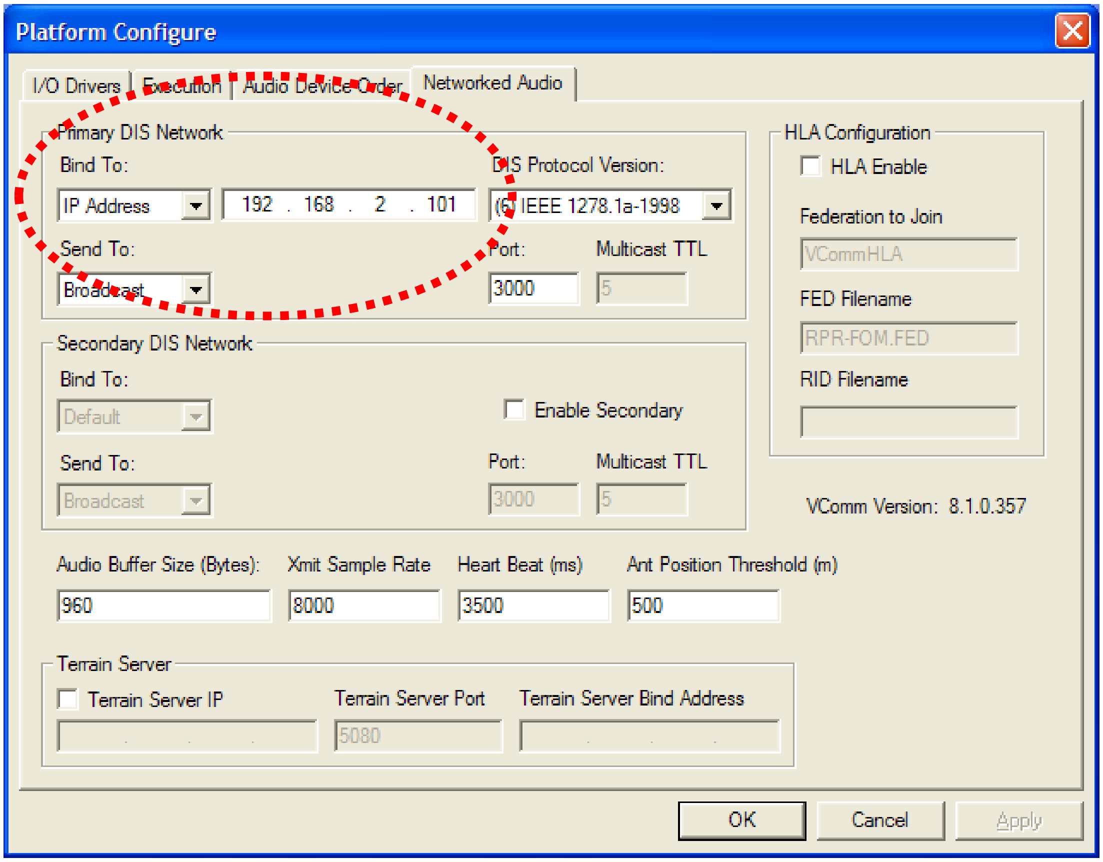


Figure 11, Networked Audio Binding To IP Address

Selecting the Host Name option allows entry of a host name. VComm will attempt to resolve the host name to an IP address and will then bind to the adapter with that IP address. This is useful when IP addresses are assigned dynamically (via DHCP for example). VComm may also bind to the adapter using its device name or friendly name. Selecting these options enables a dropdown list of available names. A name not in the list may also be entered directly. Note that adapters that are disconnected will not appear in the list of available names. For each DIS network it is also possible to specify where VComm should send DIS packets. VComm can be configured to use broadcast, to send to a specific IP address, or to send to a host name. This selection is made using the **Send To** dropdown list as shown in Figure 12. The default selection for **Send To** is broadcast. In this case, VComm sends to the IP address, 255.255.255.255. Note that when both the primary and secondary networks are enabled, selecting broadcast may result in DIS packets intended for one network to be sent to both networks regardless of the binding of the networks to specific network adapters. Instead, broadcasting on specific subnets is accomplished by sending to the subnet broadcast address.

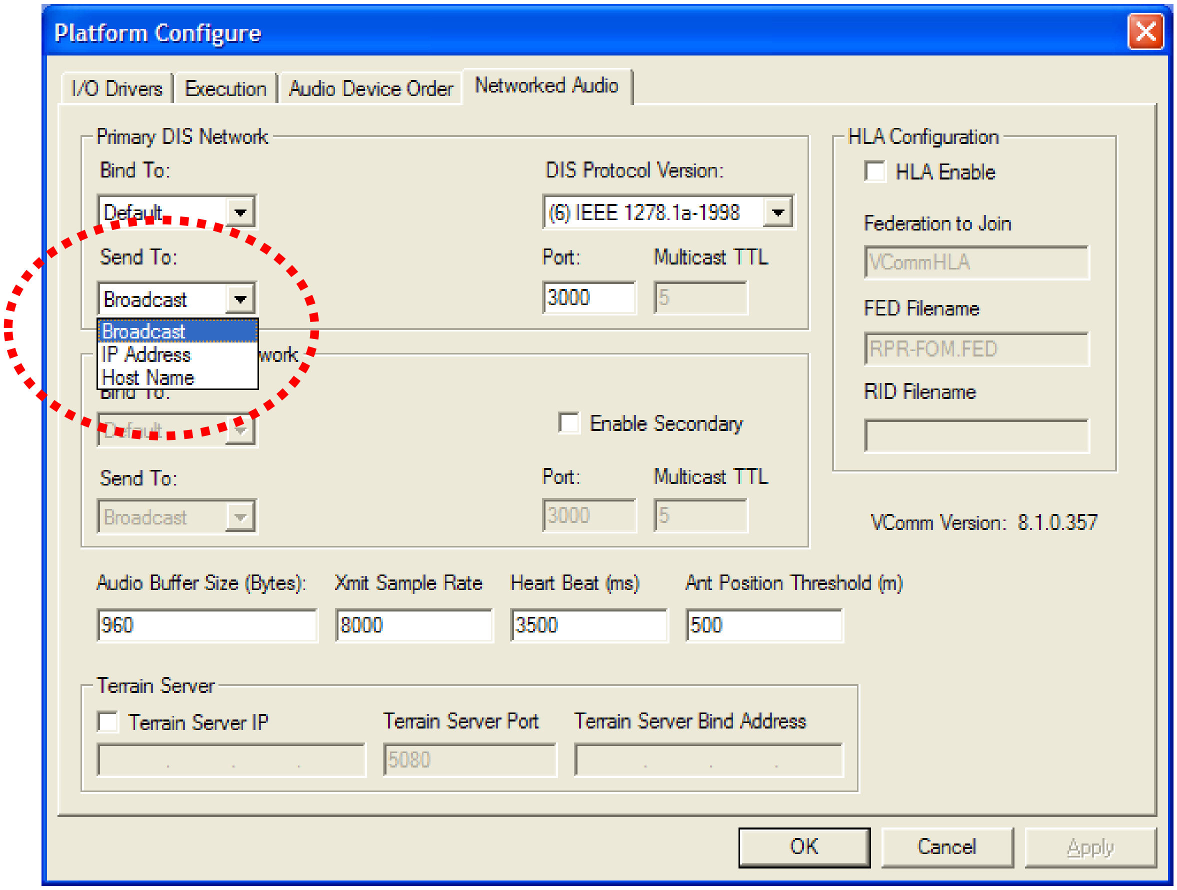


Figure 12, Networked Audio Send To Dropdown

Selecting the IP address option for **Send To** allows an IP address to be entered. VComm will send DIS packets to that IP address. The IP address may be a Unicast address to send VComm DIS packets to a specific computer, a subnet broadcast address to send DIS packets to a specific subnet, or a multicast address. If a valid multicast address is entered, then VComm will configure for multicast operation and the **Multicast TTL** (Time-To-Live) box will become active. In theory, time to live is measured in seconds. In practice, the TTL is reduced by one on every hop. That is why this field is named “hop limit” in IPV6. Selecting the Host Name option for **Send To** allows a host name to be entered. VComm will attempt to resolve the host name to an IP address before proceeding as for the IP Address option. The default network port number is 3000 as shown. Edit this field if a different port number is required.

8.2 End-to-End Latency (mouth to ear)

ITU standard G.114 establishes a satisfactory latency of 150ms of end-to-end delay for high quality voice transmission. Studies at CISCO and other networking experts has shown that there is a negligible difference in voice quality mean opinion scores (MOS) using networks built with 200-ms delay budgets. Therefore a latency of 150 ms is recommended while 200 ms would be a maximum end-to-end latency. For a 150ms end-to-end latency, a maximum jitter of 30ms is reasonable.

Radio and intercom simulation systems naturally impose a greater performance demand as compared to telephony applications because the voice system must simulate a real systems, often exhibiting a near zero latency for voice. Intercoms are often analog having near zero latency. Crews in simulation vehicles in close proximity will notice latency from mouth movements to hearing the voice. In these cases latency must be less than 10ms and fortunately this can be accommodated by local voice mixing and routing.

8.3 Audio Buffer Size

The audio buffer size is the number of digital audio samples captured from the audio input device. This value dictates the size of the Signal PDU and is limited by the maximum number of bytes that can be sent in a single UDP/IP packet, normally less than 1500 bytes. The minimum value for this field is 256 bytes and the maximum is 1024 bytes. Always use an audio buffer size that is an integer multiple of 32 for this field. The default value is 960 which is 960/32 = 30. A value of 958/32 = 29.9375 which is not an integer multiple, which may cause glitches in some vendor equipment due to improper padding at the end of the Signal PDU.

9 Radio Model Fidelity

One of the primary design philosophies of VComm is realism. Therefore, in order to understand VComm it is important to understand the fundamentals of radio. The following sections describe radio model fidelity of VComm. It should be noted here that the modeling described in this section applies to the VComm GENERIC Radios objects and not to the VComm Simple Intercom. For more information on the VComm Simple Intercom, refer to section 10.

9.1 Radio Spectrum

The radio spectrum extends from 3 KHz to 300 GHz and is divided into sections as shown in Figure 13.

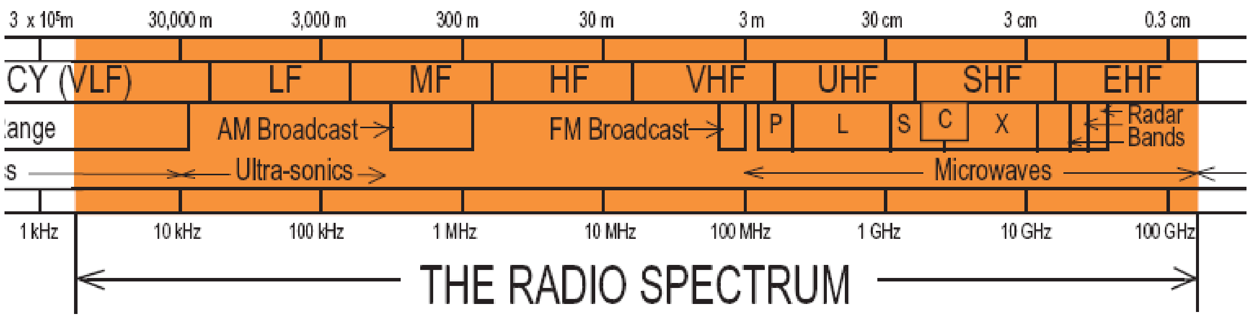


Figure 13, the Radio Frequency Spectrum

An important note about spectrum use for DIS radios. Frequencies below 100,000 Hertz are considered Simple Intercom devices instead of radios and the frequency becomes a channel number rather than a frequency. Therefore, tuner models are simply integer compares for these channels and bandwidth is ignored. This is based on de-facto and the latest draft DIS standard.

A popular radio frequency database available online: www.Radioreference.com

9.2 Commonly used Radio spectra

This document is primarily concerned with radio communications for voice although some are for data as well. This section can be used as a guide for determining frequency bands for use in interest management.

9.2.1 Suggested Interest Management for voice communications frequencies

For HLA DDM and DIS multicast group management the table below is a good suggestion

Table 4, Suggested radio frequency interest management

Name	Frequency Range
Civilian Aircraft	118.000 MHz to 136.975 MHz
Military HF	100 KHz to 30.000 MHz
Military VHF	138.000 MHz to 144.000 MHz
Military UHF	225.000 MHz to 400.000 MHz
SATCOM	1 GHz and Above
All Other Voice Communications	Frequencies Not Shown Above

Table 5, US Military Band designation

Band	Range
A	0 – 250 MHz
B	250 – 500 MHz
C	500 – 1GHz
D	1 – 2 GHz
E	2 – 3 GHz
F	3 – 4 GHz
G	4 – 6 GHz
H	6 – 8 GHz
I	8 – 10 GHz
J	10 – 20 GHz
K	20 – 40 GHz
L	40 – 60 GHz
M	60 – 100 GHz

9.3 VComm Radio Modeling

VComm addresses this problem by modeling the radio system itself and modifying the received audio signal based on many parameters and effects, to present audio to the user that actually sounds like a radio transmission. VComm calculates signal strength and noise using the simplified model diagram shown in Figure **14** for incoming radio data. DIS specifies that the effects of the simulation be applied at the receiver. Each element in the diagram is an important part of the overall receiver model. The sections that follow explain each of these models in detail.

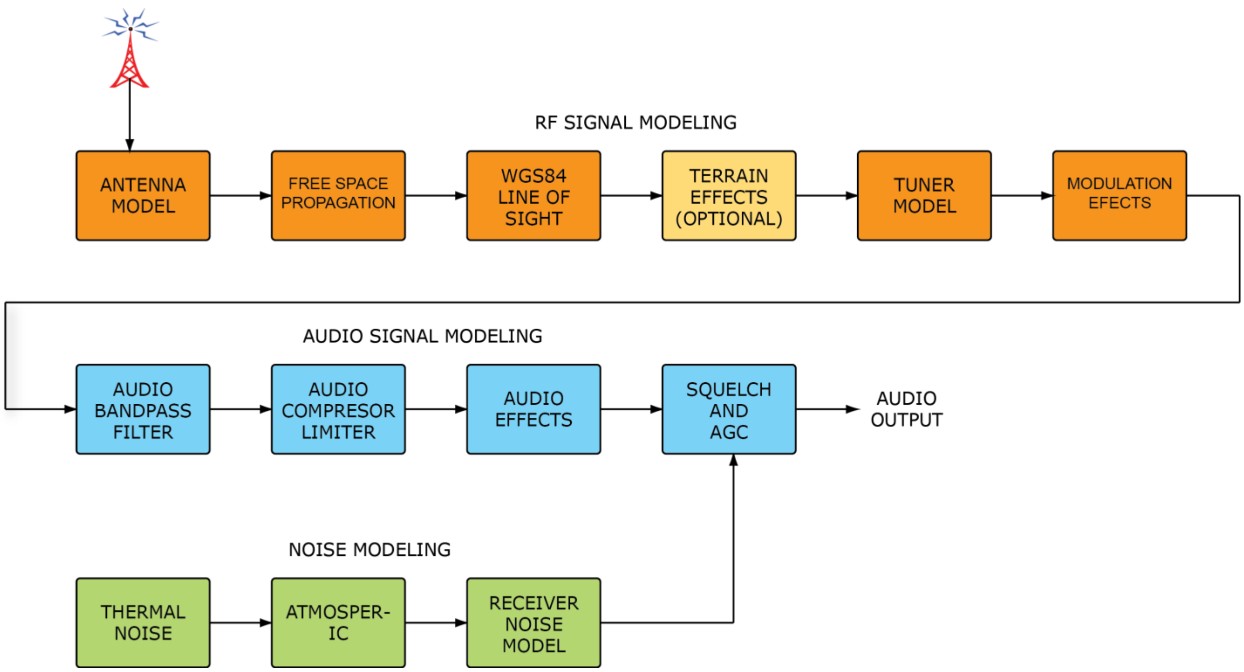


Figure 14, VComm Radio Modeling Functional Flow

9.4 Transmitter Power

Transmitter power input pins for VComm radio objects expect power to be expressed in decibel milliwatts (*dBm*). Transmitter power levels are often expressed in watts. V+ objects 2025 uses the following calculation to convert watts to dBm as shown:

$$dBm = 10\log\left(\frac{p}{0.001}\right),$$

Where: *dBm* is Decibel milliwatts

p is the transmitter power in watts

Therefore a 5-watt transmitter has an output of 36.98 (37) dBm. Typical radio transmitters on military aircraft have transmitter power levels of 5 to 25 watts. The airborne AN/ARC-164 radio for example has a 10-watt transmitter. Typical power levels of general aviation radios fall between 5 and 10 watts. Table 6 provides some values in dBm for given wattage levels.

Table 6, Watts to dBm	
Watts	**dBm**
1	30
5	37
10	40
15	42
25	44
100	50
125	51
200	53

9.5 Receiver Sensitivity

VComm radio models include a receiver sensitivity setting, which is based on industry standards and is usually published for receiving equipment. For example, an AN/ARC-210 radio receiver is specified as –103 dBm for AM and –108 dBm for FM using 12 dB SINAD.

9.5.1 SINAD

SINAD is the abbreviation for SIgnal plus Noise and Distortion, and is a parameter that provides a quantitative measurement of the quality of an audio signal from a radio receiver. The definition of SINAD is simple – it's the ratio of the total signal power level (wanted Signal + Noise + Distortion or SND) to unwanted signal power (Noise + Distortion or ND). Receiver sensitivities are usually expressed as a dBm value for a given SINAD.

9.5.2 Converting between Micro-Volts and dBm

Often, the receiver gain is expressed in micro-volts (μV). To convert µV to dBm, use the following formula:

$$dBm = 20 \log\left(\frac{\mu V}{223607}\right)$$

Therefore, a 1µV signal is equal to –106.99 dBm. A generic VComm radio class has a default setting of -117 dBm for 12 dB SINAD. The various classes of radios in VComm have different sensitivities. See the datapool section for setting different default sensitivity settings.

Notes:

When the incoming power level drops below -269 dBm for an incoming transmitter VComm will no longer process the signal PDU. In addition, VComm will not process Signal PDUs when the Transmitter PDU indicates that it is not transmitting even though some vendor equipment continues to send Signal PDUs.

9.6 RF Signal Modeling

The following sections describe how the RF signal modeling is processed within VComm as shown in Figure 15.

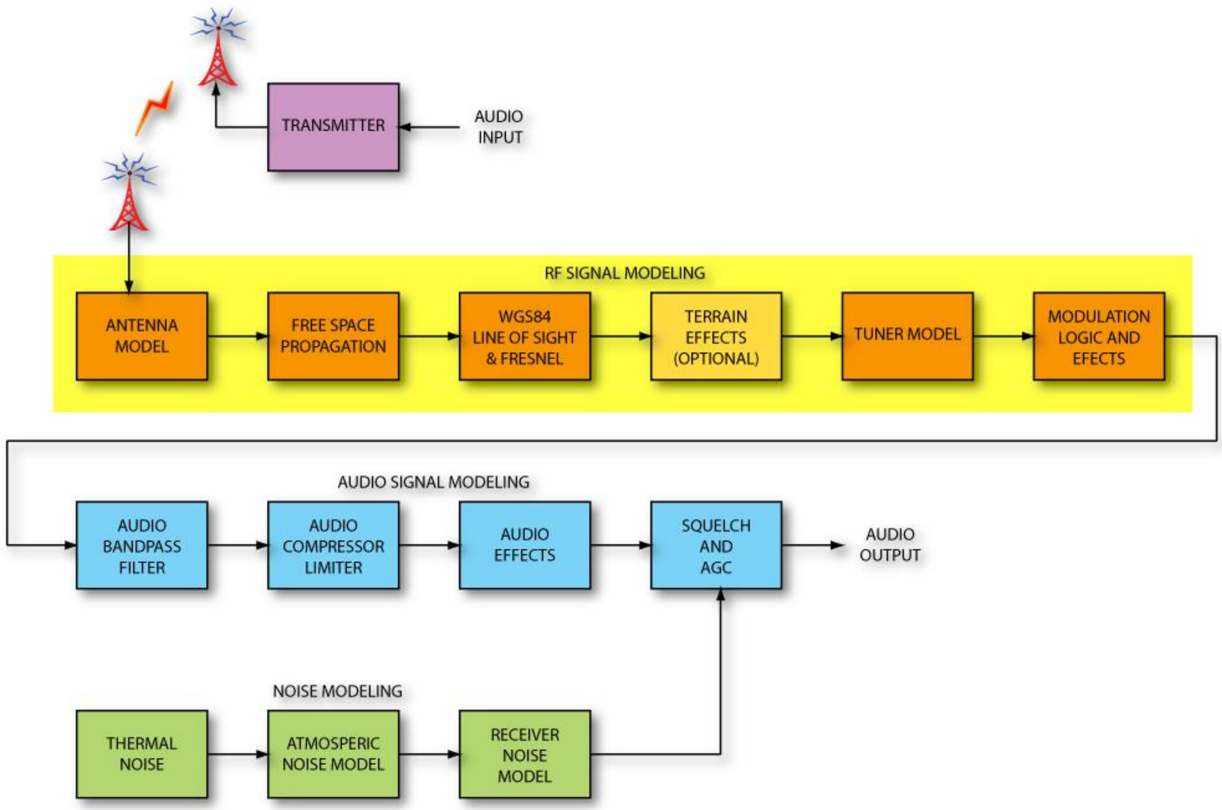


Figure 15, VComm RF Signal Modeling

9.6.1 Antenna Model

A transceiver (transmitter/receiver) usually has one antenna that the transmitter and receiver share, but it is possible for them each to have a separate antenna. The DIS Transmitter PDU contains antenna data the transmitter’s antenna only. However the receiver’s antenna data is not specified in the DIS Receiver PDU. This does not pose a problem for the model, but DIS loggers are not able to determine the receiver’s antenna type.

5.5.1.1 Antenna Patterns

VComm supports an isotropic antenna which radiates uniformly in all directions. These antennas are often called “Reference Antennas”. There are no known radio vendors that model directional antennas behavior and therefore use the isotropic antenna which is specifies the enumeration of 0 (Omni directional) in the *Transmitter PDU* for *Antenna Type*.
Note that if the antennas were directional, then the receiving simulation must account for the geometry of the antenna pattern at the transmitter and/or receiver and the parent entity orientation. In this case, antenna gains would be considered.

5.5.1.2 Isotropic Antenna

Isotropic antenna gains are by definition 1 and the transmitter and receiver gains must always be 1.0 since antenna gain is expressed relative to an ideal isotropic radiator in dBi, or loss/gain relative to an ideal antenna. If an antenna has gain, it is directional, and therefore non unity gain cannot be expressed without directional characteristics.

5.5.1.3 Real World Antennas

Future versions of VComm will support directional antennas, however new enumerations must be added to “SISO-REF-010-2006” to account for the basic types such as vertical and horizontal ½ and ¼ wave dipoles. A ½ wavelength horizontal dipole antenna radiation pattern is shown in Figure 16. The gain in the horizontal plane is 2.15 dBm.

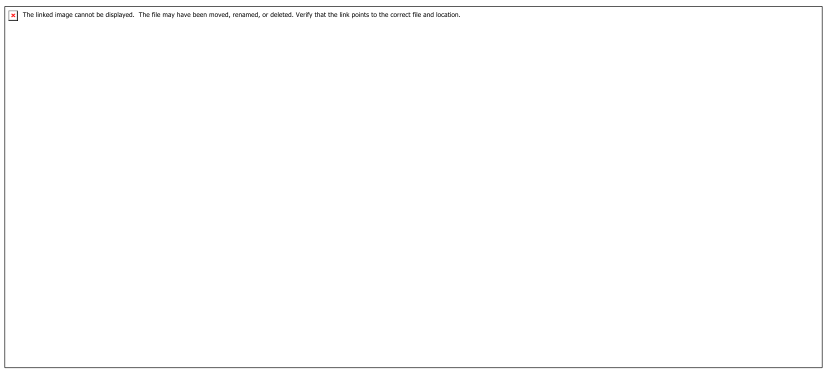


Figure 16, Horizontal Dipole Pattern

9.6.2 Propagation-less DIS De-facto Standard

There are conditions within the DIS protocol when the propagation loss is assumed to be zero. If the location of the transmitter or receiver antenna is set to (0, 0, 0), or the frequency is less than 100 KHz, there is no propagation loss since the location of (0, 0, 0) is the center of the earth using the DIS world geocentric coordinate system.

9.6.3 Antenna Position Threshold

The Transmitter Position Threshold is the antenna position change needed to generate a new Transmitter PDU in DIS or an attribute change in HLA. The default value is 500 meters. This reduces the number of updates that are issued on the network when radios are attached to moving entities.

9.6.4 Free Space Propagation Loss

Free space propagation loss is characterized by the following equation which spreads the transmitter power over a sphere whose size is the distance to the receiving antenna. The power at the receiving antenna aperture is a unit area of this sphere.

$$pr = \frac{ptgtgr\lambda^2}{(4\pi d)^2}$$

p_t, p_r = transmitter power, power at receiver antenna
g_t, g_r = transmitter Antenna gain, receiver antenna gain
d = distance in meters
λ = wavelength in meters

Losses and gains are easier to express in dBm rather than watts so rearranging and eliminating the antenna gains for isotropic radiators gives the following.

$$l = 10Log(\frac{4\pi d}{\lambda})^2$$

l = loss in dBm

Further, combining constants and using frequency in MHz and distance in kilometers results in the following classic free space propagation loss equation often called the Lee form. For the derivation, see http://www.mike-willis.com/Tutorial/PF4.htm. Note that the loss is expressed in dBm simplifying path calculations. VComm uses this free space propagation loss algorithm.

$$l = 32.4 + 20\,\mathrm{Log}(f) + 20\,\mathrm{Log}(d)$$

f = frequency in MHz
d = distance in kilometers

Figure 17 shows a graph of free space propagation loss using real world numbers.

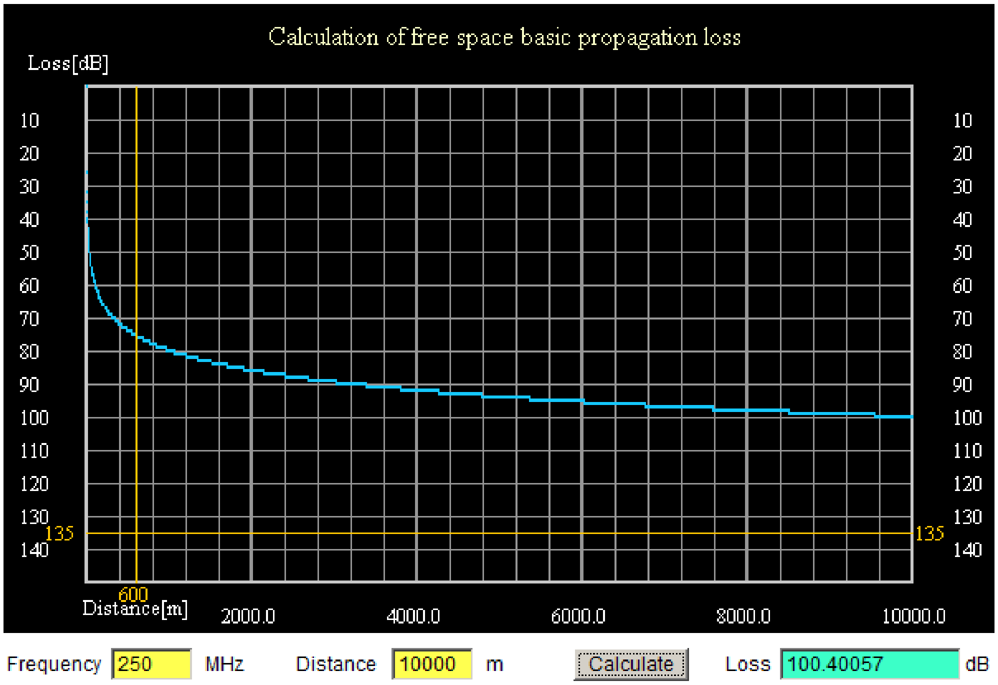


Figure 17, Free Space Propagation Loss

5.5.1.4 Free Space Propagation Loss Example

An AN/PRC-117F radio is advertised that it has a receiver sensitivity of -116dBm for FM, for a 10db SINAD. This means that it can receive a signal level of -116 dBm and still break the squelch. How far can the transmitter antenna be placed in free space and still be heard?
Using a frequency of 250 MHz and a distance of 5,000,000 meters (3,106 miles) the loss is 154.37 dBm. If the transmitter power is 42 dBm (15 watts) then the signal level arriving at the receiving antenna would still be -112 dBm, still within the squelch range. In other words, communicating from New York to Paris which is obviously an unrealistic scenario. What's wrong here? Remember, this equation is free space. If all we simulated was communications in space, this equation would work. For radios on or near the earth, terrestrial propagation effects must be considered for any realistic range simulation.

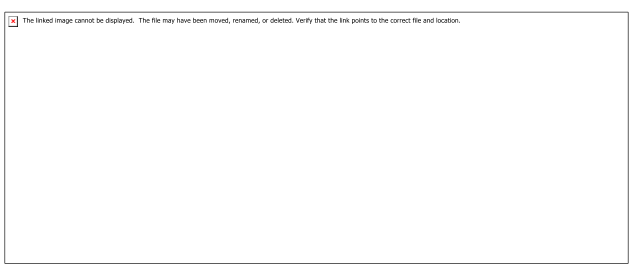


Figure 18, AN/PRC-117F Radio

9.6.5 WGS84 Line-of-Sight

The round earth limits radio range for frequencies above 30 MHz due to radio horizon. VComm computes the radio horizon and applies statistical models to the signal loss to account for the horizon, and smooth earth. A terrain server can enhance this calculation.

9.6.6 Fresnel Effects

It makes sense that obstructions between a transmitter and receiver will reduce the communication range. In order to obtain the absolute maximum communication range possible, a radio must be installed such that true RF Line-of-Sight (LOS) conditions exist between the transmitting and receiving antennas. RF LOS is different from visual LOS. Visual LOS is present when one can directly view the other antenna. RF LOS requires not only a visual sight line between the antennas but it also requires that a football shaped area between the two antennas be free of obstructions, including the earth (see Figure 19). This football shaped area is called the Fresnel (pronounced frə·nĕl´) Zone. The Fresnel zone is an area that is larger in diameter at the center and smaller in diameter at the ends. Also, the greater the distance between the antennas, the larger the diameter of the Fresnel zone in the center. Any obstructions that enter into the Fresnel zone will reduce the communication range include buildings, vegetation, the ground, etc. As the antennas get farther apart and the diameter of the Fresnel zone increases, the ground can begin to obstruct the Fresnel zone. In order to keep the entire Fresnel zone free of obstructions it is necessary to raise the antennas. To keep the Fresnel zone off the ground the heights of the antennas added together must total more than the diameter of the Fresnel zone at the specific distance. The diameter of the Fresnel zone is a function of the frequency and the distance between the antennas.

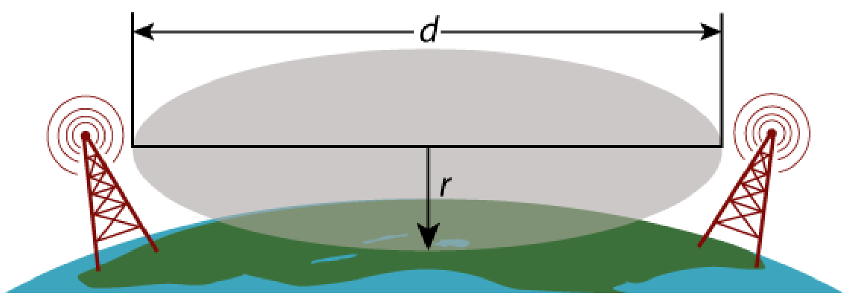


Figure 19, Fresnel Zone

VComm models signal attenuation due to Fresnel effects and curvature of the earth. These signal calculations utilize the World Geodetic System 84 (WGS84) which defines a fixed global reference frame for the Earth.

9.6.7 VComm Terrain Server

VComm 8.0 Build 331 and later versions include a terrain server interface to the VComm Terrain Server (VTS) for calculating the effect of terrain. Default terrain data is provided in DTED Level 0 format and is installed with the VTS option for the entire earth. Users can elect to insert higher resolution DTED or DEM data. The VTS is a separately licensed software product which can be purchased from SimPhonics. It is a standalone TCP/IP server which can run on the same computer as V+ or a separate computer. VComm queries the VTS as a TCP/IP client through a remote message protocol. The protocol is defined in the VComm Signal Quality Service Specification. The VTS is described in the VComm Terrain Server User Manual. Figure 20 presents an example design with two radios where VComm has been configured to run the VTS. In this example, Radio 2 is transmitting, and Radio 1 is receiving. Note the - -25.4 dBm attenuation due to terrain shown in Radio 1's Radio Data Monitor object.

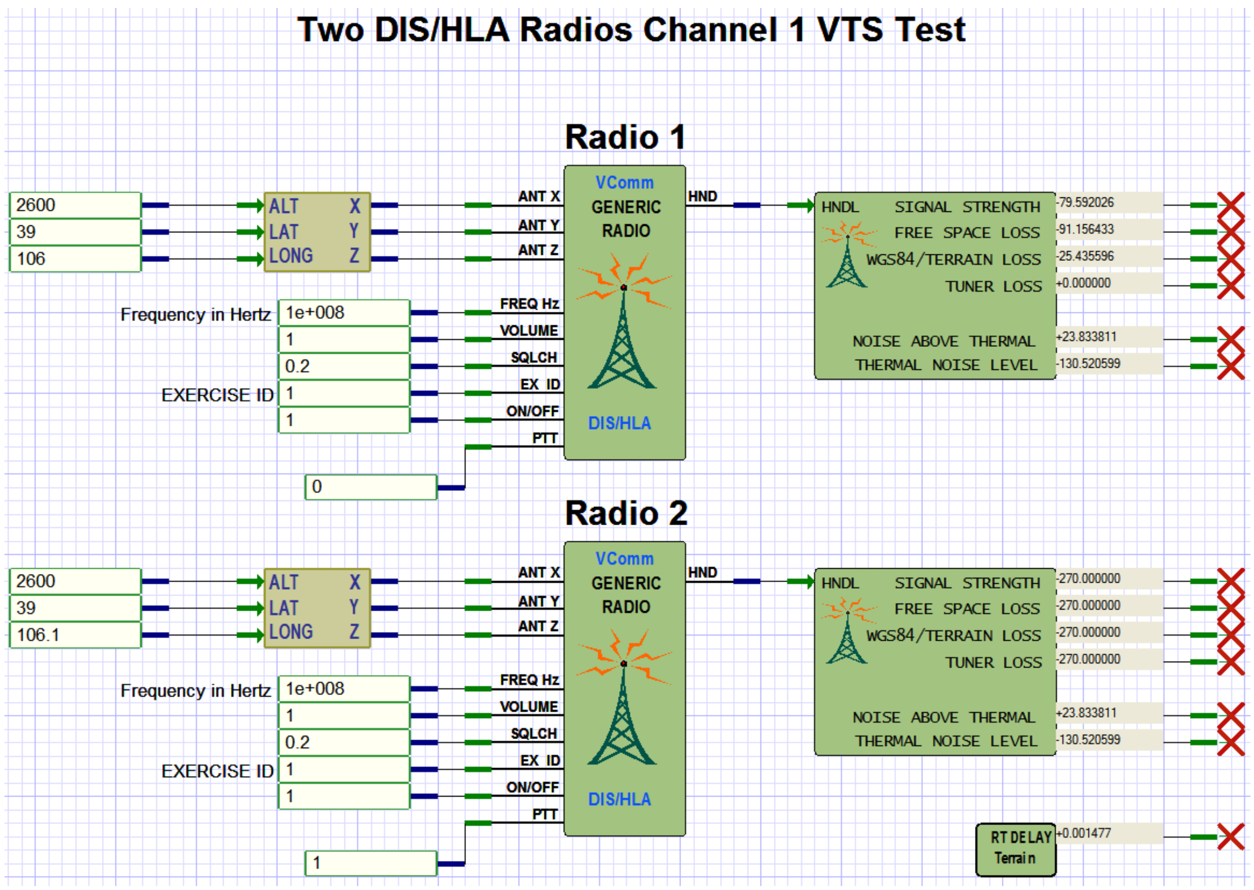


Figure 20, Example Design Using the VComm Terrain Server

At the bottom right of this example is a **VComm Terrain Server Status** object. It's output pin indicates a round trip latency of 0.001477 seconds (1.477 milliseconds) from the time VComm sent the request to the time VComm received the attenuation value to and from the VTS.

Note: *This example is available in the VPLus Samples folder of V+, Build 331 and higher.*

Figure 21 is a screen shot from the VTS which plots the same coordinates and frequency as in the figure above. The bottom part of the screen shows two antennas with a terrain profile between them. The dashed line is the direct line-of-sight line between the antennas, and the dotted line represents the

terrain profile. The resultant attenuation of
-25.4635 dBm is a little bit different than what is shown in Figure 20 (-25.435596 dBm) since the VTS does all of its math in double precision floating point, and the VComm object input pins are single precision floating point.

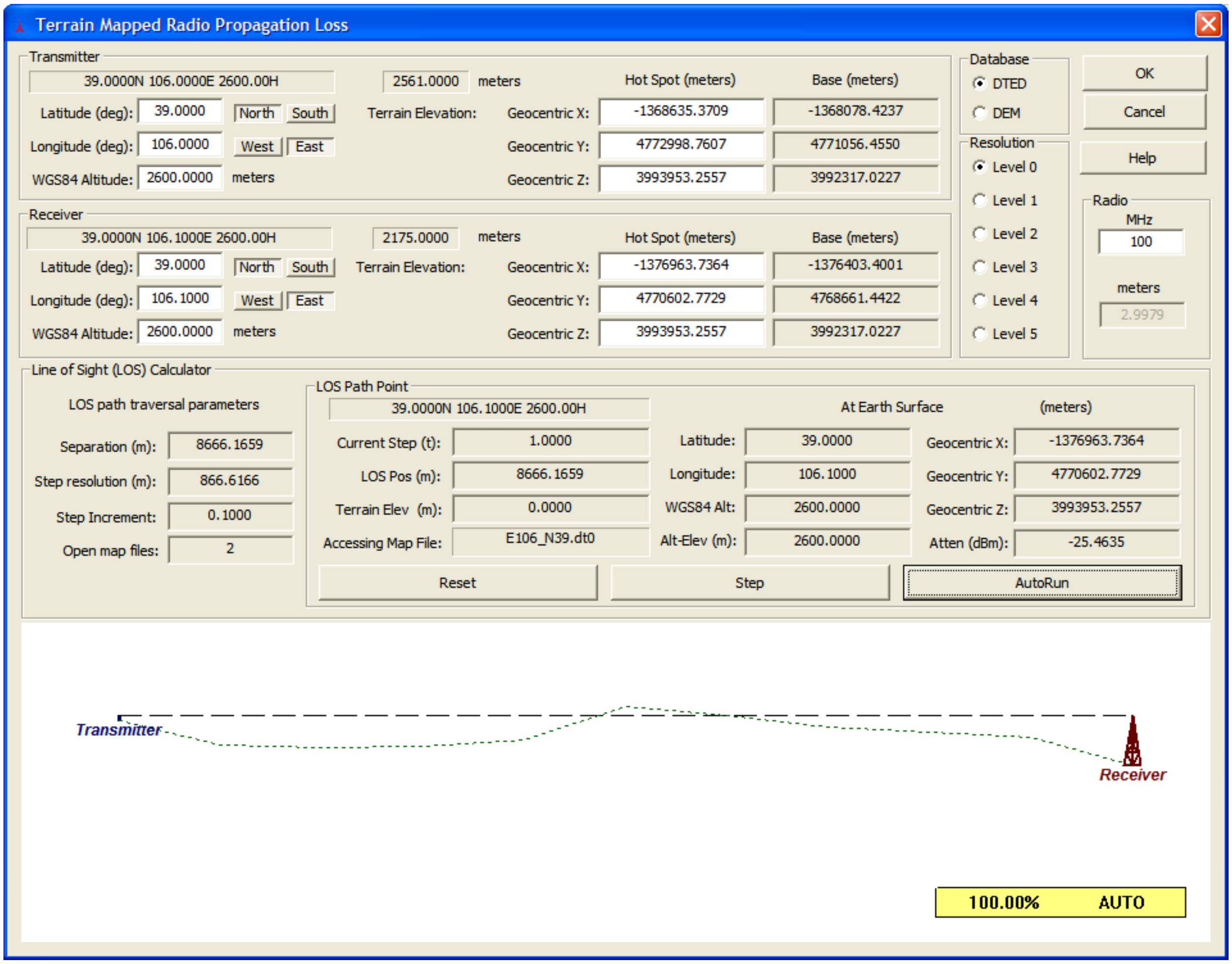


Figure 21, VTS Single Solution Plot

9.6.8 HF Model

The HF model is an optional model that is disabled by default. When enabled, this model handles the calculation of signal loss for all transmissions with frequencies from 2 to 30 MHz. V+ Object 2086, VComm HF Control, is used to enable the HF model and to control modeling parameters. HF radios are unique in that their transmissions may reach areas of the earth that would not otherwise be accessible to line of sight radio communications. This is largely due to the refraction (or bending) of these transmissions in the ionosphere. While the factors and calculations that affect which areas of the earth can receive an HF transmission are very complex, there are effects that can be modeled in a simple and predictable fashion, maximum usable frequency (MUF), and skip zones. The maximum usable frequency for an HF transmission is defined as the highest frequency where two radios can communicate if they are not within radio line of sight of each other. The HF model takes the MUF defined by the VComm HF Control object into account whenever an HF transmission is made.

9.6.8.1 Skip Zones

Skip zones are areas of the earth which are inaccessible to an HF radio. If an HF transmission is made from a transmitting radio to a radio located within the skip zone, then those transmissions will not be received unless the receiving radio is within line of sight, or the receiving radio is on the edges of the skip zone (in which case the strength of the transmission will be reduced). The HF model calculates the location of skip zones relative to the location of each transmitting radio. Two skip zones per radio are supported. The relative distance and the size of each skip zone are defined by the VComm HF Control object.

5.5.1.5 HF Model Signal Loss Calculations

This section describes the method used by the HF model to determine signal loss for HF transmissions. First of all, the HF model ignores free space propagation losses. HF transmission paths are affected by numerous factors which are beyond the scope of this model. In addition, HF transmissions may experience signal enhancement due to factors such as multipath and ducting. To keep things simple therefore, free space propagation loss is assumed to be zero by the HF model. The HF model first determines whether there is a clear radio line of sight between the transmitting and the receiving radio. If this is the case, then signal loss is deemed to be zero. This means that when the HF model is enabled all radios (in the HF band of 2 to 30 MHz) that have clear line of sight with each other will experience no signal loss. If there is not a clear line of sight between the transmitting and receiving radio, the HF model computes the signal loss that would be present for a direct transmission (i.e., as if the transmission was not an HF transmission). This loss accounts for round earth, Fresnel zone effects, and terrain effects (from the optional terrain server). The HF model then computes the signal loss resulting from MUF effects and skip zones. These two signal losses are compared and the one which results in the least signal loss is used. This ensures that there is a smooth progression of signal strength as a receiving radio moves below the horizon.

9.6.8.2 Maximum Useable Frequency

Signal loss due to the MUF is calculated by comparing the frequency of the radio transmission with the MUF setting of the VComm HF Control object. Radio transmissions at a frequency above the MUF are assigned maximum signal loss while those up to 85% of the MUF are assigned no signal loss. There is a smooth increase in signal loss from 85% of the MUF up to 100% of the MUF. Thus HF radio transmissions degrade in signal quality as the frequency of the transmission approaches the MUF setting. The signal loss due to skip zones is added to the signal loss due to the MUF. The HF model determines whether a radio receiver is located in the radio transmitters skip zone. Signal loss due to skip zones is zero if the receiver is not located within a skip zone. Maximum signal loss is assigned to radio receivers located within the skip zone unless they are close to the edges of the zone where the HF model ensures a smooth increase in signal loss as the location of the receiver proceeds further into the zone. The transition from no signal loss at the boundary of the skip zone to maximum signal loss occurs over a distance equal to 5% of the skip zone size.

9.6.8.3 Skip Zone geometry

Figure 22 illustrates the geometry of a skip zone in VComm. The transmitter is located at the point marked with the “x”. The skip zone boundaries are defined relative to the location of the transmitter. The start of the skip zone is the radial distance from the transmitter that is equal to the skip zone distance set in the VComm HF Control object. The end of the skip zone is that radial distance with the skip zone size added. The actual skip zone only exists in the area shaded in black since it does not include areas where line of sight exists. The HF model provides the V+ designer with a simple and predictable model for adding HF effects to the radio simulation.

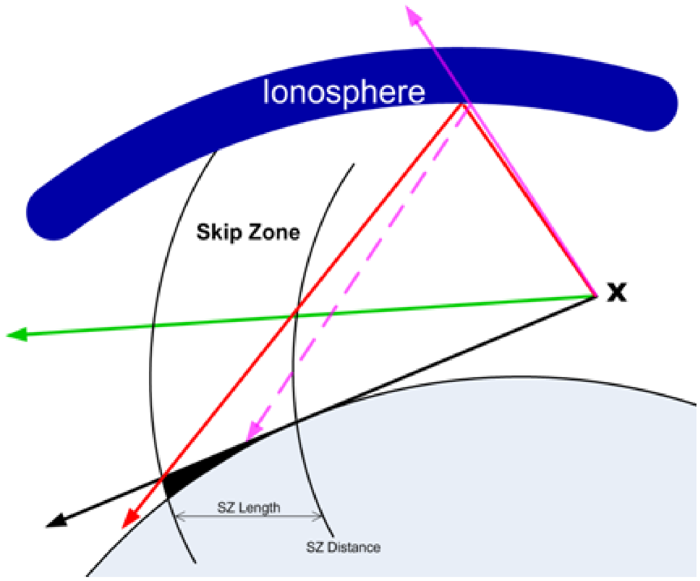


Figure 22, Skip Zone Geometry

9.6.9 Minimum and Maximum Antenna Range

The range (distance) between antennas is measured as shown in the figure below and is referred to as Line of Sight (LOS), or slant range. VComm provides a minimum range and a maximum range which can be changed on a per radio basis. These variables provide a means to force reception or reject reception of a signal based on the distance between the transmitter and receiver antennas.

Figure 23, VComm Radio Line of Sight Range

The default minimum and maximum ranges are:

- Default Minimum Range is 1 meter. Signals closer than 1 meter are considered connected directly to the receiver antenna.
- Default Maximum Range is 1,000,000,000 meters. Signals farther away than that will not be received.

5.5.1.6 Overriding Minimum Range

The minimum range can be overridden to extend the range that all signals are received at maximum strength by using object 2087, VComm Min Range. See the object help for details.

5.5.1.7 Overriding Maximum Range

The maximum range can be overridden to limit the reception range by using object 2091, VComm Max Range. See the object help for details.

9.6.10 Receiver Tuning Model

The receiver tuning model is composed of two parts: signal selectivity and tuning response.

5.5.1.8 Receiver Signal Selectivity

The selectivity of the receiver is its ability to receive a signal and reject unwanted signals in adjacent channels (frequencies). The characteristic important to selectivity is receiver bandwidth. Within the Transmitter PDU, a “bandwidth” parameter exists. The DIS specification defines bandwidth in the Transmitter PDU as:

> *“Bandwidth of the particular transmitter measured between the half-power (-3 dB) points (This value represents total bandwidth, not the deviation from the center frequency.)”*

This parameter is transmitter bandwidth, not receiver bandwidth. Do not confuse these. VComm receivers have their own independent bandwidth settings. Typically a VHF receiver has a bandwidth of 25 KHz. Receiver selectivity is normally quoted by means of a graph showing the output of the receiver in dB relative to the maximum output, plotted against the number of KHz off-tune, or by quoting some points on this graph. For example, the selectivity of a HF receiver may be quoted as -6 dB at 3 KHz bandwidth and -60 dB at 12 KHz bandwidth. Typically, an AM receiver has a 3 dB bandwidth of about 9 KHz, an SSB receiver approximately 3 KHz, and an FM receiver's bandwidth is about 200 KHz.

5.5.1.9 Receiver Tuner

VComm generic radios use Gaussian calculation for tuner frequency response. The calculation is scaled to produce a 3 dB power point equal to the bandwidth of the receiver. The result is an approximation of actual receiver response to incoming frequencies that are on or near the frequency of the receiver (see Figure 24). For example, given an incoming transmission on 10 MHz, with the receiver tuned to 10.01 MHz and the receiver bandwidth set to 25 KHz, the signal will be received, but at a reduced level. Depending on other criteria such as transmitter power, receiver sensitivity, and locations of the antennas, the signal may not be readable.

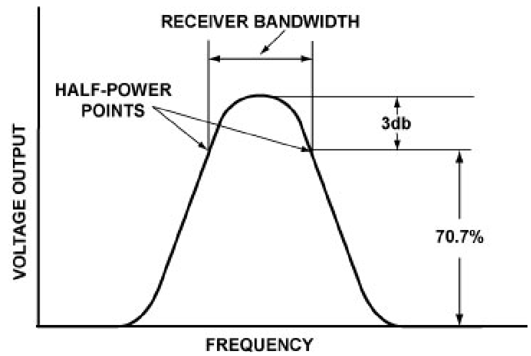


Figure 24, Approximate Tuning Response Curve

The actual response curve that VComm uses for generic radios is shown in Figure 25.

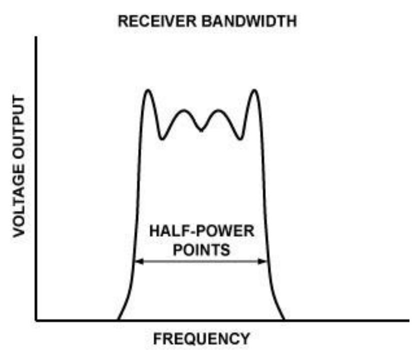
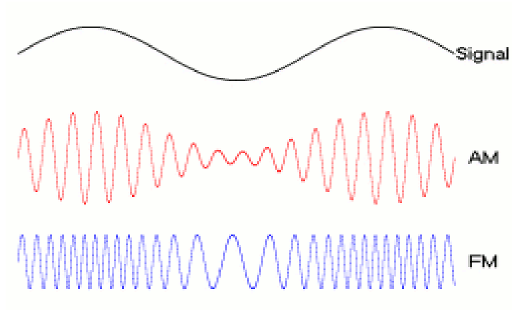


Figure 25, VComm Tuning Response Curve

Bandwidth is irrelevant for frequencies below 100 KHz, since these radios are considered ICS radios and have no concept of bandwidth. Frequencies are considered channels below 30 KHz. The FAA's Next Generation Communications System (NEXTCOM) specifies an 8.33 KHz channel spacing for VHF general aviation radios. This means that radio transmitter bandwidths must be about 8 KHz in order to support this channel spacing.

9.7 Modulation

Figure 26, Modulation



Modulation is the process of varying one or more properties of a high frequency periodic waveform called the carrier signal with respect to a modulating signal. In the case of an AM broadcast transmitter the audio or signal is conveyed on a radio frequency (RF) carrier signal to the receiver using Amplitude Modulation (AM), a common radio modulation scheme. Figure 26, Modulation shows three waveforms, the signal at the top and two carrier signals, the AM modulated carrier and frequency modulation (FM) modulated carrier. The AM carrier changes in amplitude in proportion to the signal. The FM carrier is constant amplitude and the frequency is shifted in proportion to the signal amplitude.

9.8 Modulation Types

There are several types of modulation and VComm embraces DIS and HLA RPR_FOM enumerations. See IEEE 1278.1 for more information on how the type is expressed as two variables. Table 7, Modulation Detail lists the Major and Detail modulation parameters for a given radio.

Table 7**,** Modulation Detail

Major Modulation	Value	Detail Modulation	Value
Other	0	Other	0
Amplitude	1	Other	0
		AFSK	1
		AM	2
		CV	3
		DSB	4
		ISB	5
		LSB	6
		SSB Full	7
		SSB Reduced	8
		USB	9
		VSB	10
Amplitude & Angle	2	Other	0
		AAM	1
Angle	3	Other	0
		FM	1
		FSK	2
		PM	3
Combination	4	Other	0
		AAP	1
Pulse	5	Other	0
		PM	1
Unmodulated	6	Other	0
		Continuous	1

9.9 Configuring Modulation

VComm radios default to a modulation scheme specific to the radio object unless specifically overridden by an attachable object such as Object 1095 – VComm Radio Model Data. Exercise managers may dictate modulation types instead of leaving the simulation of the radio to users. This has been done in the past because existing radio systems did not model modulation properly.

9.9.1 Default Modulation for Radios

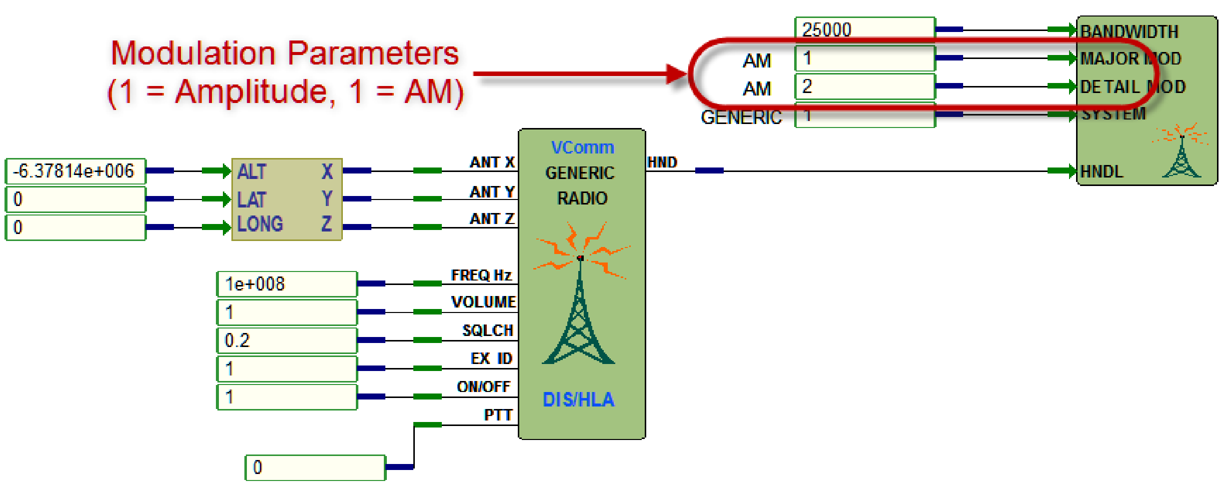
Modulation System	Generic (1)
Major Modulation	FM (3)
Detail Modulation	FM (1)

9.9.2 Default Modulation for Simple Intercom

Modulation System	Generic (1)
Major Modulation	Simple Intercom (0)
Detail Modulation	Other (0)

This object can set the modulation parameters as shown in Figure 27, Controlling Modulation Parameters. The inputs may be constants or may be connected to ports that receive data from another computer via a network or may be computed based on another model, etc.

Figure 27, Controlling Modulation Parameters



9.9.3 Modulation Effects

Table 8, Modulation Interoperability shows voice modes VComm supports. Light blue boxes indicate where modulation matches (=), enabling communications without modulation effects. There are modes where the voice can be heard but effects are modeled such as an AM receiver processing an FM signal and vice versa. Other shaded boxes are those where the signal is processed but an effect is applied. The signal may not be intelligible when the signal is weak. (Low SNR)

Table 8, Modulation Interoperability

RX

TX		AM	FM	SSB
	AM	=	AM/FM Effect	SSB/AM Effect
	FM	FM/AM Effect	=	SSB/FM Effect
	SSB	AM/SSB Effect	SSB/FM Effect	=

9.9.4 Modulation Usage Guide

The tables below list two of the most common types of radios and their settings. When the modulation type is unknown, use the following tables as a guide. Simple Intercom used a 0 as the major modulation enumeration and is unfortunately a de-facto standard created by one of the early DIS radio vendors. This is an exception to the "Do not use zero for any fields in the Transmitter PDU in DIS or in the appropriate attributes of HLA RPR_FOM" rule.

Table 9, VHF Civil Aviation Radio (AM)

Bandwidth	8.33 KHz
Frequency Range	108 to 136 MHz
System	Generic (1)
Major Modulation	Amplitude (1)
Detail Modulation	AM (2)
Transmitter Power	+38.5 dBm
Receiver Sensitivity (10 dB SINAD)	-113.0 dBm

Table 10, UHF Military Aviation Radio (FM)

Bandwidth	16 KHz
Frequency Range	225 to 399.975 MHz
System	Generic (1)
Major Modulation	Angle (3)
Detail Modulation	FM (1)
Transmitter Power	+44.0 dBm
Receiver Sensitivity (10 dB SINAD)	-102 dBm

9.10 Audio Signal Modeling

There is a common misunderstanding within the radio simulation community is that CVSD encoding sounds like a real radio compared to other encoding schemes such as PCM. This is not true. While it is true that CVSD introduces significant distortion thereby sounding more like a radio than simple digitized audio, most real radios do not sound this way unless they are using CVSD for their encoding. Even in this case, simply using CVSD is not enough to convey the sound of a real radio. There are many other issues to consider. Real radios sound different due to other audio effects. Other DIS/HLA voice equipment vendors simply ignore these important modeling aspects. SimPhonics radios incorporate band pass filters along with other effects (as shown in Figure 28) to simulate real radio sounds so that VComm radios sound like the real thing. The following sections describe the audio modeling process in detail.

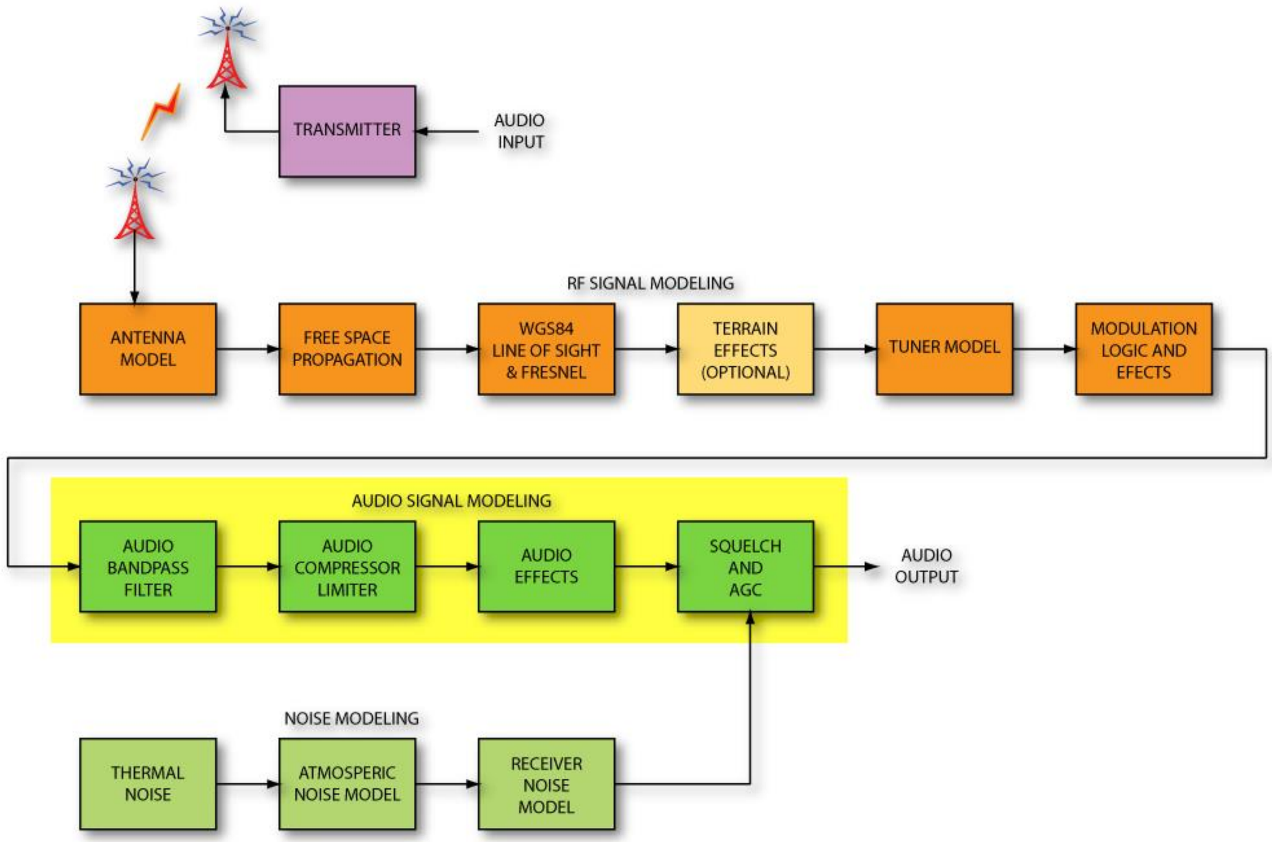


Figure 28, Audio Signal Modeling

9.10.1 Band-pass Filter

Real radios limit the transmission of audio to a spectrum of roughly 300 to 3000 hertz since most voice frequencies are in only that range. Frequencies outside that range are filtered out in order to improve modulation performance and intelligibility at the receiver. This is a significant effect and is the most noticeable radio effect compared to, for example, an intercom or telephone. VComm incorporates an efficient digital filter for this effect. Object 2055 - VComm Radio Audio Emulation Filter removes audio below 300 hertz and above 3000 hertz in real time. The filter's frequency response characteristics for an 8000 Hz sampling rate are shown in Figure 29. This effect alone changes the sound of a voice significantly and is the effect used by Hollywood when simulating radio and telephone effects. The green area shows the passband of the filter.

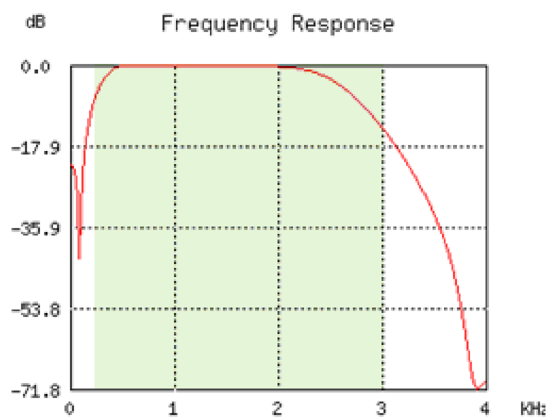


Figure 29, Object 2055 Frequency Response at an 8K Sampling Rate

9.10.2 Compressor/Limiter

Another important aspect of the VComm audio radio model is the compression and limiting process. A compressor/limiter normalizes the dynamic range of audio signals, so that all signals tend to have the same energy level. This is important since the next processing step is the Automatic Gain Control (AGC) modeling which measures energy over time rather than instantaneous amplitude. One of the most important features of the compressor/limiter is to normalize the level of the incoming audio. Other vendor equipment does not utilize this process, and often some incoming radios are too loud, while others are not loud enough. This does not happen in the real world due to the same processing performed by the radio for that very reason. Object 2056 - **VComm Audio Compressor**, can be attached to a radio to control and activate the internal VComm compressor limiter. The values shown at the pins result in the best overall compression based on audio levels encountered in DIS exercises. When object 2055 and object 2056 are used together as shown in Figure 30, a very realistic sounding radio is achieved. Pilots know when the incoming audio is not from a radio on other vendor equipment because there is no filtering and no compression. These are essential elements for any realistic simulation of a radio.

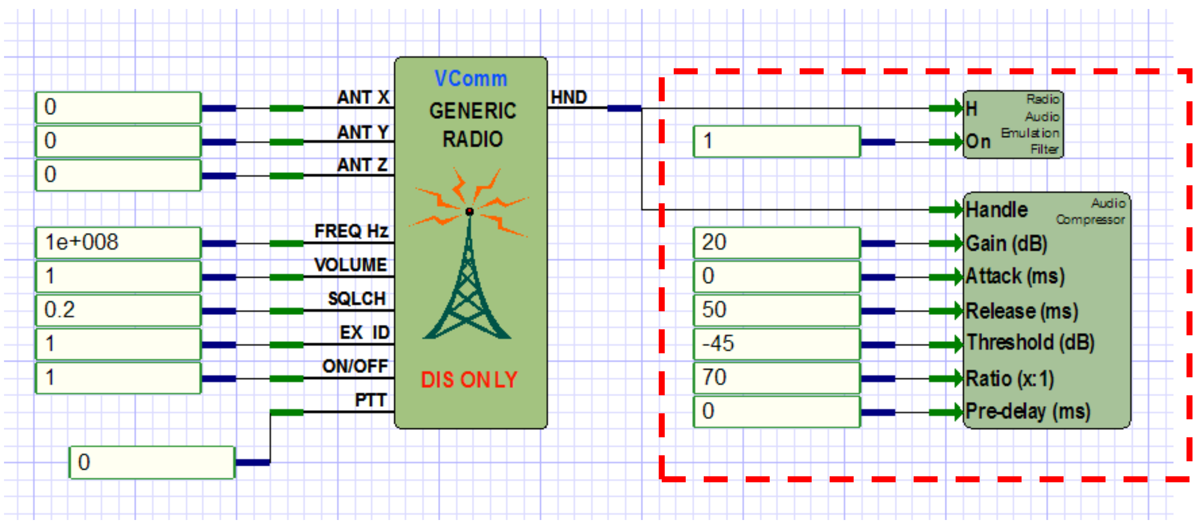


Figure 30, Audio Signal Modeling Objects

9.10.3 Audio Effects

Other audio effects such as noise and squelch tail, are imbedded wavefiles within VComm. These wavefiles are pre-processed prior to imbedding them. Noise generation, for example, has a 300 to 3000 hertz spectrum and therefore sounds like radio “static”.

9.10.4 Squelch and AGC

Squelch suppresses audio output of a receiver when a sufficiently strong input signal is not present excluding unwanted weak signals and noise at or near the interest frequency. If there were no squelch, there would be a loud background noise when the signal is not present. VComm radio objects expect a squelch input of 0 to 1. To turn squelch on for a particular radio, the squelch input must be set to 0.2 or greater. When squelch is turned on, the audio output of the receiver will be silenced when the receiver noise level is 6dB above the strongest incoming signal level (i.e. neither noise nor signal will be heard and the signal is considered too weak to be received). The receiver noise level is the greater of the receiver noise floor and the total antenna input noise level where the receiver noise floor is 12dB below the receiver sensitivity. Another effect of squelch is the so-called “squelch-tail” heard when the squelch is above “full quieting”, and a transmitter sending the signal stops transmitting. The AGC then acts to increase the gain in the absence of the signal, which causes the noise level to rise. This is then followed by the squelch system quieting the receiver. In that short period of time, the increased noise level is heard before the squelch acts to disable it. This is called the squelch tail and is a very short burst of noise at the end of an incoming transmission. VComm models the squelch tail based on signal level, receiver sensitivity, thermal noise level, etc. The amplitude of the squelch tail can be changed beyond this modeled value by adjusting a datapool value. This is the value of the attenuation of the default squelch tail amplitude. This value is expressed in decibels of attenuation. Therefore 100 would indicate that there would be an attenuation of 100 dB, which would result in virtually no squelch tail being generated. See the datapool section for details on this value. To increase the amplitude of the squelch tail, set this value to a smaller value (0 is the lowest).

Note: *Squelch is disabled for most radios types when their frequency is below 100,000 Hz. This is by design.*

To add additional realism VComm will optionally dither the strength of incoming radio signals. This optional effect must be turned on using the VComm Initialization datapool. (see section 25). When signal dithering is enabled, weak signals will intermittently break squelch. Radio operators are trained to recognize this effect and disable squelch to listen to the incoming signal.

9.10.5 Received Signal Packet Jitter

Signal PDUs do not always arrive in sequence and at the correct time that they were transmitted at the receiver. As in modern VoIP protocols, there is also no sequence number of the arriving packets, only a time stamp. While it can be argued that the time stamp is adequate, some vendors do not provide a sufficiently accurate time stamp. SimPhonics has proposed that a sequence number be inserted into the Signal PDU. Receive jitter compensation is computed for all incoming signal PDUs but the adjustment is in the datapool in the current version. While this value can be changed, the topic is beyond the scope of this manual.

9.10.6 Noise Modeling

Noise limits the range in which a signal can be received, since it masks the signal at some level. Figure 31 shows the VComm noise model section. Each section is discussed below.

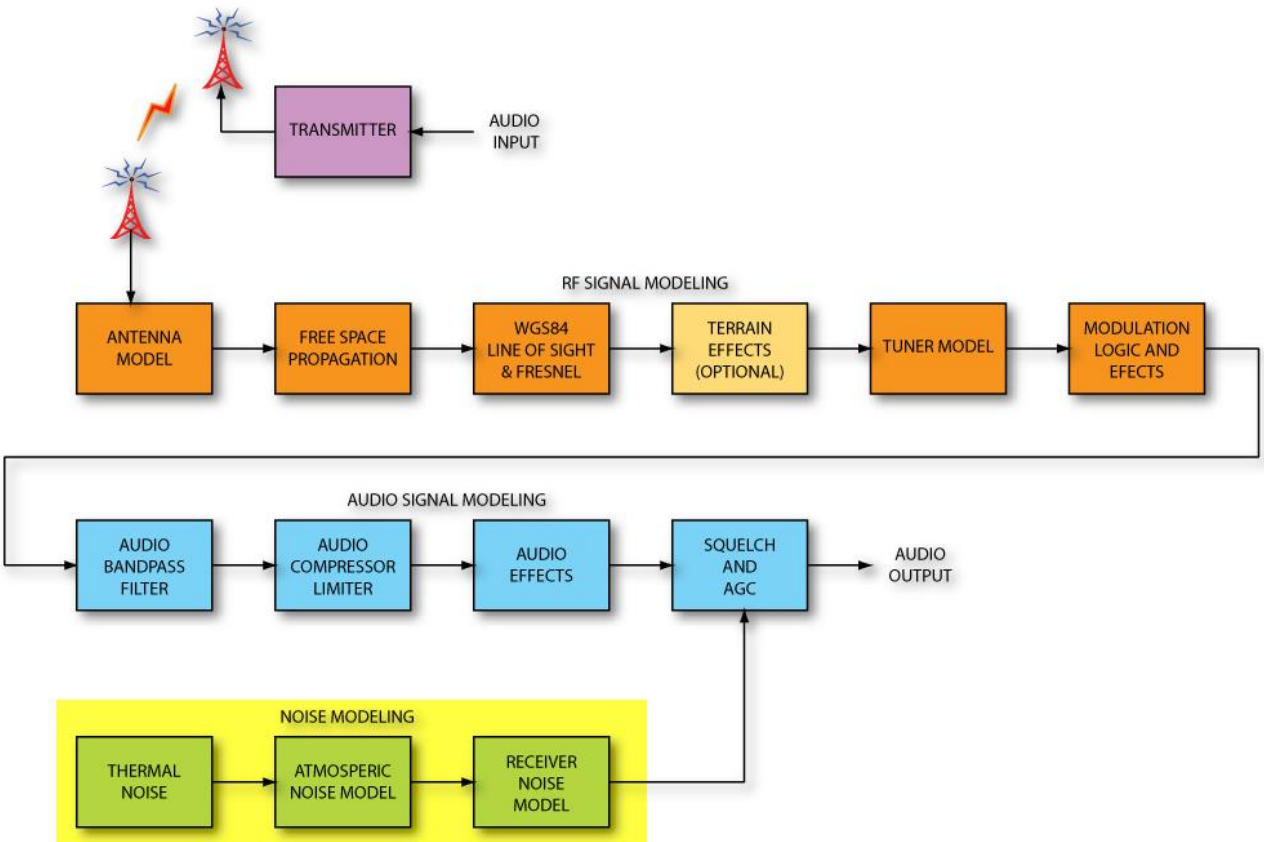


Figure 31, Noise Modeling

9.10.7 Thermal Noise

Thermal noise is the noise level present in all conductors and forms the basis of noise levels in radio receivers. VComm computes this noise level based on bandwidth. If bandwidth is increased, noise levels will increase as in real radio receivers. The noise level for a 1 Hz bandwidth is approximately -175 dBm. At a typical bandwidth of 25 kHz, the thermal noise level is approximately -131 dBm.

9.10.8 Atmospheric Noise

Atmospheric noise is added to thermal noise to form the level of noise in the receiver before other receiver specific noises are taken into account. VComm generates atmospheric noise by combining the various types into a single noise level in dBm. This is added to the thermal noise value noted in Figure 32 to arrive at the total antenna input noise level. The red dashed line approximates the value used in the VComm noise model. This is a combination of averaged man-made noise and Galactic noise.

Note: *The noise level becomes constant below 1 MHz, and is zero below 100 KHz, since frequencies below 100 kHz are considered intercom frequencies in DIS.*

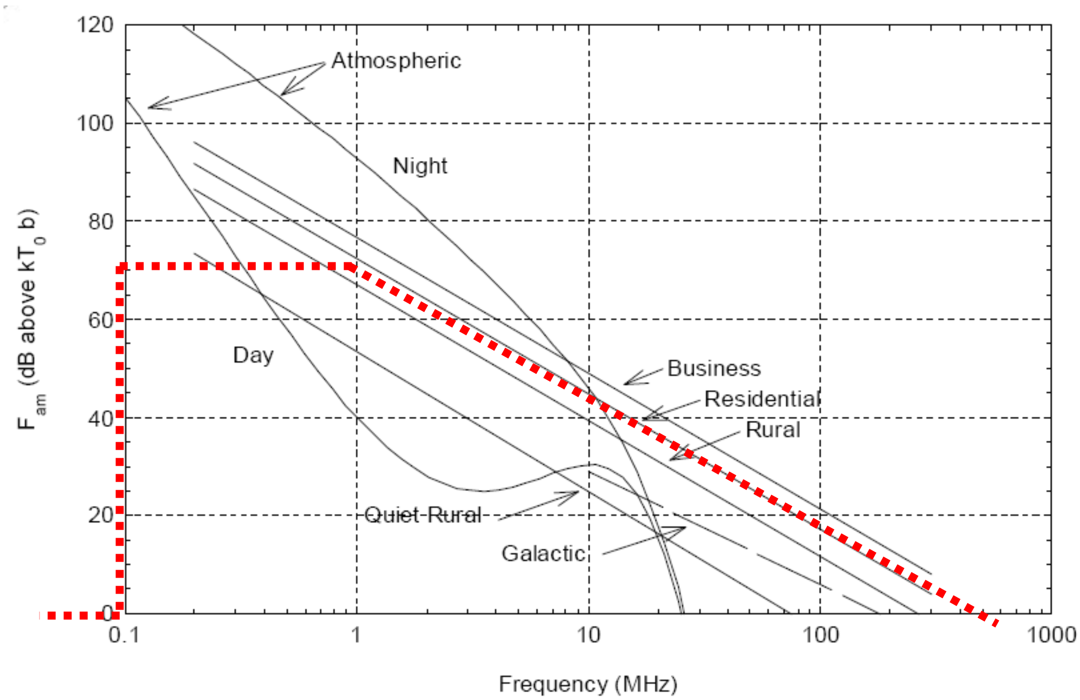


Figure 32, VComm Atmospheric Noise Model

10 Signal Quality Service

The concept of a Signal Quality Service evolved from the need to incorporate external factors into the signal quality calculations of VComm. By default, VComm determines the signal quality of received radio communications using built in line of sight and signal quality calculations. Line of sight calculations are based on a round earth model while signal quality calculations are based on standard RF propagation equations. In particular, these calculations do not take into account terrain, weather effects, and other possible sources of RF interference. To incorporate these aspects into the VComm signal quality calculations, VComm uses a Signal Quality Service.

10.1 VComm Terrain server (VTS)

The Signal Quality Service is a separate process that communicates with VComm according to the remote message protocol defined within this document. Any process that is compliant with the protocol may be used as a signal quality service. The process must act as the server while VComm acts as a client. The VComm Terrain Server (VTS) is an example of a server that is a Signal Quality Service. It provides VComm with signal attenuation data based on terrain.

10.2 Signal Quality service Specification

This Signal Quality Service specification defines all the messages that make up the remote message protocol of the Signal Quality Service. Servers and clients that are compliant with the remote message protocol do not need to support all messages. For example, VComm and VTS only use a subset of the available messages. VTS, for example, only supports those messages that are relevant to a terrain server. A server or client that claims compliance with the remote message protocol must publish which messages it supports.

See "VComm Signal Quality service Specification" a separate document.

11 VComm and DIS

DIS uses PDUs to exchange information between applications. VComm uses the Transmitter PDU, Signal PDU, and Entity State PDU for DIS functionality. The Intercom Control PDU and Intercom Signal PDU are no longer present since no other vendors systems use these PDUs. VComm receives Entity State PDUs but does not transmit them.

11.1 DIS PDUs

VComm DIS radios receive and generate Transmitter and Signal PDUs. These PDUs contain all of the information necessary for the receiving application to model a radio/ICS and carry signal information, which is usually encoded audio for voice communications.

11.2 DIS Heartbeat

Each VComm radio/ICS generates Transmitter PDUs at regular intervals and during state changes while Signal PDUs are sent when a signal is being generated such as when the PTT is active. The specification requires a periodic transmission of the Transmitter PDU called the heartbeat and ensures that all applications update properly. The DIS Heartbeat is configured for a V+ application in the Networked Audio page of the V+ Run Time System as shown in Figure 33. The value provided is in milliseconds.

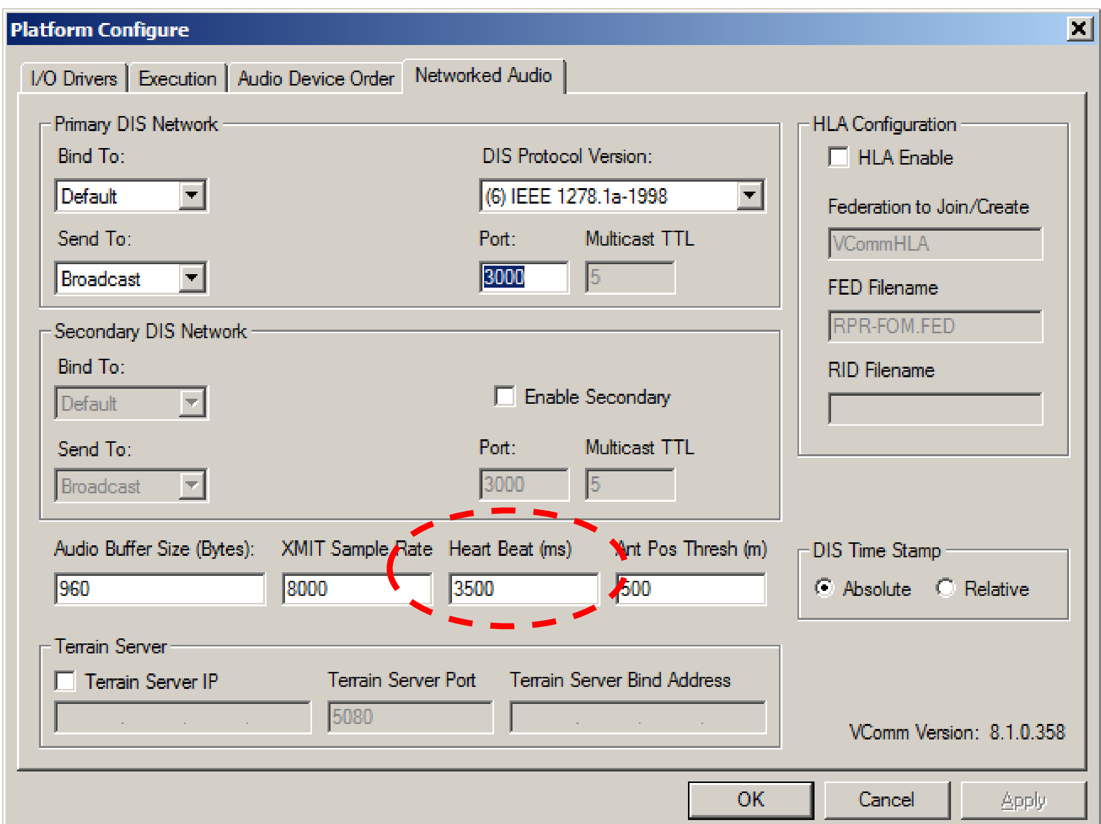


Figure 33, DIS Heartbeat Configuration

11.3 DIS Timeout

DIS also specifies a timeout value that determines when a radio is considered to no longer exist on the network and is equal to 2.4 times the Transmitter PDU heart beat interval.

11.4 PDU Sequencing

VComm ensures that multiple PDUs are not generated unnecessarily. State changes or antenna position changes can take the place of a heartbeat PDU. Multiple radios start at different times so that heartbeats do not occur simultaneously and are spread evenly across the interval. IEEE 1278.1 200X Draft 13 calls for separate stationary and moving heartbeat intervals (this draft is not yet finalized). Specific exercises may require different heart beat rates for radios. Users can control the heart beat rate, and antenna update range threshold value in the run-time system configuration. Figure 34 presents a typical section of network time and shows a single radio transmission.

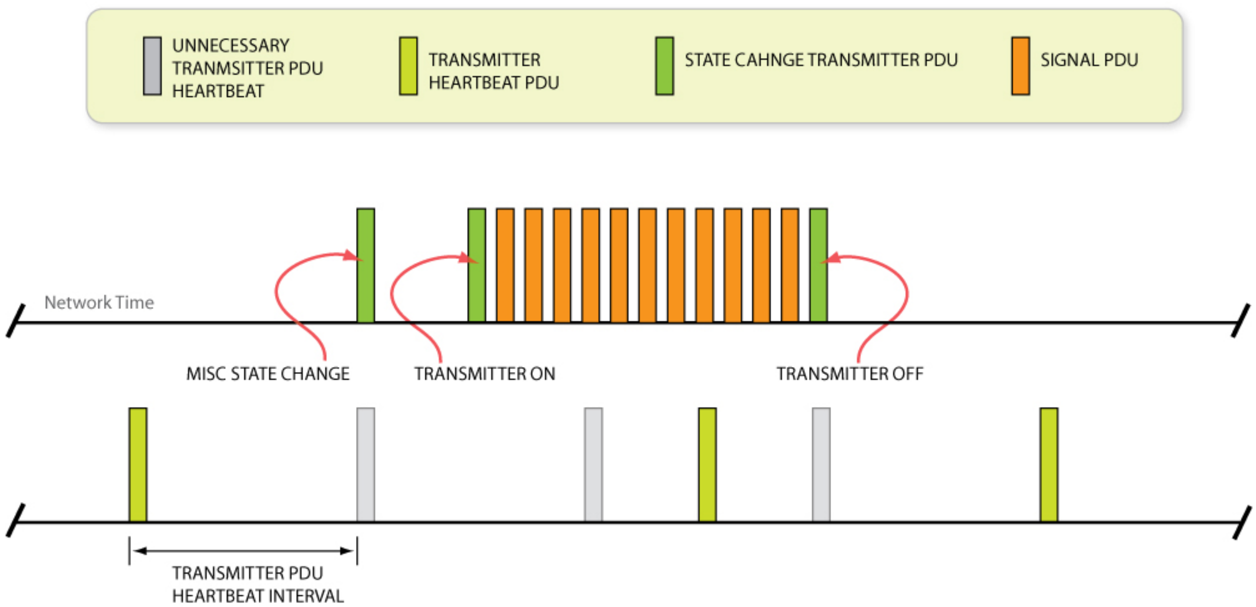


Figure 34, Transmitter and Signal PDU Time Sequencing

11.5 DIS Heartbeat Related Symbolic Names

Internally, VComm uses the DIS Symbolic Names in Table 11 as defined in the DIS specification. These values can be modified within VComm for a given exercise. The VComm Reference column describes how to make a change for the value and provides a reference to the appropriate section of this document.

11.6 Antenna Position Threshold

This symbolic name is adjusted in the V+ Runtime system configuration window, Networked Audio tab, under the edit box labeled, Ant Pos Thresh (ms). This is the distance that the antenna must move before a new Transmitter PDU is issues in DIS, or a new attribute is sent out in HLA.

Table 11, DIS Symbolic Names within VComm

DIS Symbolic Name	Description	Default	VComm Reference
HBT_PDU_TRANSMITTER	Transmitter Associated with a Moving Entity	3.5 sec +/- 10%	Configuration *see section 11.2*
TRANS_POS_THRSH	Antenna position threshold	500 meters	Configuration *see section 11.6*

11.7 Encoding Type (Encoding Scheme)

VComm supports all of the IEEE 1278.1a encoding types provided in Table 12 with the exception of VQ (6), and currently the GSM schemes 8 and 9 which are in development. Use the number in the ENUM column to specify a scheme in a VComm radio. If the value for an encoding scheme received by VComm during run-time is not listed, then VComm will not process the signal. If the user configures a VComm radio with a value not in the table, VComm will not start and produce an error in the run-time system window. If zero is specified (default value for new objects) then eight-bit mu-law will be used. Each VComm radio may have a unique encoding scheme. Each radio can also process any incoming scheme and different schemes from various transmitters simultaneously. In fact, each signal PDU may contain a different encoding scheme.

Table 12, Encoding Types			
ENUM	**Description**	**Compression**	**Standard Rates**
1	8-Bit µ-Law *(All applications are required to support this encoding scheme)*	2:1	8,000 Hz 16,000 Hz
2	CVSD per MIL-STD 188-113	16:1	16000 Hz
3	ADPCM per CCITT G.721	4:1	8,000 Hz 16,000 Hz
4	16-bit Linear PCM, Big Endian/Network Byte Order *Can be programmed via datapool for either byte order.*	1:1	8,000 Hz 16,000 Hz 22,050 Hz 32,000 Hz 44,100 Hz 48,000 Hz
5	8-bit Linear PCM	1:1	8,000 Hz 16,000 Hz
6*	VQ (Vector Quantization) RESERVED***	Variable	8,000 Hz 16,000 Hz 22,050 Hz 32,000 Hz 44,100 Hz 48,000 Hz
7	CVSD CCTT (bit reversed)	16:1	16000 Hz
8**	1.625-bit GSM 06.10	Variable	8,000 Hz 16,000 Hz
9**	0.7-bit GSM Half-Rate 06.20	Variable	8,000 Hz 16,000 Hz
100	16-bit Linear PCM, Little Endian byte order	1:1	8,000 Hz 16,000 Hz 22,050 Hz 32,000 Hz 44,100 Hz 48,000 Hz
255	Some systems use this for CVSD RESERVED***	16:1	16000 Hz

* Not Supported
** In Development at the time of this writing
*** This enumeration is reserved not to be used. (Info Only)

Note: *Enumerations of 8, 9 and 100 are newly added schemes not yet published in the official release of the SISO enumeration document. Enumerations 7 and 255 are not currently in the enumeration document.*

11.8 CVSD Variants

There are several de-facto flavors of CVSD that are in use in legacy systems in DIS networks. These are referred to as CECOM CVSD and CCTT CVSD. CCTT CVSD is not compatible with the standard enumerated version since the bits are in reverse order from the MIL-STD 188-113 version. Note that when using CVSD, the signal PDU will contain the same number of samples as the data length, since each bit is actually a sample when using CVSD. Note also that a vendor uses 255 for CVSD, which can be programmed on their systems to represent either flavor of CVSD.

11.9 Transmit Sample Rates

The input signal sample to a radio is dictated by the other transmitter. VComm can process any sample rate on the input side from 1000 Hz to 96000 Hz. The transmitter or outgoing default sample rate is determined by the run-time configuration under the Networked Audio tab in the Configure menu. This rate will be used for all radios unless object 2051 is attached to a radio which then dictates the transmit sample rate. This object provides a means of setting individual transmit sample rates for radios. When specifying the Transmit Sample Rate in the configuration of the run-time system, any positive whole integer sample rate from 4000 Hz to 48000 Hz may be used although some may not work with other vendor equipment. IEEE-1278.1a specifies that 8 bit µ-Law at 8000 hertz sample rate must be supported by all radios at a minimum. Therefore, this set of values will always work using VComm.

11.10 VComm Version Information

VComm is an add-on product to V+, a visual programming environment. You can view the version of VComm at any time by selecting the Configure menu in the V+ Run Time System. The version information is displayed as shown in Figure 35. There are four numbers that are part of the overall version of VComm. The first number is called the REV, the second and third numbers are called the major and minor versions, and the far right or least significant number is referred to as the "Build Number". New Builds of VComm are released regularly.

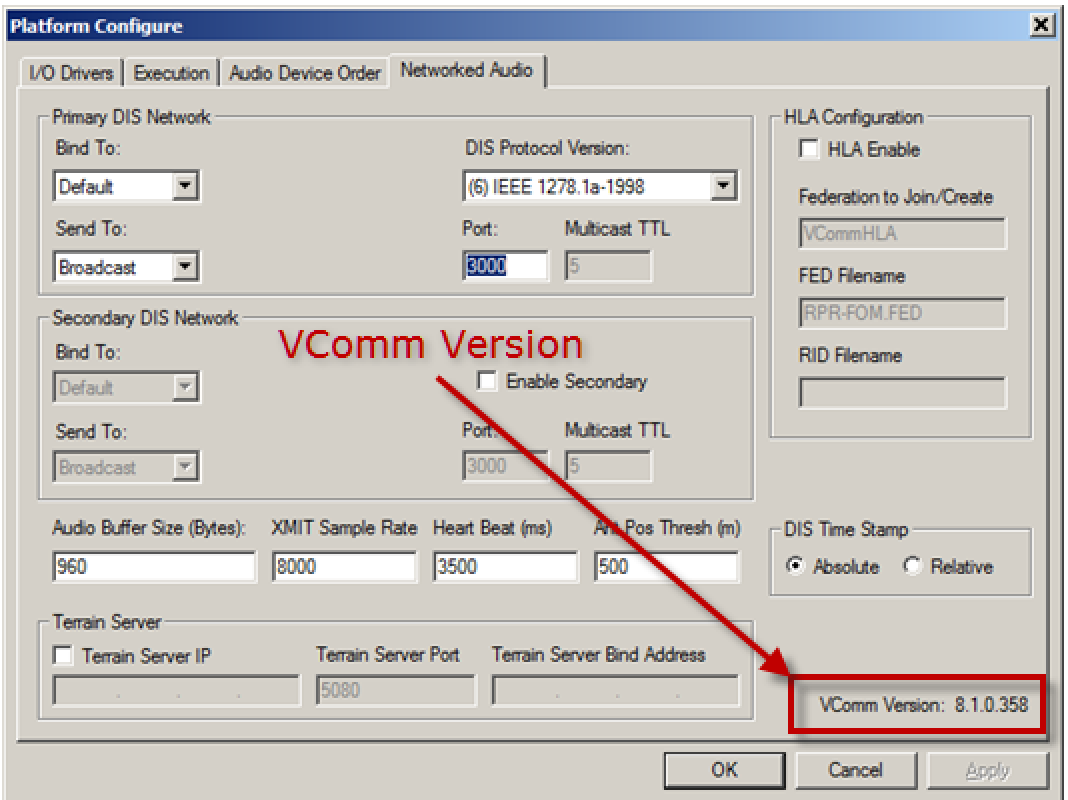


Figure 35, VComm Version Information

11.11 DIS Versions

DIS has been in use for some time, and there are radio systems on the market that were produced before DIS became an IEEE specification. If your radios will be interacting with other systems, be sure to know which version you will be using. There is a means to set this version in the system. The versions of DIS are defined in the IEEE specification. VComm is compatible with all of these versions (see Table 13).

Table 13, DIS Versions

Version	Description
1	DIS PDU version 1.0 (May 92)
2	IEEE 1278-1993
3	DIS PDU version 2.0 - third draft (May 93)
4	DIS PDU version 2.0 - fourth draft (revised) March 16, 1994
5	IEEE 1278.1-1995
6	IEEE 1278.1A-1998
7	IEEE 1278.1 – 200X (In Development)

To set the DIS version in VComm, click on the drop down list as shown in Figure 36, and select the desired version. Note that the number in parenthesis is the actual protocol number used on the network. This is saved in the .VNE file. Note that the DIS version used on the secondary DIS network is the same as the version on the primary DIS network.

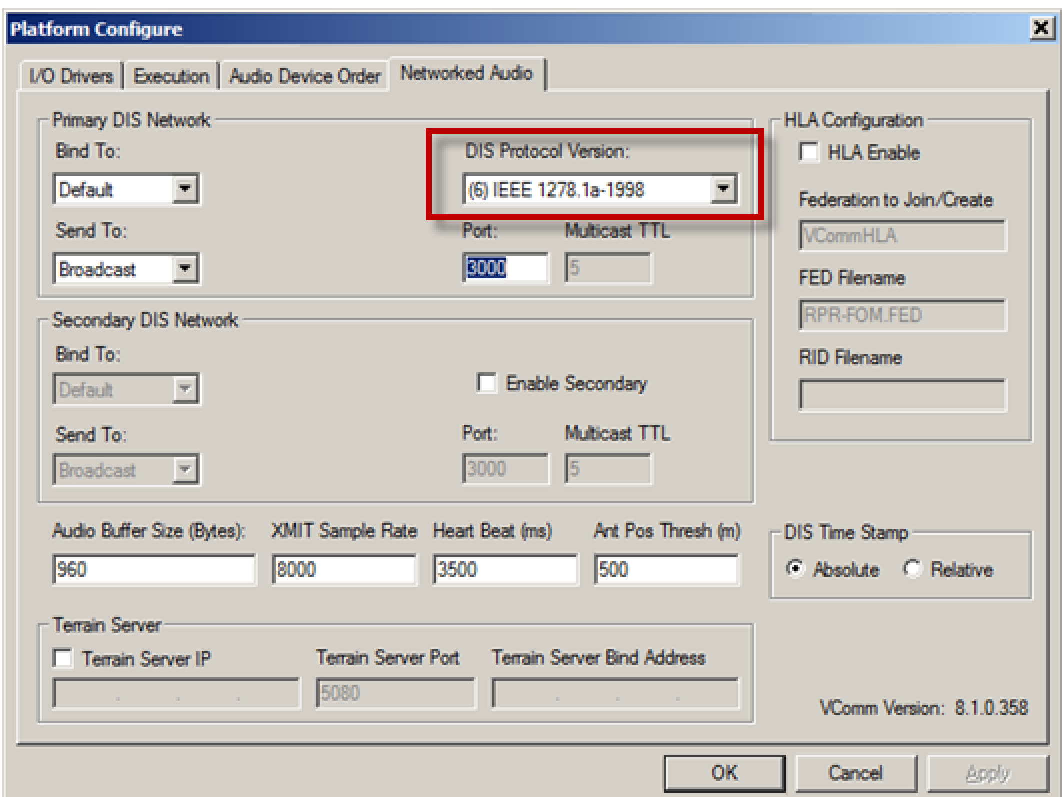


Figure 36, Selecting DIS Version in VComm

SimPhonics is an active participant in the standards process for future versions of DIS at the Simulation Interoperability Standards Organization (SISO). As part of this process a new version is evolving which will be ratified by IEEE within the next year. This will be version 7, and is currently known as IEEE 1278.1a 200X. This new version adds important interoperability features.

For more information, go to: http://www.sisostds.org/

While there are significant differences between early versions, there are no significant differences where VComm is concerned. The primary difference came in version 6 which introduced intercom PDUs. VComm dropped support for these PDUs in VComm version 8.0. They are not in use by any other known DIS radio vendor.

Important Note: *In some military exercises, the version is important, since there have been cases where various sites have filtered out PDUs that did not have a specific version. This is why VComm has the version setting, and is backward compatible with all versions.*

11.12 DIS Time Stamp

VComm stamps each PDU according to the DIS standard. This time stamp may be relative or absolute. There are radio buttons in the run time system networked audio window that establish which type of time stamp is generated.

11.12.1 Configuring Time Stamp Mode

The absolute time stamp is the default but this can be changed to relative. This setting is saved in the .VNE file and applies to all PDUs that are issued by VComm. Most large exercises use absolute time stamps for DIS PDUs. In either mode, it is always a good idea to synchronize the system to a time server to ensure that all systems are synchronized to a time source. For more information, see the Windows operating system help for information on how to setup a time server and synchronize clients to that server.

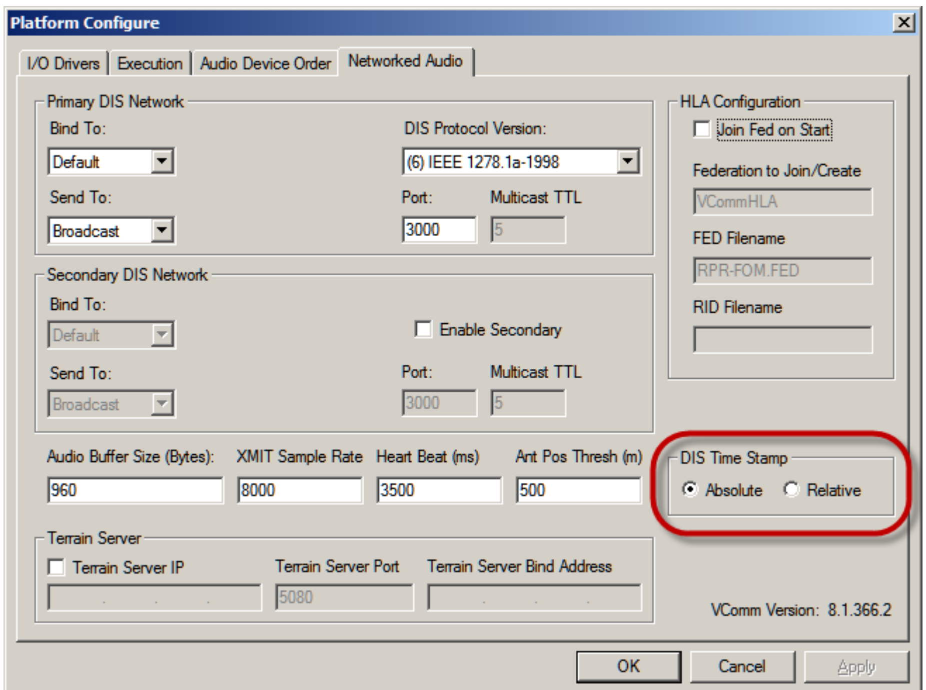


Figure 37, DIS/HLA Time Stamp

11.13 Frequency Selection for Radios

Some VComm legacy radio objects utilize frequency input pins that expect frequencies in megahertz (MHz). Therefore, these radios have a frequency resolution of ±1000 Hz.

Newer VComm 8.0 and later radios utilize frequency input pins that are specified in Hertz. Since V+ uses strictly floating-point data on all its object and port pins, precision errors can occur. Starting with Build 580, the newer radios round off the frequency received on their input pin according to the following table.

Table 14, Radio Frequency Bins	
1 Hz to 16.777 MHz	No rounding. Frequency is set exactly as specified.
16.777 MHz to 134.217 MHz	Frequency is rounded to the nearest 10 Hz.
134.217 MHz to 1 GHz	Frequency is rounded to the nearest 100 Hz.
1 GHz and greater	Frequency is rounded to the nearest 1000 Hz.

Some vendors require exact matches for frequency for a valid reception. The next version of DIS will require the radio model to consider the bandwidth in the tuner model.

11.14 DIS Radio Type Record

The Transmit PDU contains a Radio Type Record. DIS IEEE 1278.1a 1998 Transmit PDU and Entity State PDU have a different structure which was changed in DIS 7 so that the two structures match and are shown side by side below.

Table 15, Radio Type Record				
IEEE 1278.1a-1998		IEEE 1278.1-200x Draft 13		VComm Behavior
Entity Kind	8-bit enum	Entity Kind	8-bit enum	Always 7 (Radio)
Domain	8-bit enum	Domain	8-bit enum	User Programmable
Country	16-bit enum	Country	16-bit enum	User Programmable
Category	8-bit enum	Category	8-bit enum	Radio Object Type
Nomenclature Version	8-bit enum	Subcategory	8-bit enum	User Programmable
Nomenclature	16-bit enum	Specific	8-bit enum	User Programmable
		Extra	8-bit enum	User Programmable

As Table 16 indicates, all fields are programmable via V+ except Entity Kind, which is always 7 (Radio), and category which is determined by the VComm radio object. Voice only communications radios use 1, or Voice Transmission/Reception. Table 16 shows the first four category enumerations as defined in the SISO enumerations document.

Table 16, Category Enumerations	
0	Other
1	Voice Transmission/Reception *(Most VComm Radios)*
2	Data Link Transmission/Reception
3	Voice and Data Link Transmission/Reception
…	…

Note: *All user programmable fields not set by the user are set to zero by default.*

11.14.1 Setting DIS Radio Entity Type Data

V+ object 2089, **VComm Radio Entity Type** (see Figure 38) can be used to set the Radio Entity Type data as described above. Each radio may have a different set of Radio Entity Type data by using an object for each radio in the system. For more information on values for these values see the SISO enumerations document and PCR172A which proposes a change to the DIS standard for using JETDS values.

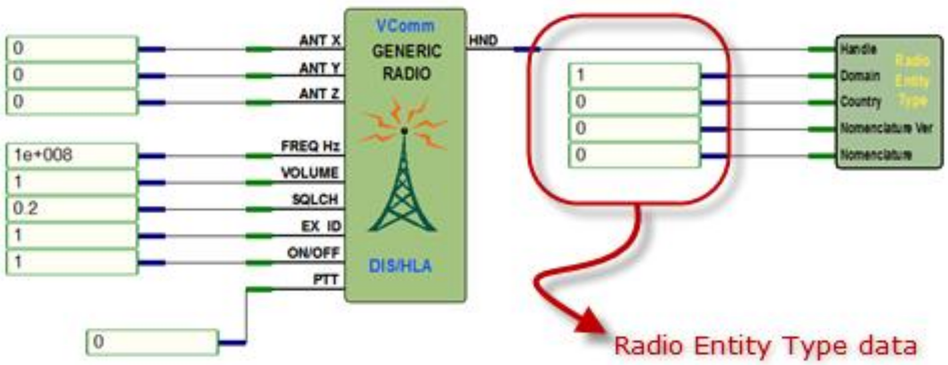


Figure 38, VComm Radio Entity Type Object

The first six Domain enumerations are shown in Table 17. In the example above, the VComm Radio Entity Type object is setting the Domain to Land.

Table 17, Domain Enumerations	
0	Other
1	Land
2	Air
3	Surface
4	Subsurface
5	Space
…	…

11.14.2 Receiving Behavior for DIS Radio Entity Type Category

Some systems do not properly set the category type field in exercises. Therefore VComm will receive all types unless the “RadioEntityCatagoryTypeFilter” variable in datapool is set to 1 which is off or zero by default. If this variable is on or 1, radios must have a category of 1 or 3 in order to be received in VComm. For DIS this is contained in the Radio Entity Type of the Transmitter PDU as described earlier.

11.14.3 Receiving Behavior for DIS Signal Encoding Class

Radio signals, Encoding Class must be of the “Encoded Audio” enumeration for voice communications radios to be received. Data radios may have different Encoding Class restrictions.

11.15 DIS Radio Identifiers

IEEE 1278 requires that all radios have a unique radio identifier. Figure 39 illustrates the construction of the DIS identifying fields in PDU headers that are used in radio communications.

Attached Radio Identifier

<table>
<tr><td>Site Number</td><td rowspan="2">Simulation Address</td><td rowspan="3">Entity Identifier</td><td rowspan="4">Radio Identifier</td></tr>
<tr><td>Application Number</td></tr>
<tr><td colspan="2">Entity Number</td></tr>
<tr><td colspan="3">Radio Number</td></tr>
</table>

Non-attached Radio Identifier

<table>
<tr><td>Site Number</td><td rowspan="2">Simulation Address</td><td rowspan="3">Reference Identifier</td><td rowspan="4">Radio Identifier</td></tr>
<tr><td>Application Number</td></tr>
<tr><td colspan="2">Reference Number</td></tr>
<tr><td colspan="3">Radio Number</td></tr>
</table>

Figure 39. Radio Identifiers

IEEE 1278.1 200x Draft 13 defines *Entity Identifier* as the Site Number, Application Number, and Entity Number. *Simulation Address* is defined as Site Number and Application Number, and *Radio Identifier* as Entity Identifier combined with Radio Number. Radios can be attached (contained within) or not attached to entities. Usually entities have multiple radios.
A given radio within an exercise is identified with an Entity Identifier and a Radio Number. Therefore, a given radio is identified by four fields. Each field can contain a value from 1 to 65,534. DIS requires that no radio be allowed on the network with a zero ID or an ID of 65,535 and VComm will not allow a radio to be created with these values.

Each radio is normally associated with an entity on the network and is “attached” to that entity. However, it is common for a radio to be stand-alone with its own Radio Identifier. When a transmitter is a stand-alone entity, there is no entity state PDU generated for it and the radio is said to be non-attached. This is a de-facto standard and the names for the fields are changed for non-attached radios as shown in Figure 39. Each radio must have a unique Radio Identifier (64-bit value) for a given exercise. If more than one radio has the same Radio Identifier, the radio may behave unpredictably or not work at all and the audio may be broken and indecipherable. Radio identifiers may be set either statically or dynamically. Static radio identifiers are assigned when execution is started and cannot be changed during execution. To set a static radio identifier it is necessary to set the appropriate static data in a radio object at development time. Dynamic radio identifiers may be changed anytime during execution. To set a dynamic radio identifier it is necessary to use an attachable object.

11.15.1 Setting Static Radio Identifiers

The V+ worksheet in Figure 40 shows a typical DIS radio. By double-clicking the radio object, all components of the radio identifier can be set for this radio. Each of the values can be manually adjusted by the user. Unless you are required to setup specific IDs, you may leave the ID fields at zero and VComm will automatically generate an ID at runtime. All VComm radio objects have static data in their V+ object which can be used to define the ID in this manner.

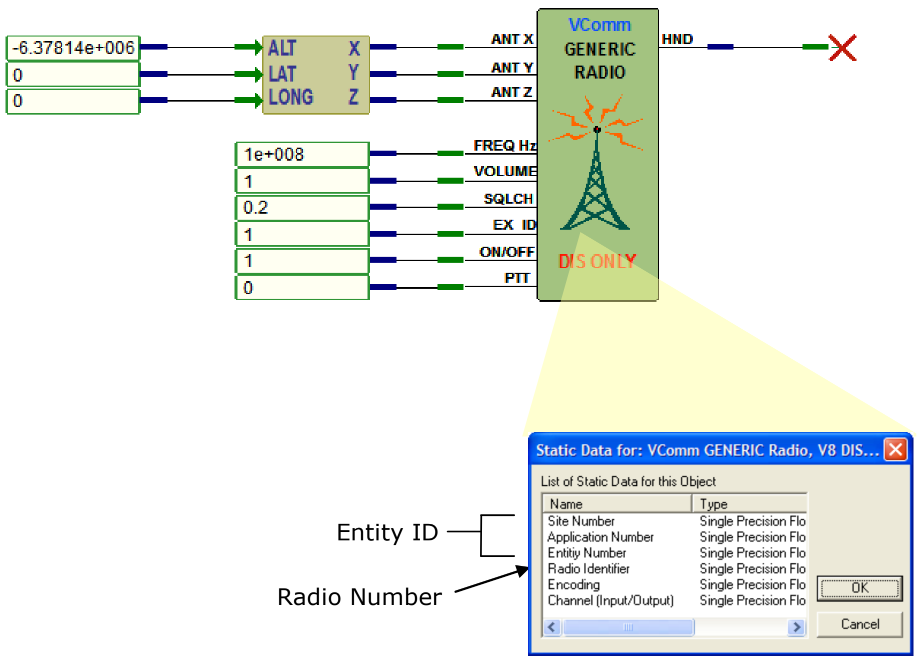


Figure 40, Setting DIS Radio Identifiers via Static Data

When manually setting IDs, each component of a radio identifier must be assigned a number from 1 to 65534. Setting a component to 0 or to 65535 will initiate automatic radio identifier assignment for that component. In many cases, the entity identifier of a radio should be assigned according to the entity (i.e. aircraft, tank etc.) to which the radio is attached. However, radios may not be attached to any entity or physical entities may not even exist in a particular application. In these cases, radio identifiers may be assigned arbitrarily. It is very important in all cases, however, that each radio is assigned a radio identifier that is unique within the entire exercise (including those radios that are defined on remote machines).

Note: *All VComm radios which have static data to set DIS IDs, must be restarted when any of these IDs are modified in order for the change to take effect. When using an attachable object that sets the IDs, it is not necessary to restart – the change will be immediate.*

7.15.1.1 Automatic Radio Identifier Assignment

VComm can automatically generate all or parts of a static radio identifier. The generation occurs when V+ is initially executed and once generated the radio identifier cannot be changed without stopping and restarting execution. To generate one or more components of a radio identifier, set the static data for the radio according to Table **18**. Note that setting either the application number or the site number to 0 or 65535 will cause both components to be auto generated; it is not possible to auto generate the application number and site number independently. The range of possible auto generated values is also specified in the table.

Table 18, Automatic Radio Identifier Generation

Setting	To The Value	Will Generate	In the Range
Radio Number	0 or 65535	Radio Number	See Below
Entity Number	0 or 65535	Entity Number	65534
Application Number	0 or 65535	Simulation Address	61439 to 65534
Site Number	0 or 65535	Simulation Address	61439 to 65534

For the radio number, VComm uses the following formula:

Radio Number = 65535 – Radio Handle

Since radio handles are generated sequentially starting at 1, the radio numbers generated by VComm are a decreasing sequence starting at 65534. If all radios on a single computer have auto generated radio numbers, then each of those radios will have a unique radio number and consequently a unique radio identifier. When auto generated, the entity number is always set to 65534. VComm will display a warning message if this value is used as a manually assigned entity number. This is not necessarily an error; it is valid to use this value when manually assigning an entity number but not doing so avoids possible conflicts with auto generated entity numbers. The computer’s default IP address is used by VComm to generate the application number and the site number. A computer IP address is divided into four fields called octets. Each octet is an 8 bit value. VComm uses three of these octets to create the generated simulation address as follows:

Octet2 = second octet of IP address

Octet3 = third octet of IP address

Octet4High = upper four bits of fourth octet of IP address

Octet4Low = lower four bits of fourth octet of IP address

Site Number = (Octet2 * 16) + Octet4High + 61439

Application Number = (Octet3 * 16) + Octet4Low + 61439

The resulting site number and application number will be in the range 61439 to 65534. VComm will display a warning message if a value in this range is used as a manually assigned site or application number. This is not necessarily an error; it is valid to use values in this range but not doing so avoids possible conflicts with auto generated numbers. The construction of the auto generated site and application numbers ensures that any two computers on the same subnet will generate unique simulation addresses. When combined with the auto generation of radio numbers, this ensures that radios with auto generated radio identifiers on the same subnet will have unique radio identifiers. Due to the fact that computers on different networks may have the same IP address (i.e. due to network address translation), there is no guarantee of uniqueness across networks. In such situations, simulation addresses should be assigned manually.

11.15.2 Setting Dynamic Radio Identifiers

Object 1094, **VComm DIS Radio Data** can be used to dynamically set the radio identifier and encoding of a radio. When this attachable object is used, the corresponding static data in the radio is ignored. Instead, the radio identifier is defined by the inputs to the attachable object. Figure **41** shows the data being set via constants. In this case, the constants are set to zero, which will cause the radio to be disabled; auto generation is not supported with dynamic radio identifiers. In fact, setting any of the components of the radio identifier to 0 or 65535 will disable the radio.

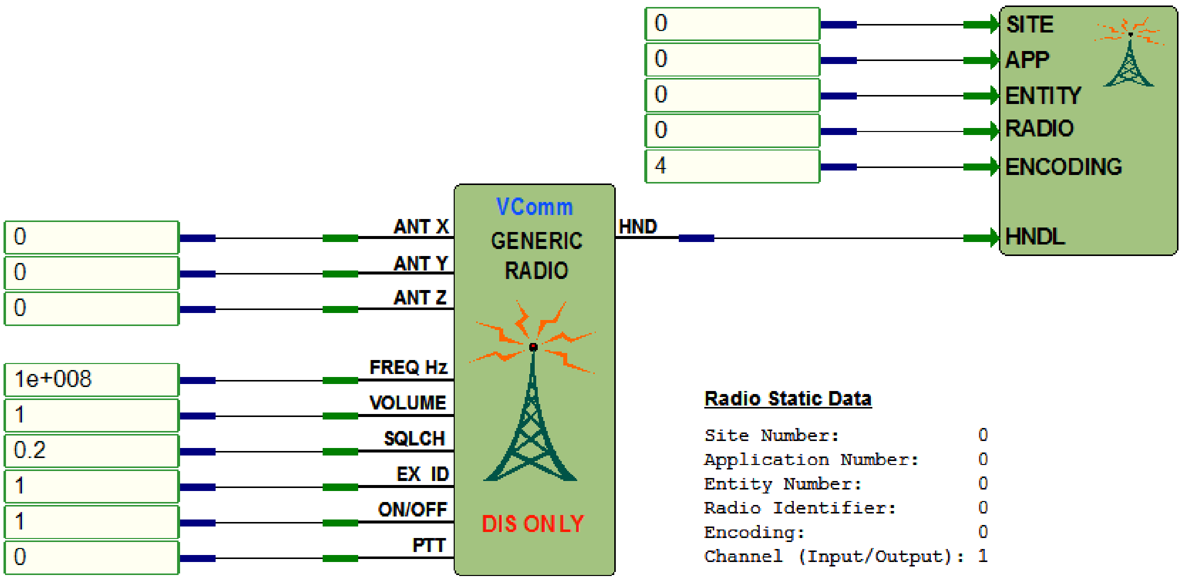


Figure 41, Setting DIS Radio Identifiers Dynamically

An external device such as a host computer can provide the radio identifier for a radio by sending this data to VComm via UDP/IP, or via any other I/O device that V+ supports. The same design shown earlier is shown in Figure 42 with an external host computer interface driving object 1094's pins from the UDP/IP I/O driver.

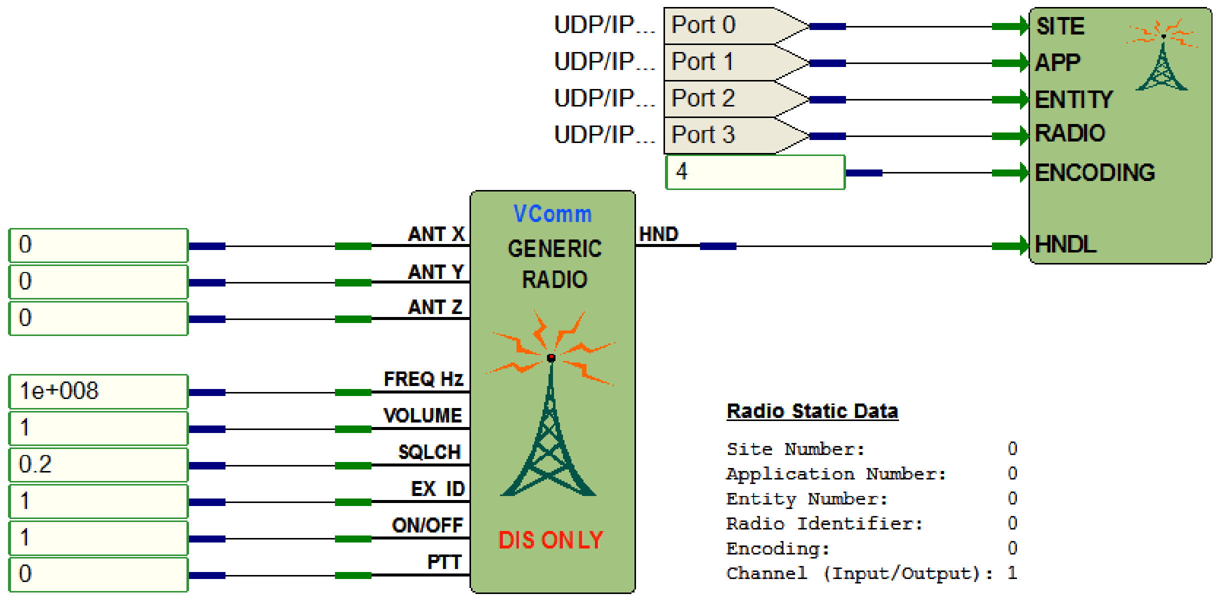


Figure 42, Using an External Interface to set a Radio Identifier

If you had multiple radios to set in this manner, you could connect the ports to worksheet connectors, and the worksheet connectors to the individual radios.

11.15.3 Radio Identifier Conflicts

VComm detects and reports possible radio identifier conflicts at runtime. This is limited to local conflicts (i.e. VComm will not detect a conflict involving radios on different computers). Every time a radio identifier is changed, VComm checks to see whether that radio identifier is already assigned to another local radio in the same exercise. If a conflict is detected, the other radio is disabled and a warning message is displayed. This resolves the conflict but leaves the other radio disabled until it is provided with a new radio identifier. While normally a radio identifier conflict report will indicate an issue with the radio identifier assignment scheme, it is possible that the conflict will resolve itself automatically. This can happen when dynamic radio identifiers are being set using an external interface and several radio identifiers are changed simultaneously (i.e. within one V+ frame execution). An example is the best way to illustrate how this can happen. Let's say that Radio A has an id of (1,1,1,1) and Radio B has an id of (2,2,2,2). Then if Radio A's id is changed to (2,2,2,2) at the same time that Radio B's id is changed to (3,3,3,3) this may result in a radio identifier conflict report if the change to Radio A is processed by VComm first. In this case, VComm will disable Radio B, issue a warning, and set Radio A's id to (2,2,2,2). VComm will then set Radio B's id to (3,3,3,3) and re-enable Radio B. The result is that the conflict will resolve itself and the warning may be ignored. To summarize, it is essential that an appropriate scheme for assigning radio identifiers is used to ensure that, within any exercise, radio identifiers are unique across your entire application.

11.15.4 Entity Attach

Entity attach mode is a mode each radio can be independently set to use which will force the radios antenna position to that of the specified entity's location, hence the name entity attach or *attached to an entity*. Any radio can be setup this way. Entity attach mode is the best way to associate entities with VComm radios if your radios are intended to be part of an entity such as an aircraft with its own entity identifier. In V+, VComm has a special object "2017 VComm DIS/HLA entity Attach" that connects to the radio handle (see Figure 43).

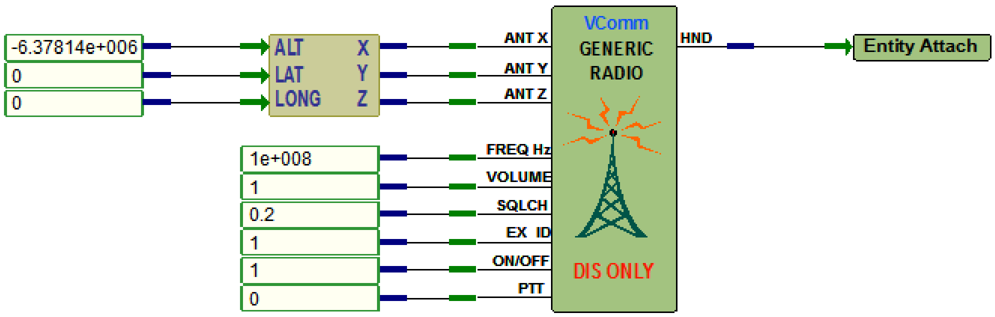


Figure 43, Using Entity Attach

Entity attach is a mechanism that attaches a radio to an entity by searching the network for an entity ID which matches the one that is setup in the radio static data, reads the X,Y,Z world location of the entity, and sets the radio antenna position to that location. The location of the entity overrides the location connected to the radio pins. If the radio cannot find an entity on the network that matches the specified ID, the antenna location will be the location specified on the input pins. When the entity attach is specified, VComm will begin processing entity state PDUs, which may cause an additional load on both the system running VComm but also other systems. Note that simply setting the Site Number, Application Number, and Entity Number the same as an entity on the network will not attach a radio to that entity. You must use the entity attach object to attach the radio.

Note: *Some DIS network systems feature two separate networks with radios on one network, and entities on the other. This is done to minimize the network loading, however, this will not work in entity attach mode, since the radio will not be able to find the associated entity.*

Note: *Setting the radio antenna location to 0,0,0 will override the entity attach mode, and cause the radio to enter the propagationless mode. Once the 0,0,0 condition is removed, the antenna location will re-attach to the its commanded entity. A Transmitter PDU is issued when the antenna location changes in this regard.*

11.16 DIS Simple Intercom

The DIS "Simple Intercom" is a de-facto standard established in DIS 7, not to be confused with the Intercom and Intercom Control PDUs. VComm implements this radio type as follows:

1. It is always positioned at the geocentric center of the Earth (x,y,z = 0,0,0).
2. It is always full-duplex.
3. It ignores bandwidth.
4. It does not model Wave Loss Propagation, Tuner Effects, Fresnel Effects, Terrain Occulting, Curvature of the Earth, Thermal and Atmospheric Noise, Squelch, and Automatic Gain Control.
5. The CHAN pin is analogous to the FREQ pin on the VComm GENERIC Radios with valid values from 1 to 100,000. Since bandwidth is ignored, the channel used between two (or more) intercoms must match exactly for communication to work.
6. The Modulation Type Record
    a. Modulation Type Record, System = 1 (Generic Radio or Simple Intercom)
    b. Modulation Type Record, Major Modulation = 0
    c. Modulation Type Record, Detail = Priority.

11.17 Variable Transmitter Parameters Records

Variable Transmitter Parameter (VTP) records are new to DIS version 7 and are records that anyone can author and add to a Transmitter PDU provided a valid enumeration is obtained and vetted by the SISO Enumerations process. See Enumerations Process VTP records are transmitted as part of the Transmitter PDU and one or more records may be associated with a radio and the same record may be associated with multiple radios. The format of a VTP record consists of a record type, a record length, and a set of record specific fields. VComm provides access to the functionality associated with VTP records through radio attachable objects that connect to the radio handle output. All VTP records are configured for Network Byte order for transport on the wire in DIS.

11.17.1 Open Mike VTP Record

The purpose of the Open Mike VTP record is to provide a means for applications to request open communications on a simple intercom channel. Applications receiving such a request on an intercom channel should immediately enable two-way communications on that channel if the request is considered valid by that application. An application may consider an open mike request to be invalid, for instance, if the request is not on a predetermined intercom channel. As an example, a request to go open mike may be used in emergency situations or as a part of exercise set up or tear down. The intercom channel(s) used for emergencies and/or exercise administration would be assigned by the exercise administrator. The record specific fields of the Open Mike VTP record are described in Table 19.

Table 19, Open Mike VTP Record

Field	Type	Description
Open Mike	Unsigned 8 bit integer	This field defines whether the Open Mike request is active or not. When set to zero the Open Mike request is inactive. When set to one the Open Mike request is active. Other values are invalid.

VComm provides two objects for setting and getting the status of an Open Mike VTP record associated with a simple intercom. As an example, these objects are shown in Figure 44 as they might be used to implement an emergency intercom on channel 35.

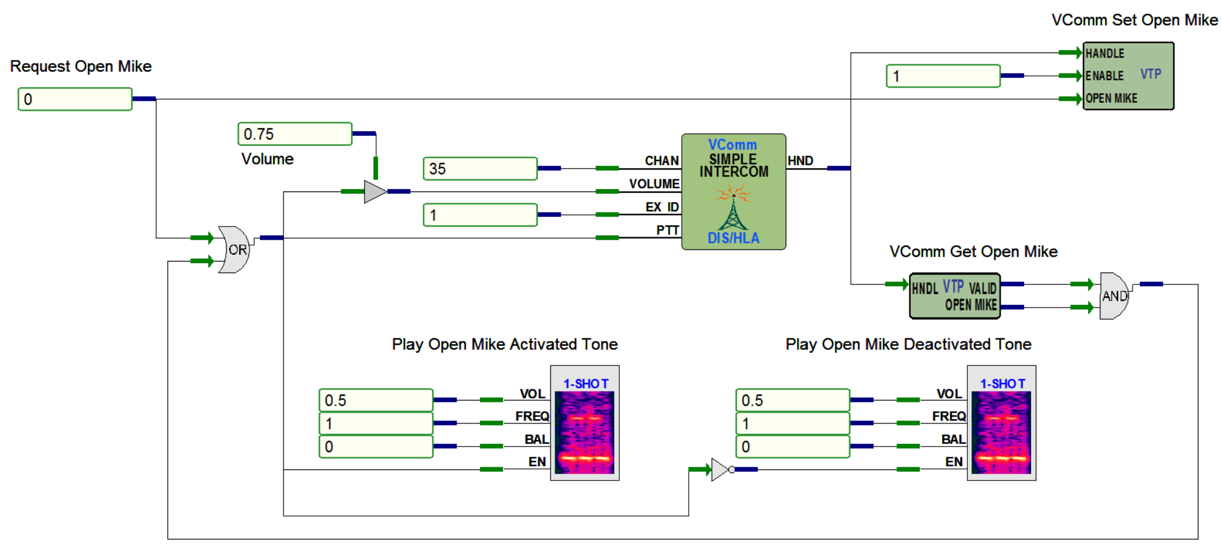


Figure 44, Open Mike VTP Record Objects

Object 2099, VComm Set Open Mike, is used to attach an Open Mike VTP record to a simple intercom. When this object is connected to a Simple Intercom object via the Handle pin and the Enable pin is set to one, it will cause an Open Mike VTP record to be sent with every Transmitter PDU for that intercom. The Open Mike pin is then used to control the contents of the Open Mike field in the VTP record. Object 2100, VComm Get Open Mike, is used to monitor incoming Open Mike VTP records. When this object is connected to a Simple Intercom object via the Handle pin, the Valid pin will be set to one whenever at least one Open Mike VTP record is being received. The Open Mike pin is set to one whenever one or more Open Mike VTP records are being received with the Open Mike field set to one. The example shows how the output of object 2100 can be connected back to the volume and PTT input pins of the Simple Intercom object, so that two way communications on the intercom channel are enabled whenever a request to go open mike is being received. It also shows how tones can be automatically played upon the activation and deactivation of the channel. This is recommended to alert the operator by an audible cue that the status of his communications channels has changed.

11.17.2 Application Specific Data VTP Record

The purpose of the Application Specific Data VTP record is to provide a means for applications to transmit a small amount of data in a Transmitter PDU that is intended to be specific to that application. Whereas other types of VTP records are defined for a particular purpose, applications may use the Application Specific Data VTP record for any purpose as long as they reserve an identifier and define the use of the data fields in the application documentation. The process for reserving an identifier is described in the definition of the Application Specific Data VTP record in the DIS standard. Applications that receive records with an unsupported identifier are required to ignore the record. The record specific fields of the Application Specific Data VTP record are described below.

Table 20, Application Specific Data VTP Record

Field	Type	Description
Identifier	Unsigned 32 bit integer	This field identifies the use of the record. Identifiers must be reserved.
Data 1	Unsigned 32 bit integer	The use of this field must be documented in the application documentation.
Data 2	Unsigned 32 bit integer	The use of this field must be documented in the application documentation.
Data 3	Unsigned 32 bit integer	The use of this field must be documented in the application documentation.
Data 4	Unsigned 32 bit integer	The use of this field must be documented in the application documentation.

VComm provides two objects for setting and monitoring the data in Application Specific Data VTP records: Object 2095, VComm Set Application Specific Data, and object 2096, VComm Get Application Specific Data. The use of these objects is described in V+ Object Help.

11.17.3 Boom ICS VTP Record

The Boom ICS VTP record was developed by MAF DMO for use in refueling operations. This includes cases where the aircraft itself is divided into two sections of a cockpit flight simulator (OFT) and a rear boom simulator (BOWST). Currently the KC-135 flight simulator aircraft uses this arrangement.

Table 21, Boom ICS VTP Record

Field Name	Description	Length
VTP Record Type	Type of Record (62101)	32 Bits
Record length	Length of the Record	16 Bits
Record-Specific Field	1. Set to **0** if the Boom Simulator Interphone is in the Off state. 2. Set to **1** Boom Simulator Interphone is in the Private state with boom operator push-to-talk button depressed. 3. Set to **2** Boom Simulator Interphone is in the Private state with boom operator push-to-talk button depressed. 4. Set to **3** Boom Simulator Interphone is in the Control state. 5. Set to **4** Boom Simulator Interphone is in the Control State with boom operator push-to-talk button depressed. 6. Set to **5** Boom Simulator Interphone is in the Common state.	8-bit Enumeration
Padding	N/A	8-Bits

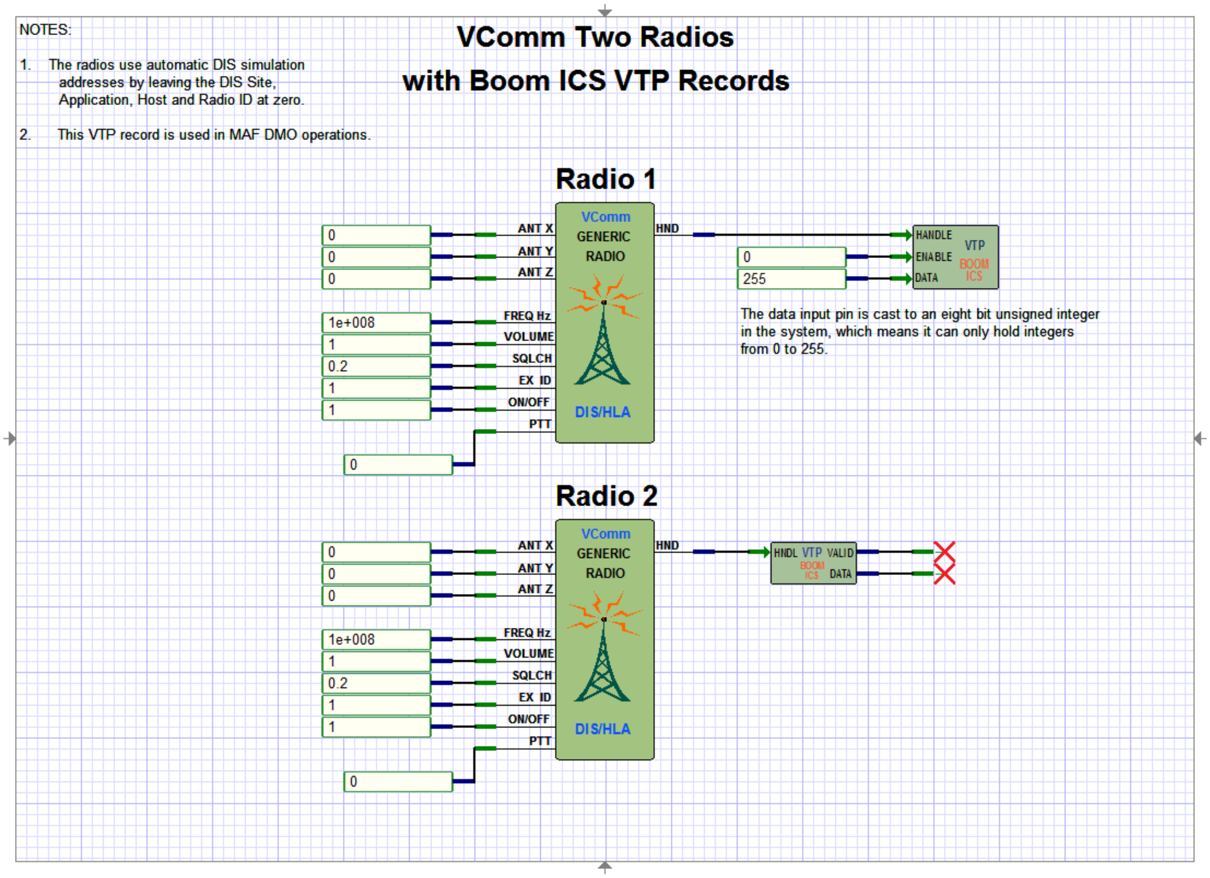
11.17.4 V+ Sample Worksheet with Boom ICS VTP Record

The figure below shows a V+ sample worksheet where two radios demonstrate the Boom ICS VTP Record. V+ uses two objects to set and get the record.

1. Object 2109, VComm Set Boom ICS VTP Record, sends the record
2. Object 2108, VComm Get Boom ICS VTP Record, gets the record

Data is carried in one field, an eight bit enumeration that defines the operation to be performed.

Figure 45, VComm Boom Set/Get Boom ICS VTP Record Demo Worksheet


NOTES:
1. The radios use automatic DIS simulation addresses by leaving the DIS Site, Application, Host and Radio ID at zero.
2. This VTP record is used in MAF DMO operations.
VComm Two Radios
with Boom ICS VTP Records
Radio 1
VComm
GENERIC
RADIO
DIS/HLA
ANT X
ANT Y
ANT Z
FREQ Hz
VOLUME
SQLCH
EX ID
ON/OFF
PTT
HND
1e+008
0.2
255
HANDLE
ENABLE
DATA
VTP
BOOM
ICS
The data input pin is cast to an eight bit unsigned integer in the system, which means it can only hold integers from 0 to 255.
Radio 2
HNDL
VALID
DATA

12 Coordinate Systems

The most commonly used coordinate system today is the geodetic system represented by latitude and longitude and elevation above sea level. DIS and the HLA RPR-FOM use the DIS World Coordinate System. Objects are provided to convert coordinate systems.

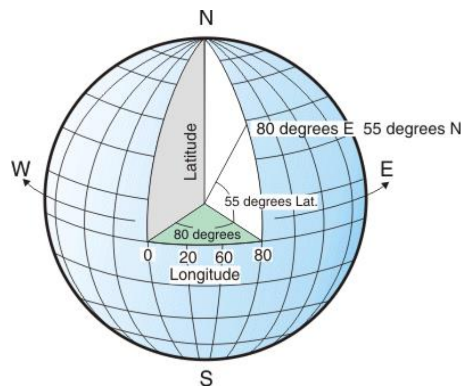


Figure 46, Geodetic Coordinate System

12.1 DIS World Coordinate System

Locations in the simulated DIS world are identified using a right-handed, Geocentric Cartesian coordinate system called the world coordinate system in the DIS specification. This Geocentric coordinate system is sometimes called ECEF or Earth Centered Fixed Cartesian. The origin of the coordinate system is the centroid of the earth. The axes of this system are labeled *X, Y*, and *Z*, with the positive *X*-axis passing through the prime meridian at the Equator, the positive *Y*-axis passing through 90 east longitude at the Equator, and the positive *Z*-axis passing through the North Pole as shown in Figure 47. A distance of one unit measured in world coordinates corresponds to a distance of 1 meter in the simulated world.

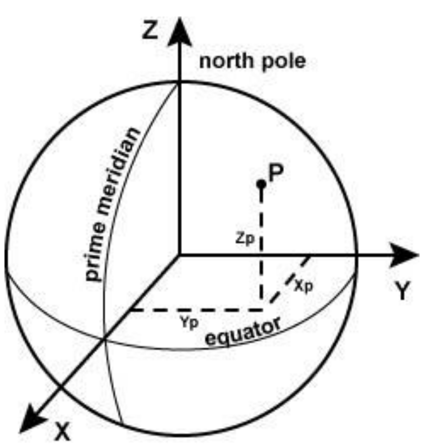


Figure 47, Geocentric Coordinate System

12.2 Radio Antenna Location

The antenna location for VComm radios are specified in either geocentric or global coordinates. Legacy VComm radios prior to VComm version 8.0 used global coordinates, while VComm radios after 8.0 use geocentric coordinates. Since global coordinates are most often used in simulation and easier to understand, there are objects to translate global to geocentric coordinates. Object 2029, **ALT, LAT, LONG to Geocentric conversion** converts global coordinates to geocentric coordinates (see Figure 48). The de-facto standard for DIS radio antenna locations is (0,0,0) geocentric. Since the antenna is effectively located at the center of the earth at this location, the radio is intended to not have any electromagnetic propagation loss for any reception regardless of where the transmitting antenna is located. In other words, any DIS radio with (0,0,0) geocentric means that a transmitting radio's antenna is always at the same location as other receiving radio antennas in a given simulation exercise. The new IEEE 1278.1a 200X will show this in the standard as a requirement. The V+ design below shows object 2029 connected to constants with inputs of 0. An altitude of 0 will cause an X value in geocentric coordinates to be 6378137, since this is the distance from the center of the earth to the surface of the earth in meters.

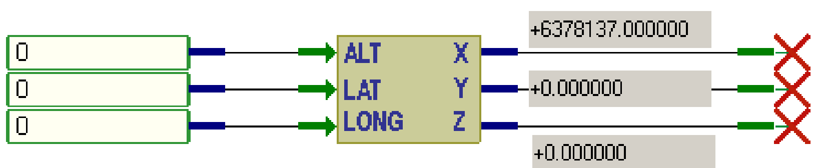


Figure 48, Object 2029 – ALT, LAT, LONG to Geocentric Conversion

To set a radio for “propagation-less” mode, set the antenna location to (0,0,0) Geocentric. If your inputs are in geodetic coordinates, set the altitude to -6378137 meters as shown in Figure 49.

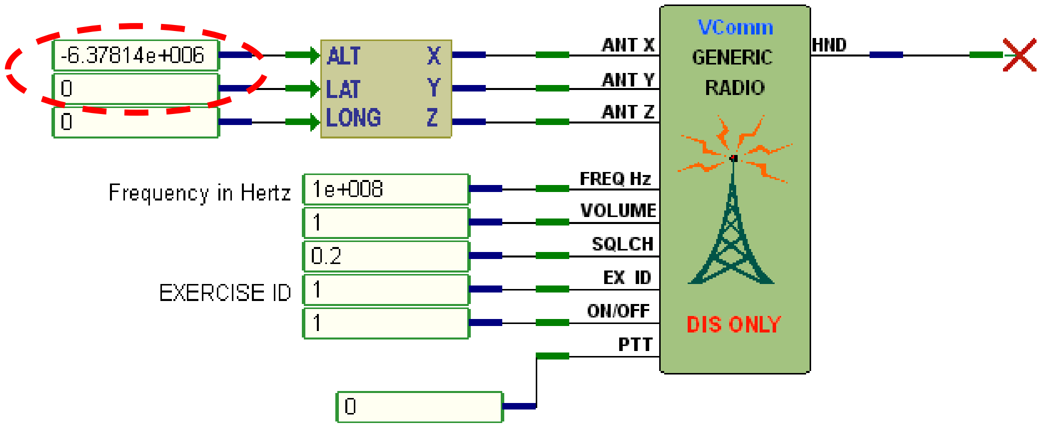


Figure 49, Setting Position to Geocentric (0,0,0)

The position of the antenna may be attached to an entity or controlled via manual means. A new Transmitter PDU will be issued when the antenna position changes more than the default threshold value of 500 meters. This value can also be changed in the datapool since the standard requires that this value must be modifiable by the user. For more information, see TRANS_POS_THRSH_DFLT.

13 VComm and HLA

VComm supports both DIS and HLA with DIS supported by default. HLA require a purchase of an RTI and possibly more software based on the application. SimPhonics does not recommend HLA for new systems or when a choice of DIS and HLA is available. Despite vendor claims, HLA is not interoperable with other RTIs' by design and is an API interface to a closed architecture instead of a standardized wire protocol with DIS. Each RTI is different and one may work for audio streaming while another may not. Worse, the same RTI vendor version may not work while the previous one did as each RTI version is not interoperable by design in order to support a business model.

13.1 Problems with HLA Interoperability

HLA seemed to be the answer for the DM&S community as DIS began to mature. However, HLA is perhaps the most misunderstood so called interoperability standard. DIS included a networking protocol using PDUs to transfer the data in broadcast mode. HLA improved the networking since it is a publish-and-subscribe architecture.

13.1.1 HLA is an Architecture Standard and Not a Protocol

The problem however is that there is no standard beyond the software API that connects your M&S application to the RTI. Only the HLA software at the API level will interoperate with others, and that was never the problem. The software that your HLA software talks to is vendor specific and is not compatible with any other RTI vendor be design. Worse, noting is compatible on the wire. Even worse, the data model is so wildly extensible, that vendors are encouraged to carve out niches for themselves in order to monopolize a portion of the market where they excel. HLA is clearly not the future, since it only helps to ensure that applications will interoperate without prior agreements and the use of the same vendor software.

13.2 Federate Object Model (FOM)

All federates in a federation must use the same Federate Object Model (FOM). Currently, the RPR-FOM version 1.0 is the most widely used FOM for simulation. RPR-FOM version 2.0 adds the new portions of IEEE-1278.1a 1998 to the original version 1.0, but version 2.0 is not officially released.

13.3 FED File

A Federation Execution Data (FED) file contains information about the FOM that the RTI requires, including the names of all object and interaction classes, attributes, and parameters, the hierarchical relationships among the classes, and the default transport and order types to use for each class or attribute. The FED file is specific to a federation and must be identical for all federates within a given federation. The federate that first creates the federation dictates the name of the FED file to all joining federates. There may be differences among RTI implementations as to where the FED file must be located. In some RTI implementations, only the federate that creates the federation execution reads the FED file and the information is automatically distributed to the other federates. The local RTI component locates the FED file by first searching in the working directory (the directory where the run-time system is started) and then the path specified by the environment variable **`RTI_CONFIG`.** If the local RTI components cannot find the FED file, VComm will not start. When VComm is installed, the environment variable **`RTI_CONFIG`** is created, which contains the folder location of the FED file and is set to the following string value:

1. **64-bit Windows**

   a. **C:\program files\VPLus\HLA\RPRFOM10**

2. **32-bit Windows**

   a. **C:\Program Files (x86)\VPLus\HLA\RPRFOM10**

VComm uses a default FED filename of RPR-FOM-fed. Users can change this name in the run-time configuration window for networked audio under FED Filename. The FED filename and extension is forced to lower case by VComm since some RTI implementations will not start with an uppercase (.FED) extension.

13.3.1 Federation Name

You can either create a federation or join an existing federation, by using the appropriate name. A VComm federation name can be entered in the V+ Run Time System as shown in Figure 50. Note that the default name is "VCommHLA". You must obtain the federation name from the network administrator of the HLA system. If the federation does not exist, a new federation with the name will be created. For example, RPR-FOM exercises are usually named RPR-FOM. For Some RTIs, only the first three characters of the federation name are used by the some RTI vendors. You must therefore ensure that federate names are unique in the first three characters.

13.3.2 Federate Name

VComm federate names are formatted as follows:

VComm@<COMPUTER NAME>

Where, **COMPUTER NAME** is the name of the federate computer.

13.3.3 RTI Object Identifier Names

All radio objects are given a default HLA name by the RTI at initialization. All VComm HLA radios will create a name of the form "**<Site Number>.<Application Number>.<Entity Number>.<Radio ID>.TRANSMITTER**". This name is provided for a human readable form for ease of debugging. For example a radio with a Site Number of 1, an Application Number of 2, an Entity Number of 3 and a Radio ID of 4 will register with the RTI as the name "**1.2.3.4.TRANSMITTER**", Note the "." character between the numbers and the "TRANSMITTER" string.

13.3.4 RTI Object Identifier Custom Text Names

Optionally, an additional name string can be tagged onto this name via an attachable object in V+. Object 2059, "VComm Set Radio/ICS Name" will tag an additional string of text onto the RTI Object Name defined in the above section. For example, adding the string "– HH60 OFT UHF Radio" changes "1.2.3.4.TRANSMITTER" to "1.2.3.4.TRANSMITTER – HH60 OFT UHF Radio". Currently this object has no purpose for the DIS protocol.

13.3.5 RTI Object Identifier Prefix

Optionally, a global prefix of up to 16 characters can be specified using the Transmitter Name Prefix field in the Networked Audio tab of the Platform Configure window in the VPLus Runtime. This prefix is added for all radio transmitter objects. For example, specifying the prefix "AB" changes "1.2.3.4.TRANSMITTER" to “AB.1.2.3.4.TRANSMITTER”. If for example Object 2059 is also used to add the additional string, “– HH60 OFT UHF Radio”, to a specific radio transmitter, then the RTI Object Identifier becomes “AB.1.2.3.4.TRANSMITTER – HH60 OFT UHF Radio”.

13.3.6 Exercise ID use in HLA

HLA radios do not use the exercise ID pin, and therefore this pin has no effect on HLA radios. The HLA equivalent of the DIS Exercise ID is the “Federation to Join” name set globally in the V+ run-time system configuration Networked Audio window.

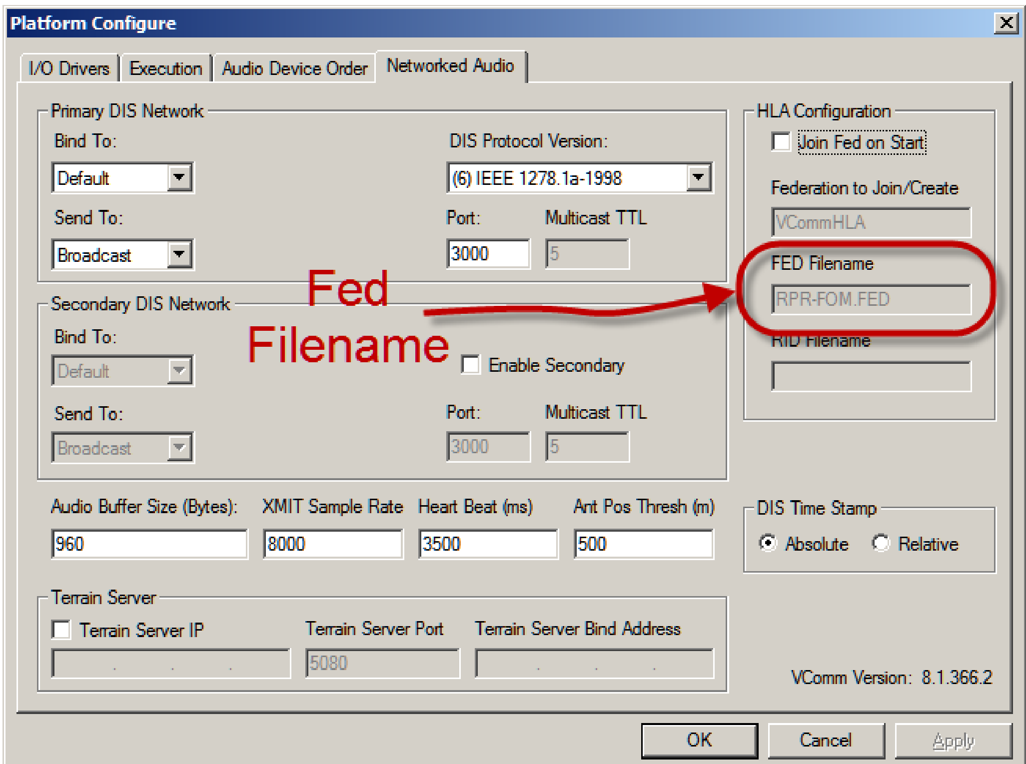


Figure 50, Setting the Federation Name

13.4 HLA Initialization

If the HLA RTI does not respond within 10 seconds, V+ will stop during initialization and indicate an error in the Run Time System window message area: "Cannot Initialize HLA….."

13.5 VComm HLA Extensions

In order to use HLA radios or intercoms with VComm, an HLA version and vendor specific extension must be added to VComm. If a VComm object is set to use the HLA network and HLA is not installed, the HLA object will do nothing. A warning is not generated at run-time for this condition.

13.6 Network Modes

VComm uses several methods to determine how individual radios communicate on the network. These are combinations of three distinct modes:

- Primary DIS Network
- Secondary DIS Network
- DIS Loopback
- HLA

Internally, each of these modes is a separate bit mask which can be combined to form unique values. Table 22 lists the recognized combinations of these three modes.

Table 22, VComm Network Modes	
Mode	**Description**
1	Primary DIS only
2	Secondary DIS only
3	Primary and Secondary DIS
4	DIS Loop Back
8	HLA only
9	Primary DIS and HLA
10	Secondary DIS and HLA
11	Primary DIS, Secondary DIS, and HLA
12	DIS Loop Back and HLA

VComm can operate without a network connection in “software loop-back mode” only. Most VComm radios and intercoms can set this mode with the **Send To Network** (or **Send To**) static data element. When in software loop-back, PDUs are sent from the output directly back into the input of the system, bypassing the network interface. Remember, when you are in software loop-back mode, there are no packets going out on the network. Tools that rely on reading network PDUs will not record any activity in this mode, including the VComm Monitor tool. DIS and HLA modes will cause the radio to operate in only that mode. VComm DIS modes are always available, while HLA mode will work only if the HLA system has been enabled and is initialized. DIS radios will not function at all without a valid network connection when in DIS mode. If local radio communications are necessary then set the mode to DIS LOOP BACK mode when there is no valid network connection, or when it is necessary to remove any DIS traffic from the network. The network specification is defined on a per radio basis, which means each radio can have an independent network mode. This is how a DIS radio can be “bridged” to an HLA radio.

Note: *The Send To Network mask cannot be changed during run time.* ***V+*** *must be stopped and restarted for a change to take effect.*

13.7 Terrain Server and Signal Quality Server Configuration

The Networked Audio configuration page is also used to configure VComm to work with the VComm Terrain Server (VTS) or a 3rd party Signal Quality Server as shown in Figure 51. There are three fields on this page which can be edited for this configuration:

1. Terrain Server IP
2. Terrain Server Port
3. Terrain Server Bind Address

Note that while these fields are labeled “Terrain Server”, they perform the same function for a signal quality server. Please see the section on datapool entry settings to see how VComm determines what kind of server to expect. If the **Terrain Server IP** check box is enabled, the three edit boxes become active. The string entered in the Terrain Server IP edit box represents the server’s IP address. The **Terrain Server Port** defaults to 5080 but can be changed if necessary. Make sure this corresponds with the port used by the server. The **Terrain Server Bind Address** is used to identify which network adapter VComm should use for remotely accessing the server. It is possible to run VComm and the server on the same machine with the same network address. In other words, the IP address in the **Terrain Server IP** and **Terrain Server Bind Address** may be identical.

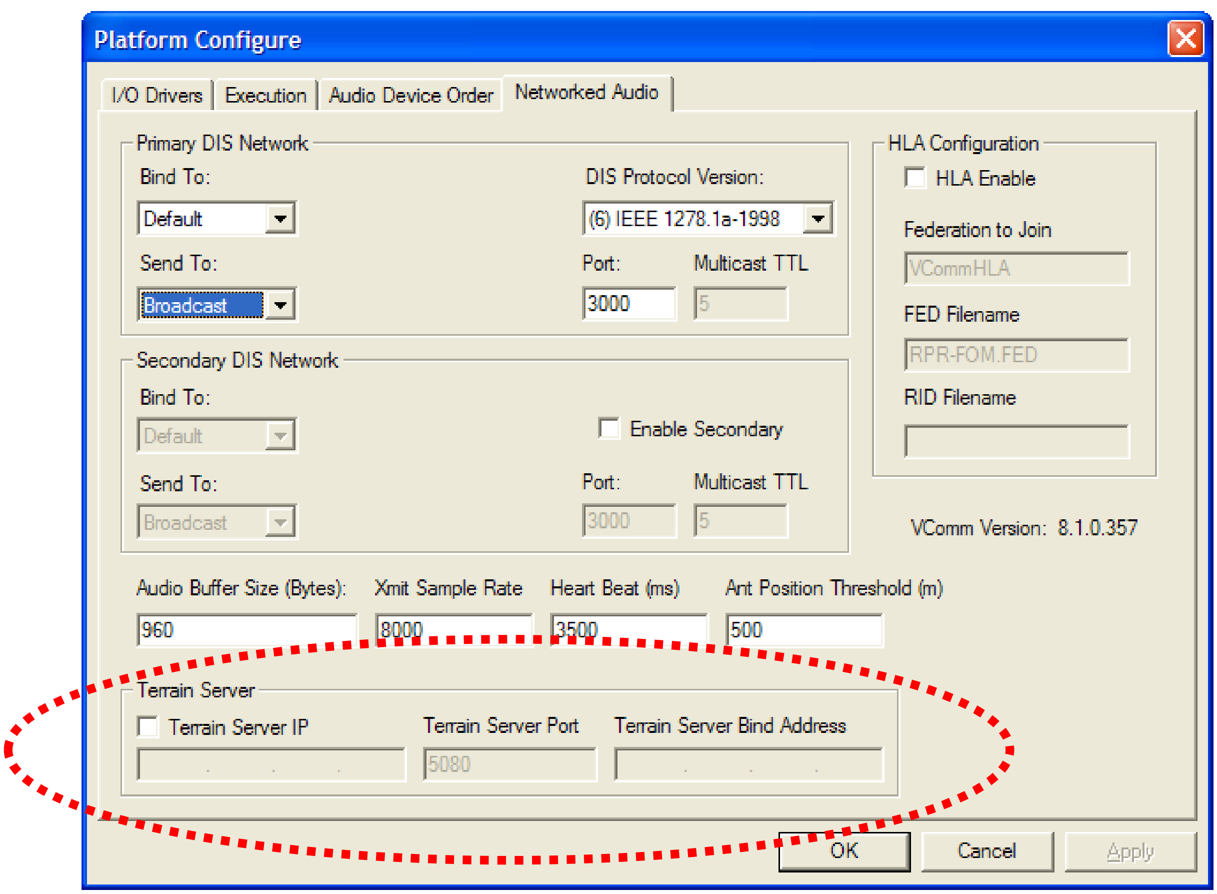


Figure 51, Terrain/Signal Quality Server Network Configuration

14 Filters

14.1 Filter Modes

Any VComm radio can utilize various filters to filter specific incoming Transmitter PDU or Signal PDU packets. Object 2024, **VComm Entity Filter**, shown in Figure 52, can perform a number of filtering tasks when attached to a radio. To set more than one mode, simply attach additional objects to a given radio. Available modes and their descriptions are provided in Table 23.

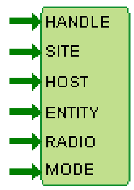


Figure 52, VComm Entity Filter Object

Table 23, VComm Entity Filter Modes

Value	Mode	Description
0	FILTER OFF	
1	ENTITY FILTER	Filters Transmitter PDUs with the specified ID.
2	ENTITY FILTER EXCLUSIVE	Filters Transmitter PDUs that are not the specified ID.
3	ENTITY FILTER FORCE RX	Forces the specified Radio Entity ID transmission frequency to match our radios receiver frequency. In other words, this mode forces the specified radio entity to be heard regardless of the radios entity’s frequency.

These filter modes can be used to build “recorder” radios whose audio is routed directly to disk for recording radio traffic. In some cases there is a need to separately record what a specific entity would hear, using ENTITY FILTER, and/or specifically what that entity says on the radio, ENTITY FILTER EXCLUSIVE, while removing all other traffic. Of course, there are other uses for these filters.

14.2 What You Cannot Change in Real-Time

VComm is very flexible in allowing most of the DIS parameters to be changed during run time. Run time, for all practical purposes, implies that V+ is executing. Most pin values and some static data values can be changed in real-time with immediate effects on the network. The following are static data that you CANNOT change in real-time and the system must be stopped and restarted in order to affect the change.

- Channel (Audio Channel number)
- Network or “Send-To” number.

    This variable is a static constant in most radios. It selects the network to use, and cannot be changed at run-time.

14.3 HAVE QUICK

HAVE QUICK (HQ) is a radio technology that helps to protect UHF radios from being jammed and provides an additional measure of voice communications security. It works by establishing a mutually agreed frequency-hopping pattern and rate for both the receiver and transmitter. A UHF radio must be equipped with HQ capability to interoperate with other HQ radios. There are a number of different modes of operation based on the evolution of the technology. HAVE QUICK is a crude brute force method of spread spectrum operation. Since HAVE QUICK has been introduced, other spread spectrum radio standards have appeared which are considered to be more of a standard, such as SINCGARS. SINCGARS is a more modern standardized approach to anti-jam operations, and is digital (see section 15.3 for more information on SINCGARS). All HAVE QUICK radios are AM radios, which operate in the frequency range of 225 to 399.975 MHz on a 25 KHz spacing (12.5 kHz bandwidth) yielding 7000 frequencies. An example of a typical HAVE QUICK radio is the AN/ARC-164, the control head of which is shown in Figure 53. It has a receiver sensitivity of -106 dBm, a transmitter output level of 10 watts and a bandwidth of 12.5 KHz.

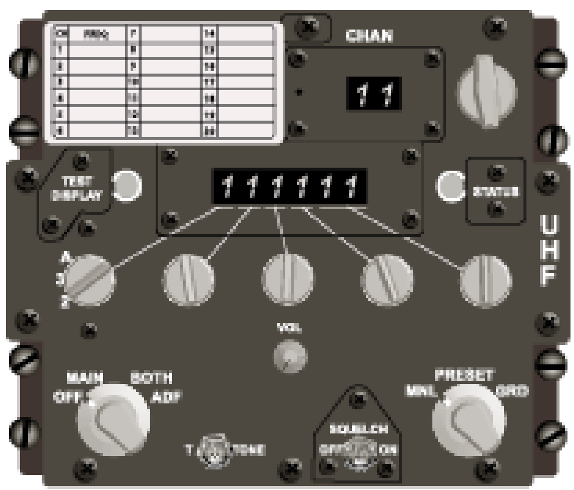


Figure 53, AN/ARC-164 Radio Control Head

HQ radios may be operated in normal mode, which behaves like any other UHF AM radio, or in HQ mode. The HQ mode of operation provides a jam resistant capability by means of a frequency hopping technique that changes frequency many times per second. Automatic frequency changing in an apparently random manner provides the jam resistance of the radio.

14.3.1 HAVE QUICK Detailed Description

Three elements are required for successful communication in HQ mode. Radios must use the same set of Word-Of-Day (WOD) values, be time-synchronized with each other with a Time-Of-Day (TOD), and share a common NET. The WODs determines the frequency hopping pattern and rate; the TOD synchronizes the hopping; the NET provides for multiple radios to operate independently on the same frequencies without interference. These values are distributed by a frequency management authority. There are a number of methods of inserting these values into a radio which include, electronic transfer methods, or manually by entering the value via the radio controls. The image in Figure 54 is a sample KAL-9200 KEY-TAPE that contains the WOD set for training and maintenance.

HAVEQUICK WORD OF DAY (TRAINING ONLY) CONF US/ALLIED SEG 03

CH14/34	CH15/35	CH16/36	CH17/37	CH18/38	CH19/39	CH20/40	KAL ED	REGNO
305.000	287.400	297.600	314.300	359.100	376.000	300.050	9200 C	225

Figure 54, Sample KAL-9200 KEY-TAPE

14.3.1.1 HAVE QUICK TODs, WODs, and MWODs

A Multiple WOD (MWOD) is a complete set of six WODs. HQ II radios allow the operator to store an MWOD for each day called the OP Day or Operational Day. Up to 31 days may be stored in this manner in the radio. The advantage of storing multiple MWODs is that the radio will automatically switch to the next MWOD at midnight. Figure 55 provides an example operational diagram of how a TOD helps to determine which MWOD to use.

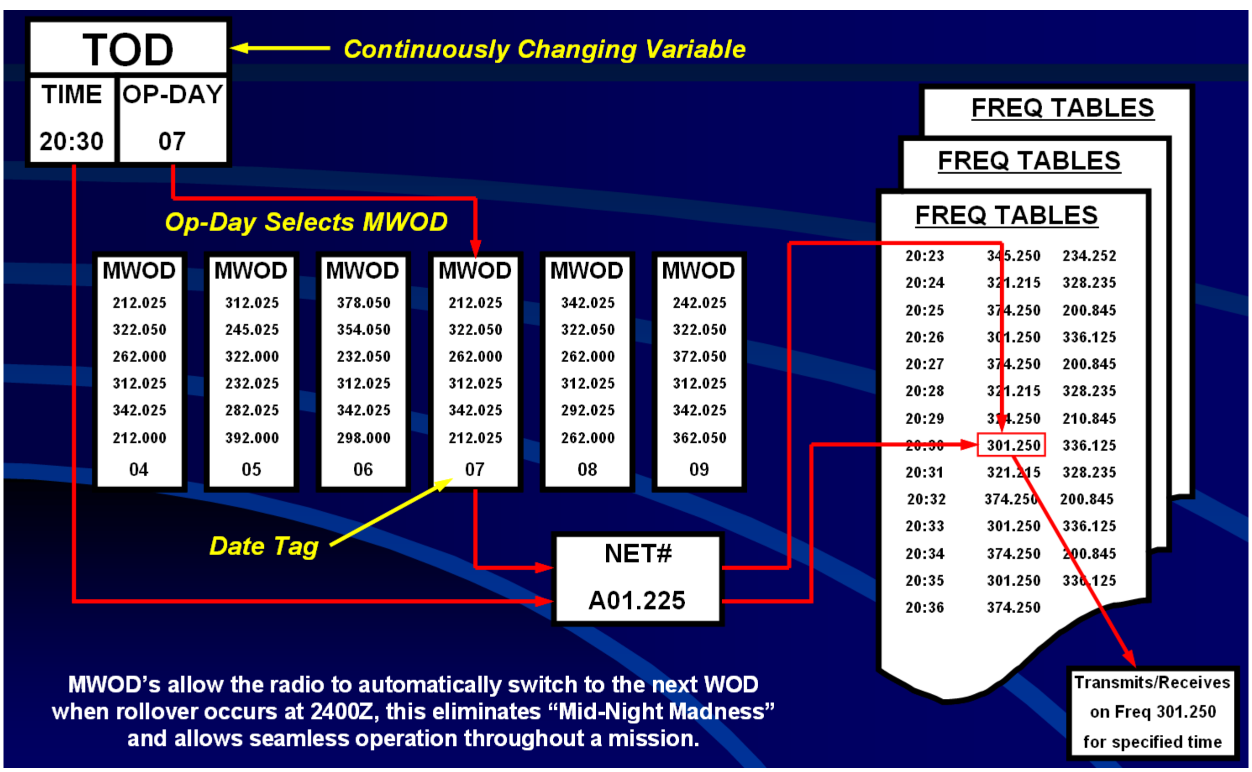


Figure 55, HAVE QUICK Operational Diagram Example

14.3.1.2 HAVE QUICK NET Number

The net number is used in the anti–jamming mode in the same fashion as a radio frequency in the normal mode of in the normal mode of operation. The net number enables multiple users to operate with other users while sharing a common WOD and TOD. The format of the NET Number is shown in Figure 56.

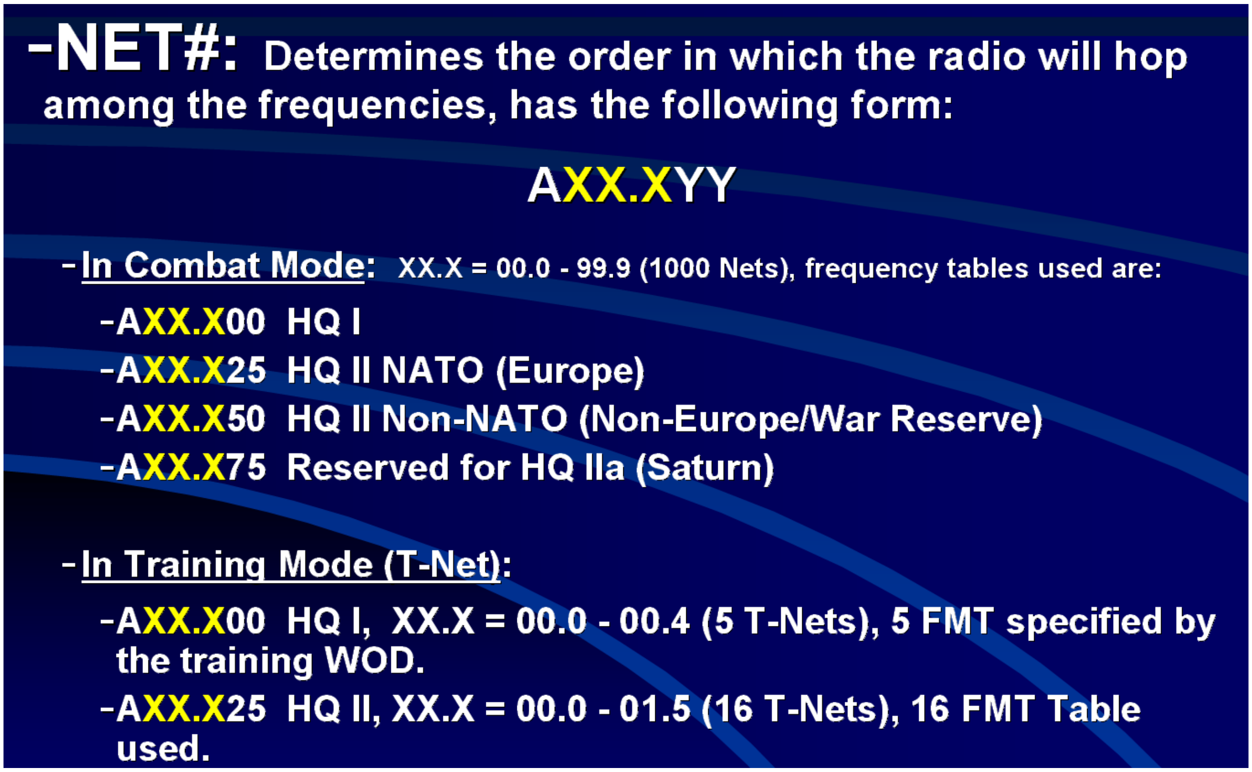


Figure 56, HAVE QUICK NET Number Format

There is more than one format of NET Number notation depending on the HAVE QUICK system being used. The format shown in Figure 56 is the most common.

14.3.1.3 HAVE QUICK WOD

Frequencies, hopping pattern, and hopping rate are determined by the WOD. There are six WOD segments that together form what is called the Multiple Word-Of-Day (MWOD). Table 24 shows the individual numbered WOD segments containing six digit values which resemble frequencies in order to be loaded via radio frequency controls. The AN/ARC-164 and most other HQ radios use channel numbers to load these values, and therefore the CHAN numbers are shown.

Table 24, MWOD Segments

Segment Number	Value
SEGMENT 1 (CHAN 20)	200.475
SEGMENT 2 (CHAN 19)	234.500
SEGMENT 3 (CHAN 18)	345.600
SEGMENT 4 (CHAN 17)	456.700
SEGMENT 5 (CHAN 16)	567.800
SEGMENT 6 (CHAN 15)	678.900

The first WOD (CHAN 20) segment has special meaning. The first four digits dictate one of the following operation modes:

300.0 = Training
200.0 to 299.9 = Tactical
300.1 to 399.9 = Tactical

The last two digits dictate one of the following hopping rates:

00 = Slow
25 = Medium Low
50 = Medium High
75 = Fast

The second WOD (CH19) also contains special information for conferencing mode. Conferencing mode allows two HAVEQUICK radios to transmit simultaneously and be received by the other NET members.

The last two digits indicate the conferencing mode.

00 = Enabled
25 = Disabled
50 = Enabled
75 = Disabled

14.3.1.4 HAVE QUICK TOD

Since radios in HQ mode are frequency hopping, they must do so at same instant in time in order to communicate. HQ radios have an internal high resolution clock that can be synchronized to other HQ radios or to another time synchronization sources such as a Universal Time Coordinated (UTC) signal (the UTC signal can come from a variety of sources, such as a Command Post, GPS or AWACS. When a HAVEQUICK radio is manually synchronized to another HAVEQUICK radio this is called a “Mickey” which is derived from the two words, Mic and Key, or a PTT (Push-To-Talk).

14.3.1.5 HAVE QUICK Training and Maintenance MWOD

There is a standard NET number and MWOD used training and maintenance. It is suggested that this be used in exercises since real radios use these data during normal operations. Table 25 provides the channel number, WOD value, and Net number for the Training and Maintenance MWOD.

Note: *These data are loaded into the V+ High Fidelity object by default if the TRAIN pin is set true and the values for this table are in datapool. See section 15.2.3 and V+ object help for more information.*

Table 25, Training and Maintenance MWOD		
Segment Number	**WOD Value**	**NET Number**
SEGMENT 1 (CHAN 20)	300.050	A30.000
SEGMENT 2 (CHAN 19)	376.000	A30.000
SEGMENT 3 (CHAN 18)	359.100	A30.000
SEGMENT 4 (CHAN 17)	314.300	A30.000
SEGMENT 5 (CHAN 16)	297.600	A30.000
SEGMENT 6 (CHAN 15)	287.400	A30.000

15 SINCGARS & HAVEQUICK radio simulation in DIS/HLA exercises

The DIS specification, IEEE-1278.1a 1998 provided for HAVEQUICK I, II, and IIA, SINCGARS and a CCTT SINCGARS as enumerations. The enumeration document for CCTT SINCGARS included a data structure as modulation parameters at the end of the Transmitter PDU including issuance and receipt rules within the enumeration document, which was moved to an Annex in DIS 7. The original CCTT SINCGARS modulation parameter record was developed by the ADST project at Lockheed and then adopted by CCTT, which carries its name. Combat Air force (CAF) Distributed Mission Operations (DMO) utilized this structure to represent HAVEQUICK and SINCGARS radios and documented this in their common models standard.

15.1 Basic Fidelity and High Fidelity

When the information for the SINCGARS in the enumerations document was moved to an Annex in DIS 7 and further documented to include CAF DMO’s HAVEQUICK common model standard, this was called the Basic Fidelity SINCGARS and HAVEQUICK and is in use today. A high fidelity HAVEQUICK and SINCGARS was also developed by the Radio Tiger Team at SISO in order to interoperate with real and simulated radios.

15.1.1 High Fidelity

The Basic Fidelity modulation parameter record in the DIS Transmitter PDU carries information for modeling the radio. It is documented in Modulation Parameter Record below.

Table 26, CCTT SINCGARS Basic Fidelity

Modulation Parameter Record	
FH Net ID	16-bit unsigned integer
Hop Set ID	16-bit unsigned integer
Lockout Set ID	16-bit unsigned integer
Start of Message	8-bit enumeration
Clear Channel	8-bit enumeration
FH Synchronization Time Offset	32-bit signed integer
Transmission Security Key	16-bit unsigned integer
Padding	16-bit unsigned integer

Total Size = 128 bits

This table corrects several errors.

1. Combat Air Force Distributed Mission Operations, Common Models standard MO Common Model Standard, document number Version 13.0 and earlier have the Clear Channel and Padding rows swapped. This was corrected in version 13.1 on 07/03/13 via SimPhonics urging.

2. The DIS IEEE 1278.200X Draft 15 and earlier showed the Clear Channel as an 8-bit data type and not an enumeration, and the Padding field has been extended an additional eight bits for 32-bit alignment.

15.2 VComm and HAVE QUICK Radios

VComm provides HAVE QUICK radio simulation via V+ objects that attach to existing VComm radios. There are two forms of DIS/HLA HAVE QUICK radios: Basic Fidelity and High Fidelity. The Basic Fidelity HAVE QUICK functionality is a de-facto standard established by CAF DMO while the High Fidelity HAVE QUICK is a new standard that SimPhonics and other vendors helped to establish for DIS/HLA systems and is currently in draft form in IEEE-1278.1a-200X. The CAF DMO organization is currently specifying the use of the Basic Fidelity version in their exercises. The High Fidelity version requires that the Basic Fidelity version be implemented also, in order to maintain compatibility.

Note: *When a VComm radio is in HAVE QUICK mode, it will be forced into UHF AM mode at a frequency of 312.5 MHz This will override any default or explicit radio mode and frequency settings. There was no need to enforce frequency to be at any particular frequency as it is ignored by the model. Forcing the radio frequency to be at 312.5 MHz makes no sense and unnecessarily complicates the radio model. Hopefully this will be changed in the future.*

15.2.1 Basic Fidelity Radio Logic

The NET ID, WOD and TOD values must match in order for valid communications. A NET ID of zero is invalid.

15.2.1.1 HAVE QUICK Simulated Audio Effects

The audio effects of HAVE QUICK communications is a distinct clicking in the received audio. Each click represents the radio changing to the next hop frequency and is a function of the hopping rate determined by WOD segment 1. Otherwise the audio characteristics are the same as any other radio. This clicking effect is provided by VComm for both High and Low Fidelity versions. Slightly garbled communications indicate a slight difference in the TOD between radios. Real world radio TOD clocks will drift over time. VComm simulates this effect by garbling incoming audio which becomes worse until the timing difference is 100ms. Values greater than 100ms disable communications altogether. To simulate the effect, a small portion of the received audio buffer is replaced with silence which is proportional to this time difference. The VComm High Fidelity HAVE QUICK object provides a pin for TOD clock drift which can be set to any value. (*See section 15.2.3 and V+ object help for more information.*)

Note: *The Basic Fidelity HAVE QUICK does not allow for clock drift in the TOD. Therefore, simulated garbled audio is not performed in the V+ Basic Fidelity HAVE QUICK object.*

Entering invalid data for WOD or NET numbers can result in a variety of warning tones and error tones. For example, selection of a Frequency Managed Training (FMT) NET greater than A01.525 or ending in 50 0r 75 will result in a pulsating tone. This can be simulated in VComm by creating a wave player which plays the appropriate tones when the condition exists.

15.2.2 Basic Fidelity HAVE QUICK

The Basic Fidelity HAVE QUICK was derived from the SINCGARS structure of data established in the SISO enumeration document. This information has been moved to the new IEEE-1278 – 200X, Draft 13 specification as Annex H as of this printing. When this mode is enabled, transmit and receive frequencies are automatically set to 312.5 MHz (note that this is not the way real HAVE QUICK radios work). Therefore, the value of the frequency pin for the radio is overridden. If the mode is turned off, the frequency is reset to the last value of the frequency pin for the radio before HAVE QUICK mode was enabled. The VComm object for Basic Fidelity HAVE QUICK connects to a radio as shown in Figure 57. For more information, refer to the object's on-line help within the V+ Development System (object ID 2050).

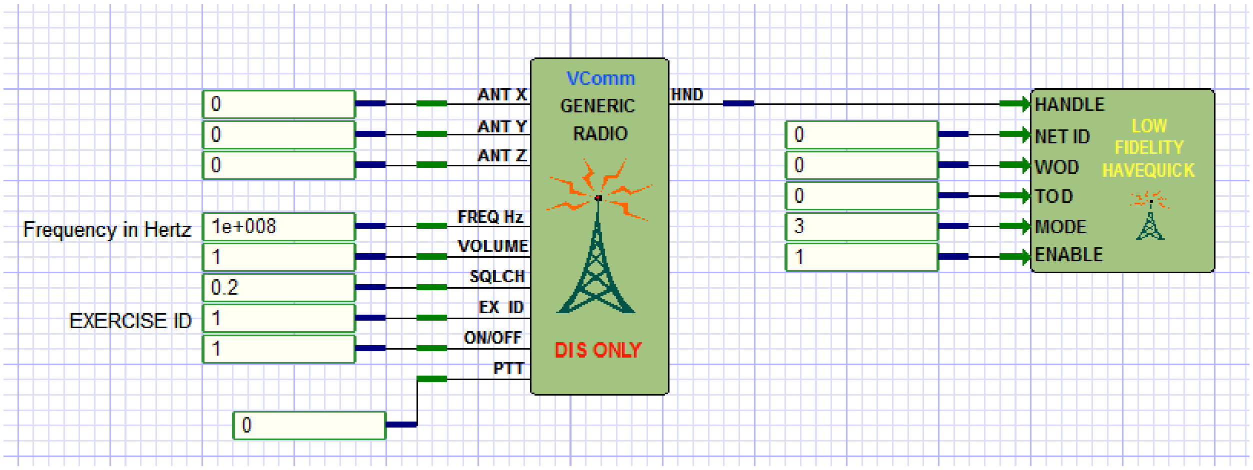


Figure 57, VComm Basic Fidelity HAVE QUICK Object

15.2.3 High Fidelity HAVE QUICK

The High Fidelity HAVE QUICK is a new implementation designed to work much like the real HAVE QUICK specification. The Basic Fidelity HAVE QUICK only uses a single 16-bit field to describe the WODs and TOD, while there are a number of WODs in a real HAVE QUICK implementation as well as other significant differences. The High Fidelity HAVE QUICK is designed to interoperate with live HAVE QUICK radios.

The VComm High fidelity HAVE QUICK object is currently under construction.

15.3 SINCGARS

SINCGARS (Single Channel Ground and Airborne Radio System) is a US and allied military Combat Net Radio (CNR) that handles voice and data. It has a frequency hopping capability similar to HAVEQUICK but SINCGARS differs from HAVE QUICK radios in that SINCGARS is a digital radio capable of handling data. Voice is handled digitally in the form of 16 KHz CVSD. A SINCGARS radio is a VHF FM radio and operates in the frequency range of 30 to 87.975 MHz operating on 25 KHz channel spacing. An example of a SINCGARS transceivers is the AN/ARC-201, the control head of which is shown in Figure 58. It has a receiver sensitivity of -113 dBm, a transmitter output level of 10 watts, and a bandwidth of 12.5 KHz. Modern digital radios usually feature internal encryption devices.

Figure 58, AN/ARC-201 SINCGARS Radio

15.3.1 VComm and SINCGARS Radios

VComm provides SINCGARS radio simulation via V+ objects which attach to existing VComm radios. There are two forms of DIS/HLA SINCGARS radios: Basic Fidelity and High Fidelity. The Basic Fidelity SINCGARS functionality, also called “CCTT SINCGARS” is a de-facto standard established by CAF DMO while the High Fidelity SINCGARS is a new standard that SimPhonics and other vendors helped to establish for DIS/HLA systems and is currently in draft form in IEEE-1278.1a-200X. The CAF DMO organization is currently specifying the use of the Basic Fidelity version in their exercises. The High Fidelity version requires that the Basic Fidelity version be implemented also, in order to maintain compatibility. The default encoding scheme for VComm SINCGARS objects is 16 KHz CVSD since this is the same as the real radio. An example of object 2058 – VComm Basic Fidelity SINCGARS is shown in Figure 59. The VComm High Fidelity SINCGARS object is currently under construction.

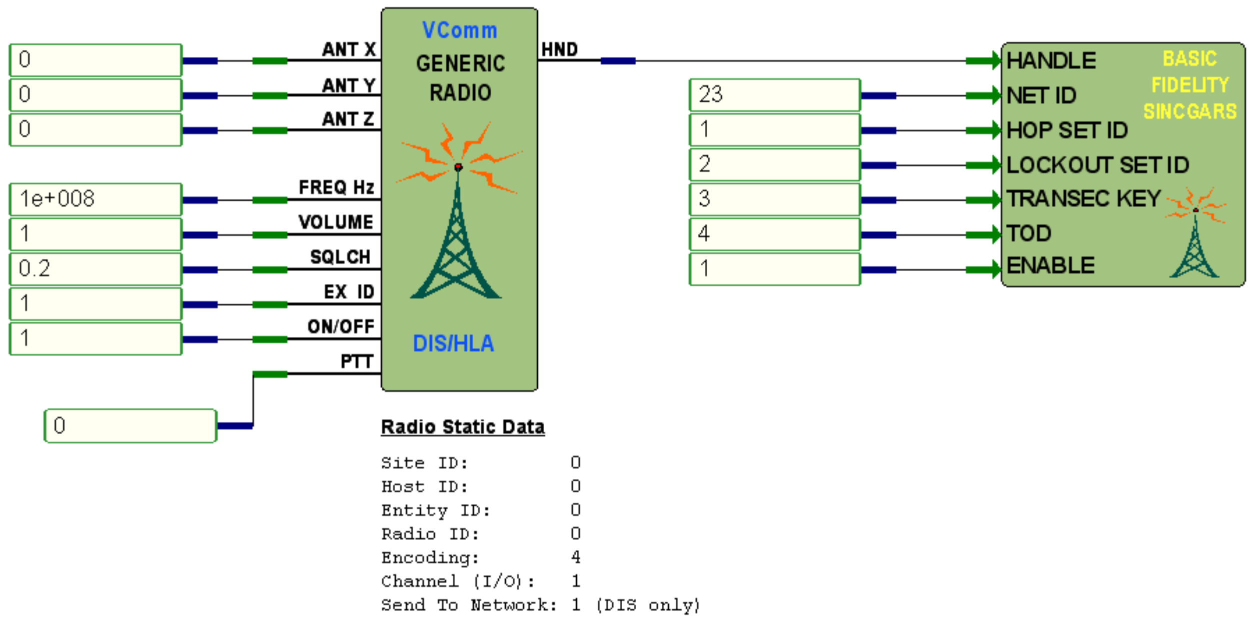


Figure 59, VComm Basic Fidelity SINCGARS Object

16 Cryptographic Modeling

VComm provides secure voice simulation for radios for the most common types of encryption devices. For example, Object 2040, VComm Crypto System attaches to VComm radio or intercom objects via the Radio Handle output pin and provides simulated radio encryption. There are a number of crypto equipment types such as the KY-58 (DIS Enumeration 2) shown in Figure 62. In addition to providing encryption and decryption of audio for secure communications, most crypto gear also generates a number of tones that are used to inform that radio operator of various conditions and warnings. Most of these tones are built into VComm and are part of the model. Where possible, the tones and noise effects used by VComm for crypto simulation are actual recordings of real crypto gear and therefore are very realistic.

16.1 Crypto Tone and Effects Waveforms (wave files)

The waveforms (tones) that are generated by the crypto model are built directly into the VComm software and the user has no access to the wavefiles. In some cases the effect is an algorithm and there is no associated wave file.

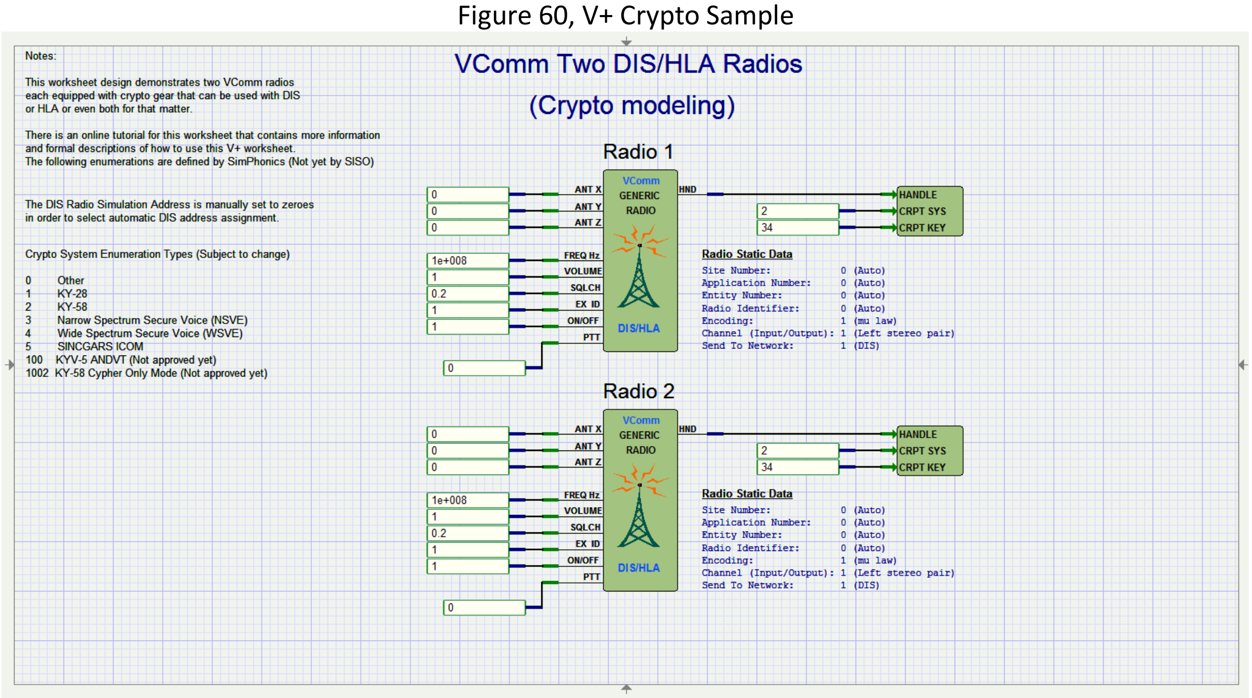
16.2 Limitations of Crypto Key modeling in DIS

Unfortunately the current DIS standard does not provide for the use of actual secure keys which are loaded into real encryption devices. Instead, there is a single 16 bit field in the Transmitter PDU. Hopefully, later versions will more closely model real equipment by providing for all keys.

16.3 V+ Crypto Sample

The figure below shows a sample V+ worksheet that ships with V+ that can be used to test Crypto for DIS and HLA.

Figure 60, V+ Crypto Sample



16.4 Modeling technique

A VComm radio with the encryption object attached is shown in Figure 61. There are three pins for this object, all of which are input. The HANDLE pin attaches to a radio. The CRPT SYS pin is used to identify the type of crypto system. The CRPT KEY pin provides the key value for the crypto system. The CRPT SYS and CRPT KEY pins are connected to data which is sent directly into the Transmitter PDU. The CRPT SYS pin in the figure is set to **2** which is the DIS Enumeration for a KY-58. Exercise authorities such as CAF DMO normally provide a crypto key for their exercises to all participants.

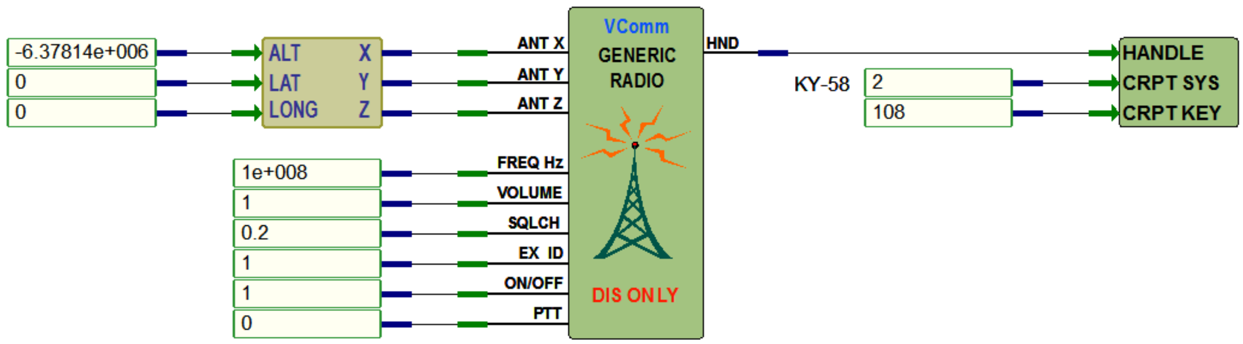


Figure 61, VComm Crypto System Object

16.5 VComm Crypto System Types

The currently available VComm Crypto System object types are provided in Table 27. Note that these values come from the DIS Enumerations document and are subject to change. At present, the KY-58 is modeled when any of the other types are selected (i.e., a value of 1, 3, 4 or 5 set for the CRPT SYS pin).

Table 27, VComm Crypto System Value	Type
0	Other
1	KY-28
2	KY-58
3	Narrow Spectrum Secure Voice (NSVE)
4	Wide Spectrum Secure Voice (WSVE)
5	SINCGARS ICOM
6	KY-75
7	KY-100
100	KYV-5 ANDVT This enumeration is not yet approved into the DIS standard and may become the next enumeration in this series, i.e. 6.
1100	KYV-5 ANDVT, Cipher Only Mode This enumeration is not an actual enumeration, but a value to indicate cipher only mode.
1002	KY-58, Cipher Only Mode This enumeration is not an actual enumeration, but a value to indicate cipher only mode.

16.6 Clear Versus Encrypted Voice Reception

Table 28 is a state table which describes what is received between two radios using Crypto System objects. This table assumes all other things are equal (e.g., Frequency, Exercise ID, within range, etc.).

Table 28, Clear Versus Encrypted Voice Reception

Transmitting Radio	Receiving Radio	Receiving Radio Audio
Crypto System Disabled	Crypto System Enabled Crypto Key = **X**	Voice heard
Crypto System Disabled	Crypto System Enabled Crypto Key = **X** **Crypto Only Mode**	No Voice is heard
Crypto System Enabled Crypto Key = **X**	Crypto System Enabled Crypto Key = **Y**	Audio Encrypted Effect
Crypto System Enabled Crypto Key = **X**	Crypto System Enabled Crypto Key = **X**	Voice heard
Crypto System Enabled Crypto Key = **X**	Crypto System Disabled	Audio Encrypted Effect

16.7 "Cipher" mode and "Cipher Only" mode

The KY-58 features the capability to receive both encrypted and plain text or non-encrypted signals in the normal mode of "Cipher" or C mode. In Cipher Only mode or CO mode, the KY-58 unit will only receive encrypted signals. See Table 27, VComm Crypto System.

16.8 Audio Encrypted Effect

The Audio Encrypted Effect sound is heard when receiving an encrypted signal and the audio is not deciphered properly. This will occur if the transmitter and receiver keys do not match, if the encryption equipment is not interoperable of the receiver is in plain and the transmitted signal is encrypted. Each crypto equipment type may have a different type of effect. Table 29 lists the effects for each crypto type. For example, the KYV-5 ANDVT effect is an actual recording of the effect of receiving cipher on plain, or when the keys do not match when both the transmitter and receiver are encrypted.

Table 29, VComm Crypto System

Crypto System	Audio Effect
1 - KY-28	Incoming Signal Multiplied by Random Noise
2 - KY-58	Actual Waveform From KY-58
3 – NSVE	Incoming Signal Multiplied by Random Noise
4 – WSVE	Incoming Signal Multiplied by Random Noise
5 - SINCGARS ICOM	Incoming Signal Multiplied by Random Noise
100 - KYV-5 ANDVT	Actual Waveform From KYV-5

16.9 KY-58

The KY-58 is a common encryption device that encrypts audio before input to the radio and controls the PTT signal as well. A set of keys are loaded into the unit with a key loading device and once the unit is "keyed" it can be used to encrypt audio. Both sides of the communications must be keyed identically in order to communicate. A typical unit is shown below although there are variants.

Figure 62, KY-58 Encryption Panel

Figure 63 shows a recorded transmission from a radio with a KY-58 in secure mode.

Figure 63, Example KY-58 Reception of Secure Transmission

16.9.1 Preamble Tone

A preamble tone is generated by the crypto gear in order to inform the operator not to try to speak until after the tone has completed.

There are two types of preamble tones, one heard when starting a transmission and one when receiving during the beginning of the incoming transmission. VComm simulates each crypto type preamble appropriately.

16.9.2 Crypto Circuit On and Crypto Circuit off Clicks

The KY-58 crypto system generates a sharp click when a secure transmission starts and ends. This click is the crypto circuitry turning on and off.

16.9.3 Squelch Tail

The squelch tail in this case is the same as any other transmission.

16.9.4 KY-58 Crypto Alarm

A continuous beeping with noise in the background will be heard if keys are not loaded or have been "zeroized" (i.e., CRPT KEY = 0), and the Crypto System object is enabled by setting the CRPT SYS pin. To stop the tone, set the PTT to 1 and then back to 0. This tone can also be stopped if a key value other than 0 is provided.

16.9.5 Practical Considerations Simulating KY-58 Crypto Gear

VComm includes tones in the object that are mixed into the audio stream eliminating the need to manipulate waveforms when simulating crypto gear. In the case where there is no enumeration for the crypto gear being simulated or if the model is a high fidelity simulation, tones may have to be simulated to triggering waveforms at certain points in the transmission. Depending on the fidelity of host simulation, other tones may be necessary. All operations can be modeled by manipulating two tone generators:

1. Continuous tone
    a. 1000 Hz triangle waveform
2. Single Beep
    a. 1000 Hz triangle waveform, 60ms duration with 2ms attack and decay time

16.9.6 KY-58 Transmitter Hold off PTT

The KY-58 VComm model delays the PTT to the radio just as the real KY-58, so that the simulated KY-58 has time to begin encrypting. This results in Signal PDUs not going out until after the preamble. Students are trained to wait for this tone to complete before talking, because before the preamble is done, the transmitter is not active. This is an important training effect that VComm supports that no other vendors provide.

16.9.7 Received Encrypted Audio is Realistic

The received audio is very realistic for receiving cipher on plain since the incoming audio is distorted in the same way it would be with the real system. This is also true when the incoming audio is encrypted and the keys are matching. Other vendors merely play a noise wave file while the voice is coming in, which is very unrealistic since the operator can still hear the voice under the noise.

16.10 KYV-5 ANDVT

The KYV-5 is simulated with the same precision as the KY-58 and operates similar to the KY-58. The preamble tone is different than the KY-58, for example. This is a new model for VComm, so more information will follow in a later version of this manual. For more information contact SimPhonics. (info@simphonics.com)

16.10.1 Encrypted Audio

In order to model the audio as realistic as possible, VComm will automatically switch the transmitter to 16-bit 16 KHz CVSD encoding which sounds very close to the actual encrypted audio of the real KYV-5.

17 Waveform Audio Transmission in VComm

Most audio effects that are added to the radio stream to simulate an effect such as jamming and test tones are added to the receive side of the audio stream. The DIS protocol specifies that all effects are to be added at the receiver and all transmitters send their audio without any effects to improve interoperability. In some cases however, it may be necessary to send the waveform effect out to the networked audio stream (e.g., jamming, HAVEQUICK MICKEY synch, etc.). VComm has the capability to transmit waveforms in the networked audio stream by attaching Object 2057 – **VComm Radio Transmitter Wave File Player** to a VComm radio or intercom (see Figure 64). Simply attach the object to a VComm radio or intercom and set the appropriate controls and static data. A wave file is used to generate the waveform which is mixed into the outgoing audio stream. The microphone's audio stream can be muted if so desired. Restrictions for the wave file to be used are as follows:

1. The wave file format must be PCM, mono or stereo, and 16-bits per sample (Only the left channel of stereo files is played).
2. The sample rate must match what is specified for radio transmission. The sample rate for a radio is specified in the V+ Run Time System's Configure menu (Networked Audio Tab, Transmit Sample Rate). The object will generate an error if the format is incorrect at run-time.
3. Specific wave file naming conventions are used and described in the object's on-line help.

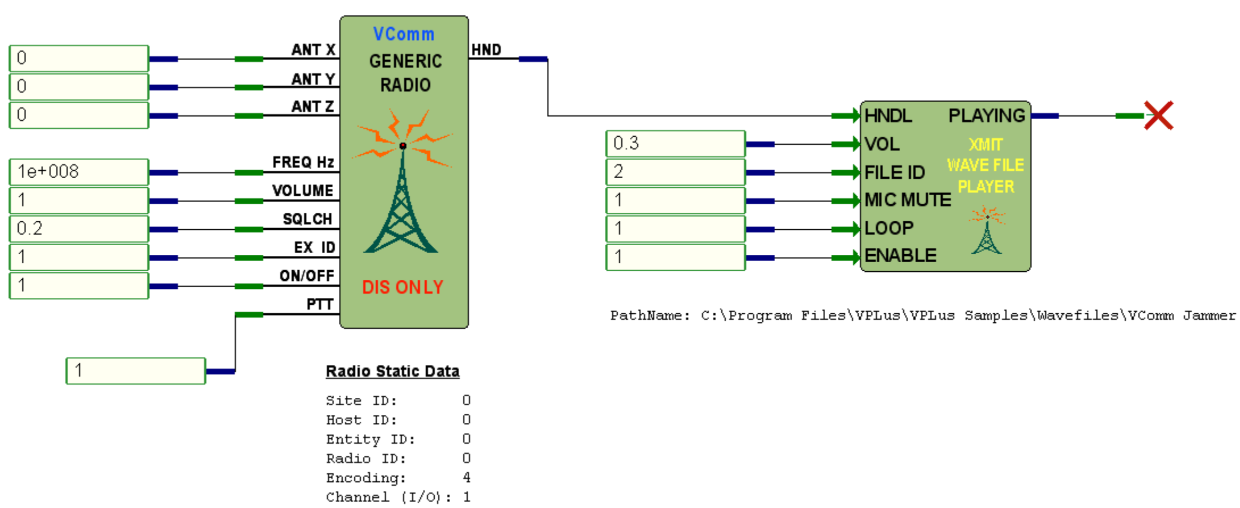


Figure 64, Object 2057 - VComm Radio Transmitter Wave File Player

This object is very handy for generating Jamming audio, chatter, Test Tones, HAVE QUICK "mickeys", and the like. For more information on how to use it, refer to the on-line object help.

18 Recording

There are a number of ways to record incoming radio signals using VComm, each with pros and cons depending on what is being recorded, for what purpose, and if the recording must be automated by V+, etc. One of the most straight forward means to recording

18.1 Windows Built-in Recorder

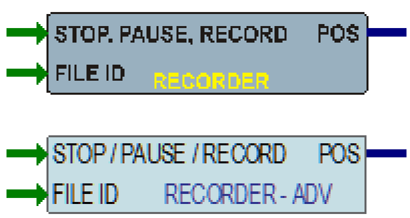
Windows has a recorder that is shipped with Windows and can be found in the menu system at **Start Menu\Programs\Accessories\Entertainment\Sound Recorder**. This recorder uses DirectSound to record any sound device input into a wave file. The advantage to this method is that recorded files can be set to a host of formats to minimize the file size. However, V+ cannot control the sound recorder application to turn it off and on, etc. To setup a recording the Windows Audio Mixer controls must be adjusted properly.

Figure 65, Windows Sound Recorder

18.2 V+ wave Input Recorder Objects 2012 and 2093

V+ features objects for recording wave input audio to a file, objects 2012 and 2093. Both have the means to record audio input under V+ control. Again, the Windows Audio Mixer or the SMx Super Mixer, if your using the SMx system, must be setup to mix the radio output back to a wave input for recording. V+ also has an I/O device that can control the Windows Audio Mixer for this purpose under program control.

Figure 66, Wave Input Recorder Object 2012 and 2093



18.3 Radio Recording using Object 2085

VComm includes radio recording capabilities featuring recording of incoming radio transmissions on a per radio basis. Only one recorder may be used per radio. A separate recording file is created for each recorded radio. Signals are recorded prior to any signal modeling which means that the recorded signal is always free of noise, signal fading, etc. The VComm Recorder V+ 2085 object is used to control recording of a single radio. To record radios, attach the object to the radio as shown in Figure 67.

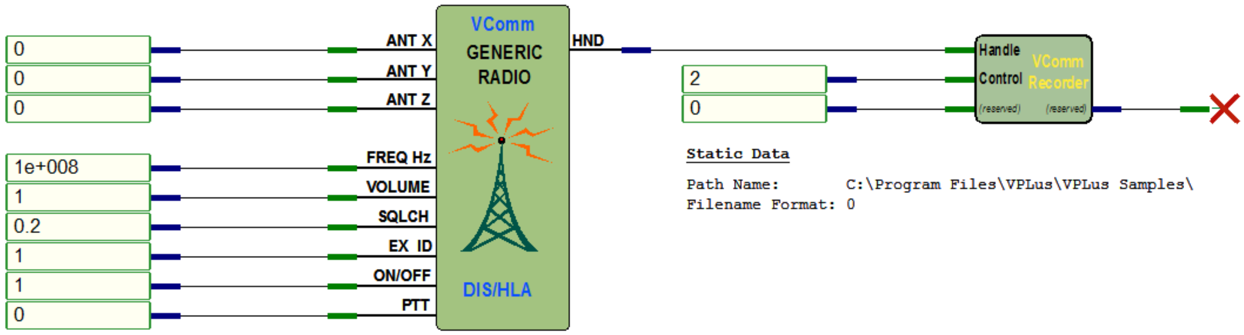


Figure 67, Object 2085 - VComm Recorder

A control pin on the Recorder object is used to start, pause, and stop recording of the attached radio. The filename for the recording is specified using static data. The recording is stored in the VComm Signal File (VSF) format. This format was developed by SimPhonics to improve streaming performance allowing recordings to be stored efficiently with minimal performance impact. The VSF file contains all the decoded audio that is received by the attached radio and also other data such as a pause and resume event. All audio data and events are time stamped. It is necessary to post process a VSF file in order to play back the recording. The VSF Converter utility is used for converting the VSF file into a WAV file that can be played back by audio players.

18.3.1 VComm Signal File Converter

The VSF converter utility can be found in the V+ installation directory. It is a command line tool that is invoked with the command:

```
vsfc <source filename> <destination filename> <mode>
```

The source filename is the name of the VSF file; the destination filename is the name of the output file to create. The mode is optional and specifies the type of conversion.

The utility can convert a VSF file into either a WAV file or a text file containing a list of transmission events. If no mode is specified, then a WAV file is created.

18.3.2 Conversion to a WAV file

To convert a VSF file into a WAV file use the command:

```
vsfc <source filename> <destination filename> wav
```

The resulting wav file will contain all the transmissions recorded in the VSF file.

18.3.3 Conversion to a Transmission Event file

To convert a VSF file into a transmission event file use the command:

vsfc <source filename> <destination filename> txevent

The resulting text file will contain a list of records that describe the transmission events recorded in the VSF file. Each record is divided into fields that are delimited by commas. The general format of each record is:

<Type>, <Site>, <App>, <Entity>, <Radio>, <Date1>, <Time1>, <Date2>, <Time2>, <Duration>, <Note>

The **<Type>** field determines the interpretation of the remaining fields and is a string identifier. The possible record types are:

1. START – This record is always the first record in the file and contains the time when recording started.
2. END – This record is always the last record in the file and contains the time when recording ended.
3. TX – This record represents a transmission.
4. PAUSE – This record contains the time when recording was paused.
5. RESUME – This record contains the time when recording was resumed.
1.

The **<Site>**, **<App>**, **<Entity>**, and **<Radio>** fields are integers that together define the DIS ID of a radio (e.g. the transmitting radio). These fields are set to zero when they do not apply to the record type. The **<Date1>** and **<Date2>** fields are in the format **yyyy-mm-dd**. The **<Time1>** and **<Time2>** fields are in the format **hh:mm:ss**. The **<Duration>** field is in seconds with one decimal place. Finally, the **<Note>** field contains keywords that provide further amplifying information related to the record.

The format of the START record is:

START, 0, 0, 0, 0, <Start Date>, <Start Time>

The format of the END record is:

END, 0, 0, 0, 0, <End Date>, <End Time>

The format of the PAUSE record is:

PAUSE, 0, 0, 0, 0, <Date Paused>, <Time Paused>

The format of the RESUME record is:

RESUME, 0, 0, 0, 0, <Date Resumed>, <Time Resumed>

Note that these four records all follow the same pattern; that is, they only require a single date and time and do not include the additional fields at the end of the record.

Each TX record represents a single transmission. The format is as follows:

TX, <Site>, <App>, <Entity>, <Radio>, <Start Date>, <Start Time>, <End Date>, <End Time>, <Duration>, <Note>

In most cases, the **<Note>** field will contain a minus sign "-" to indicate that there is no amplifying information. This indicates that the record represents a normal transmission event. Abnormal transmission events occur and are noted as follows:

1. Recording was paused during an active transmission (Note = PAUSED)
2. Recording was ended during an active transmission (Note = ENDED)
3. An active transmission timed out (Note = DELETED)

Abnormal transmission events simply indicate that the duration of the transmission may not be accurate because the information is not available in the VSF file. This may be the result of recording being paused or ended, or it may be the result of a simulation computer going off line without issuing the proper "end of transmission" notifications.
A simple example of a transmission event file is provided below. Notice that the last transmission has a note indicating that it was terminated because recording ended while the transmission was active. Therefore, the duration of that transmission may have been greater than the reported 9.6 seconds.

```
START, 0, 0, 0, 0, 2010-07-26, 22:29:58
TX, 5, 8, 3, 9, 2010-07-26, 22:30:06, 2010-07-26, 22:30:09, 3.2, -
TX, 5, 8, 3, 9, 2010-07-26, 22:30:14, 2010-07-26, 22:30:19, 4.5, -
TX, 5, 8, 3, 3, 2010-07-26, 22:30:36, 2010-07-26, 22:30:44, 8.2, -
TX, 5, 8, 3, 3, 2010-07-26, 22:31:14, 2010-07-26, 22:31:17, 3.3, -
TX, 5, 8, 3, 3, 2010-07-26, 22:31:23, 2010-07-26, 22:31:32, 8.6, -
TX, 5, 8, 3, 9, 2010-07-26, 22:31:37, 2010-07-26, 22:31:43, 6.0, -
TX, 5, 8, 3, 5, 2010-07-26, 22:31:59, 2010-07-26, 22:32:09, 9.6, ENDED
END, 0, 0, 0, 0, 2010-07-26, 22:32:09
```

Figure 68, Transmission Event File Example

19 Duplex Modes

Voice communications can be categorized as either full or half duplex. Half duplex communication causes reception and transmission to be mutually exclusive; only one can happen at a time. In other words, you cannot receive anything while you are transmitting. This is the traditional mode for radios and is due to a radio's receiver being deactivated while its transmitter is active. This is done to protect the radio's receiver from being damaged by the radio's transmitter during transmission. Full duplex communications are those where both parties can speak to and hear each other simultaneously. A telephone is a common example of full duplex communication. Intercom systems often go into full duplex mode by either VOX or "hot-mic" circuitry (see section 21). Object 2032 – **VComm Simple Intercom (DIS/HLA)** is capable of full duplex communication. By default, the VComm radio objects 2021 and 2036 do not allow full duplex communication. Object 2041 – **VComm Set Radio Duplex Mode** can be used to force full duplex communication for these radio objects (see Figure 69). If you attach this object to a VComm radio and set the DUPLEX pin to 1, the radio will go into full duplex mode.

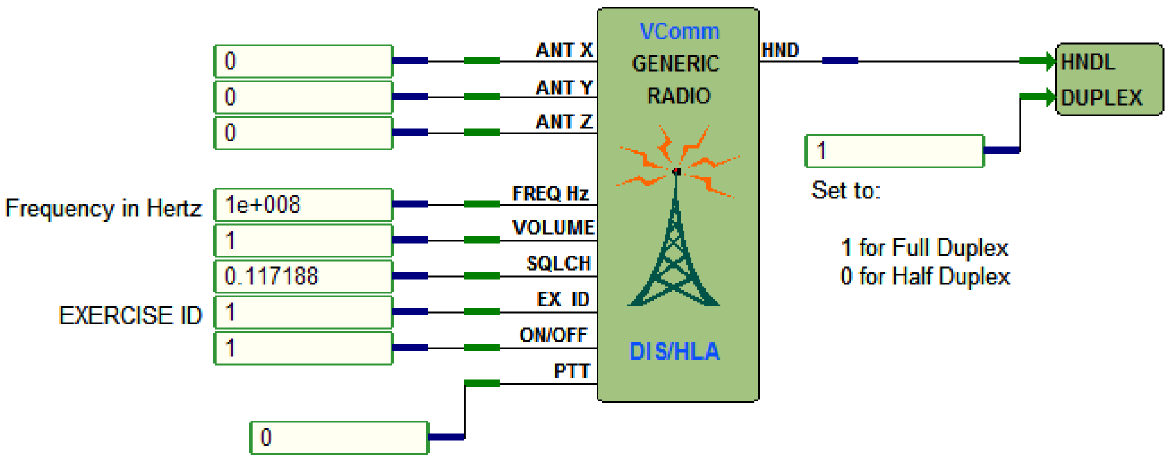


Figure 69, Object 2041 - VComm Set Radio Duplex Mode

20 Sidetone

Sidetone is an audio feedback mechanism for verification of valid transmission within a radio or intercom. It is an often misunderstood and underutilized concept. For example, your own voice is fed back in telephones to the handset's earpiece when you pick up the receiver. here are two good reasons for sidetone in radios and intercoms. First, sidetone verifies that you are actually transmitting. If the transmitter fails, or the PTT is not actuated properly, you will not hear sidetone. Second, sidetone can be used to adjust your own transmit speaking level. If you talk louder, then the sidetone will be louder and this feedback tends to cause the speaker to talk with less volume. In VComm, sidetone can usually be achieved by mixing a microphone input to a headphone output. This can be accomplished through either the **V+** Windows Audio Mixer driver (used for on-board or off-the-shelf audio cards), or the SMx driver. With some sound cards, there are no controls to mix the microphone to the headphones. That's where the **VComm Software Sidetone** object comes in handy (see Figure 70). Adjusting the volume of this object controls the microphone level fed to the headphone. The microphone/headphone audio device is defined by the radio or intercom object to which this object is attached.

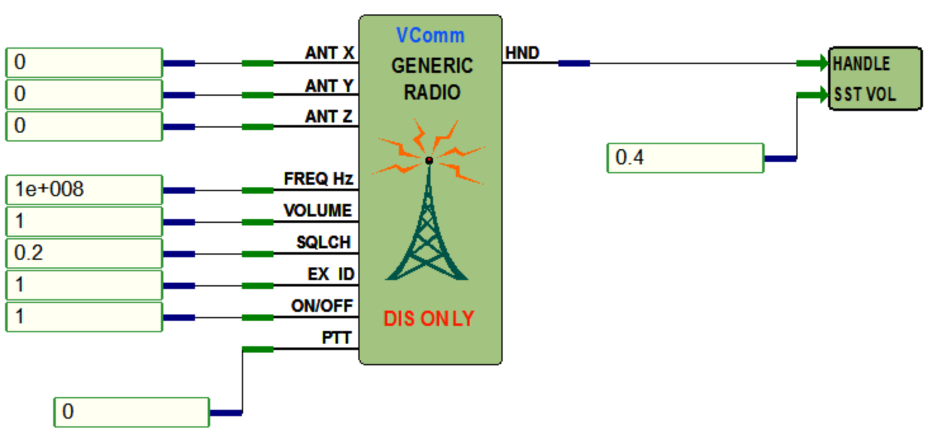


Figure 70, VComm Software Sidetone

This object should only be used when a sound card is not capable of mixing its microphone input to its headphone output. The reason for this is that a slight delay can be experienced due to the capture buffer size configured in the Networked Audio page of the V+ Run Time system. A larger buffer size will cause a longer delay. The smallest definable capture buffer size in VComm is 80 bytes. If set to this value, the latency of the sidetone is not noticeable. However if the value is set to the default of 960 bytes there is a noticeable delay. This value is the default for interoperability with other vendor systems. Other vendors may not be able to operate properly at a smaller than 960 bytes buffer size. If you use this object, you will want to tune the amount of sidetone volume by adjusting the **SST VOL** pin. Different headsets have different microphone sensitivities and headphone performance characteristics. Normally, a value of approximately 0.5 should be sufficient. Sidetone levels should be 6dBv below the level of the received audio from other stations. This is a standard for intercom and radio systems.

21 VOX

“Hot-Mic” operations are normally performed via a Voice Operated Switch, otherwise known as VOX. This can be accomplished in VComm without the need for special hardware. Object 2045 – **VComm S/W VOX**, can be attached to an intercom as shown in Figure 71. This object can also be attached to a VComm radio, although in the real world, it is most commonly used with intercoms.

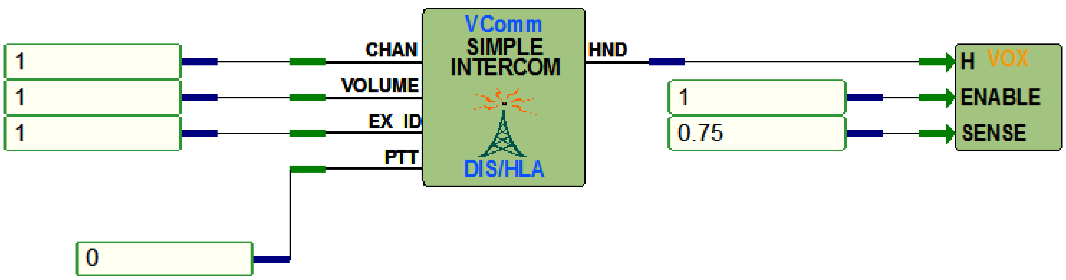


Figure 71, VComm S/W VOX

This object is very handy for voice transmission without having to use an intercom or radio's PTT. When activated, it will in fact, disable the PTT. Sensitivity can be adjusted in real time via the SENSE pin. A static data value called **off delay**, specifies the amount of time it takes to deactivate the circuit after the audio input has dropped below the sensitivity level. This keeps the circuit from turning off during short pauses in speech. Object 2097 – **VComm S/W VOX with Activity**, implements the same functionality and it also provides an output pin to indicate when the VOX circuit is active.

22 Converting Legacy Radios to Version 8

VComm legacy radios and intercoms have been discontinued. In their place, a new generation of radios and intercoms has been introduced and is actively in use within VComm. The following sections describe how to convert legacy radio designs to use current VComm radio and intercom objects. For more detailed information on the specifics of the new radios and intercom, refer to the VPLus Release Notes and the VPLus On-line Object Help System.

22.1 The Legacy Radios

The legacy radios needed Split Audio Device and Stereo Connection objects to select a sound card channel and connect the wave in and wave out streams to the network (see Figure 72). These objects

Legacy Radio

have been discontinued because they are just not needed as their capabilities have been incorporated into the new radios.

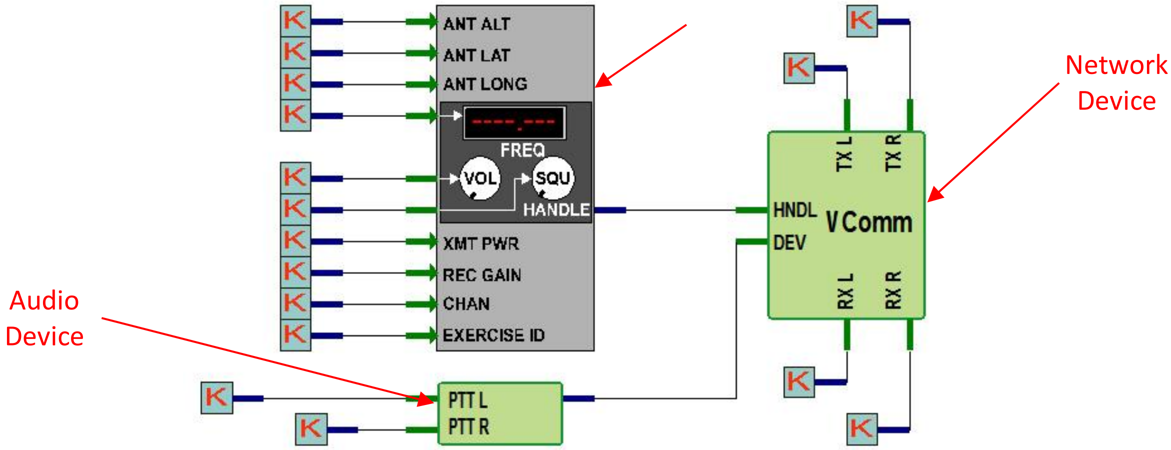


Figure 72, Legacy Radio

22.2 The New and Easy to Use VComm Radios

The new radios simplify your V+ designs by removing the Split Audio Device and Stereo Connection objects. Use the **VComm GENERIC Radio, V8 DIS Only** (2026) or **VComm GENERIC Radio, V8 DIS/HLA** (2031). A design utilizing a VComm GENERIC radio is presented in Figure 73.

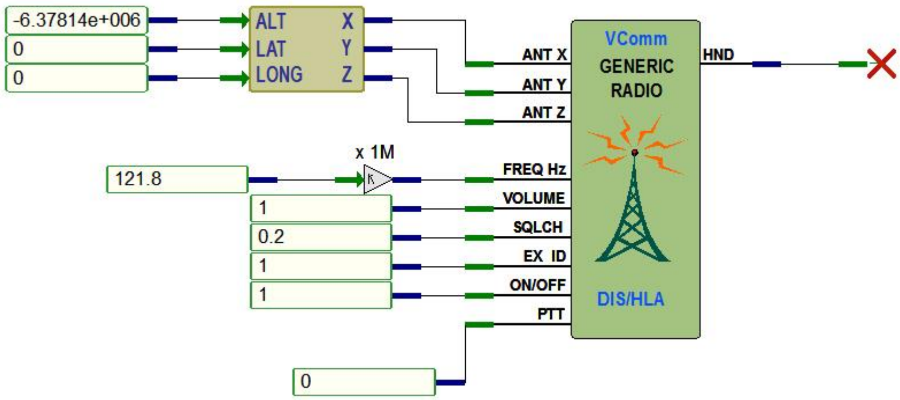


Figure 73, VComm GENERIC Radio, V8 DIS/HLA

The antenna position information is now accepted in Geocentric X, Y, Z coordinates instead of Geodetic Altitude, Latitude, and Longitude coordinates. If your old radio was accepting antenna position in Geodetic coordinates (for example, an own ship position coming from the host), you can convert this position to X, Y, Z Geocentric coordinates by wiring up object 2029 – **ALT, LAT, LONG to Geocentric conversion**.

22.2.1 Specific Pin Changes

Another important change is the Frequency pin. In the legacy radios, the frequency was expressed in Megahertz (MHz). The VComm radios expect this input to be in units Hertz (Hz). Converting from MHz to Hz is easy though. All you need is object 1018 – **Multiply by Static Data Constant** with a static value of 1,000,000 as shown above. The Volume, Squelch, and Exercise ID pins remain the same as in the legacy radios. Volume and Squelch have a continuous range from 0 to 1; Exercise ID ranges from 1 to 255. The On/Off and PTT pins are new and are Boolean in nature, with 0 representing the off state, and 1 the on state.

22.2.2 Static Data Changes

Static data remained pretty much the same. With the legacy radios you would use a Split Audio device to allocate a channel of a sound card for input and output. This is now part of the static data for the new GENERIC radios. Also note that the DIS/HLA radio has a Send To Network element which used to be a pin on some of the legacy radios. You would normally want this to be set to a value of 1 for sending it to the Primary DIS Socket. If a value of 0 is entered, the radio will not transmit over the network.

22.3 The Legacy Intercoms

The legacy intercoms also needed Split Audio Device and Stereo Connection objects much like the legacy radios (see Figure 74). Again, these objects are not needed as their capabilities have been incorporated in the new intercom.

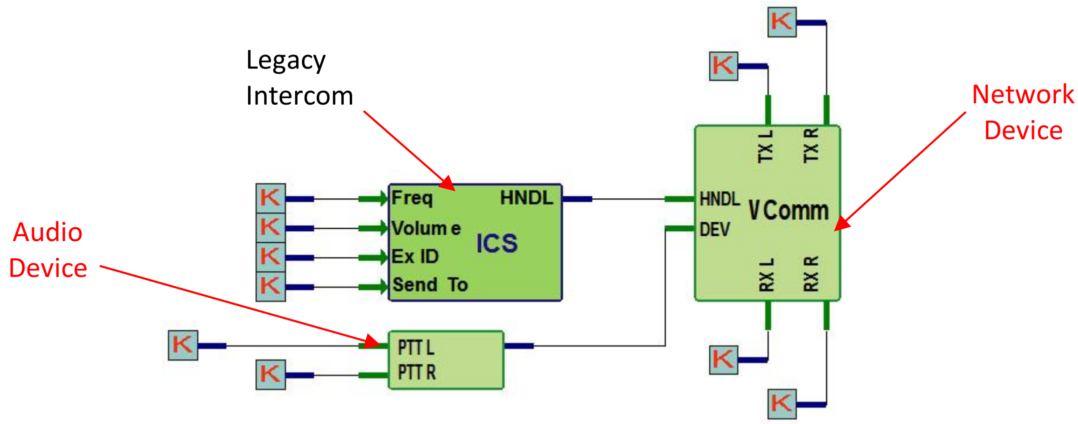


Figure 74, Legacy Intercom

22.4 The New and Easy to Use VComm Intercom

The new intercom simplifies V+ designs by removing the Split Audio Device and Stereo Connection objects. Use the **VComm Simple Intercom (DIS/HLA)** (2032) shown in Figure 75.

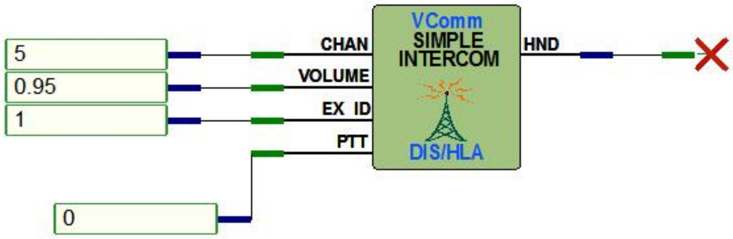


Figure 75, VComm Simple Intercom Object

The Simple Intercom object is essentially a VComm GENERIC Radio with the following fixed attributes:

1. It is always positioned at the geocentric center of the Earth (0, 0, 0)
2. It is always full-duplex.
3. It ignores bandwidth.
4. It does not model Wave Loss Propagation, Tuner Effects, Fresnel Effects, Terrain loss, Curvature of the Earth, Thermal and Atmospheric Noise, Squelch, and Automatic Gain Control.

The CHAN pin is analogous to the FREQ pin on the VComm GENERIC Radios. Since bandwidth is ignored, the channel used between two (or more) intercoms must match exactly for communication to work. The PTT pin is new and is Boolean in nature with 0 representing the OFF state, and 1 the ON state.

22.4.1 Static Data

Static data remained pretty much the same. With the legacy intercoms you would use a Split Audio device to allocate a channel of a sound card for input and output. This is now part of the static data for the new Simple Intercom. Also note that there's a “Send To” Network element which used to be a pin on some of the legacy intercoms. You would normally want this to be set to a value of 1 for sending it to the Primary DIS Socket. If a value of 0 is entered, the radio will not transmit over the network.

23 VComm Monitor

The VComm monitor is a means of monitoring DIS and HLA activity on the network. There is an upper limit to the number of radios that can be handled by the system. This has been measured at approximately 500 with a 3.0 GHz processor.

23.1 VComm Monitor Refresh

Figure 76 is a snapshot of the VComm Monitor. The information in the left pane is refreshed as often as data arrives. Radios that are detected on the network are placed into the pane for viewing details and are maintained there for 45 seconds. This is called the monitor's heartbeat interval. Therefore, ensure that the radio systems being monitored have at least a 45 second heart beat interval or the radio will be removed from the list after 45 seconds. By selecting View, Refresh, the information will be cleared and updated when new data arrives. The F5 function key can also be used for this purpose.

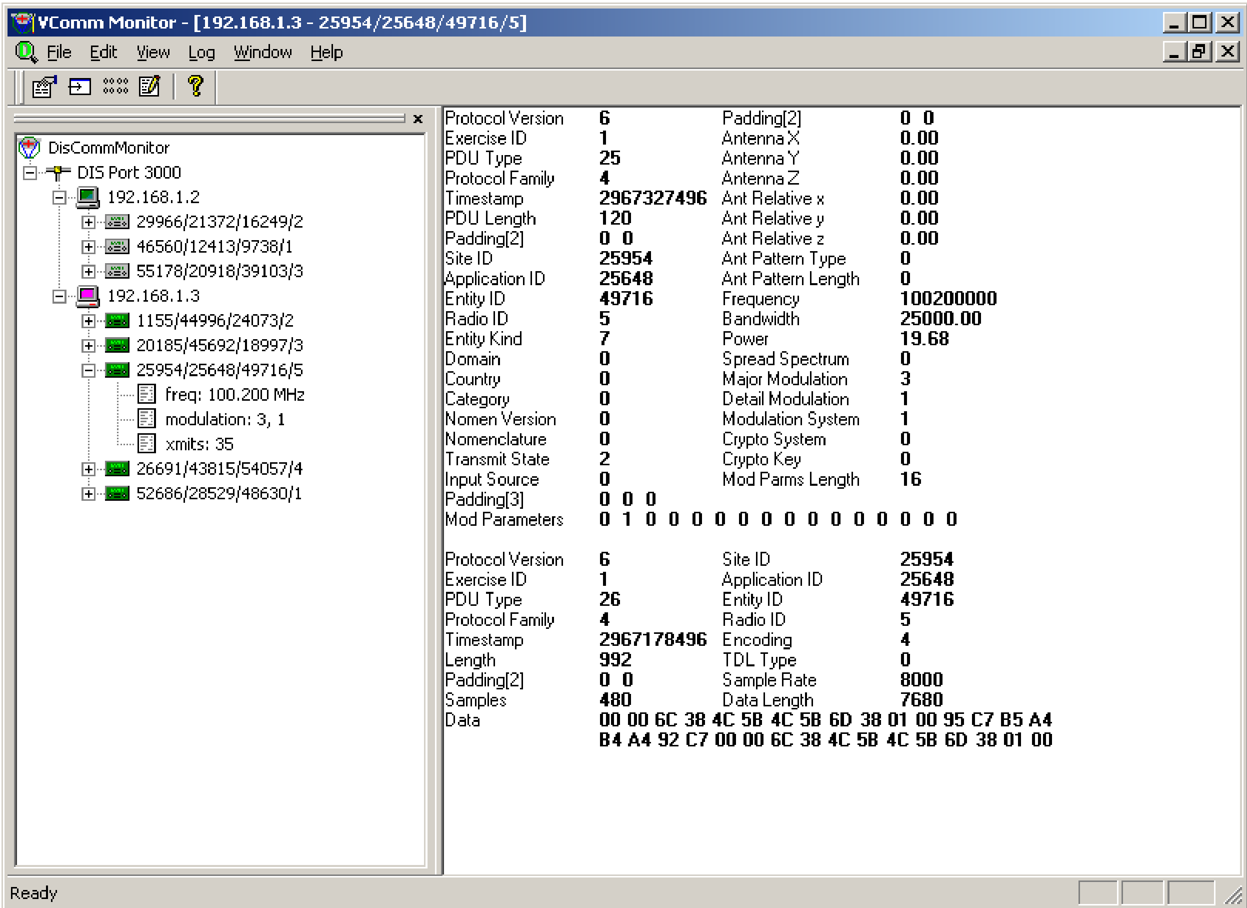


Figure 76, VComm Monitor

24 Instrumentation

A number of Performance Counter data is available in VComm which can be monitored using the systems performance monitor. The performance monitor can be launched from the Windows XP control panel, under Administrative Tools by selecting **Performance**. It can also be started clicking **Start » Run**, typing `perfmon` and clicking **OK**. All data collected is from all exercises that are arriving on the port established in the VComm configuration. Figure 77 is a snapshot of the Performance Monitor tool.

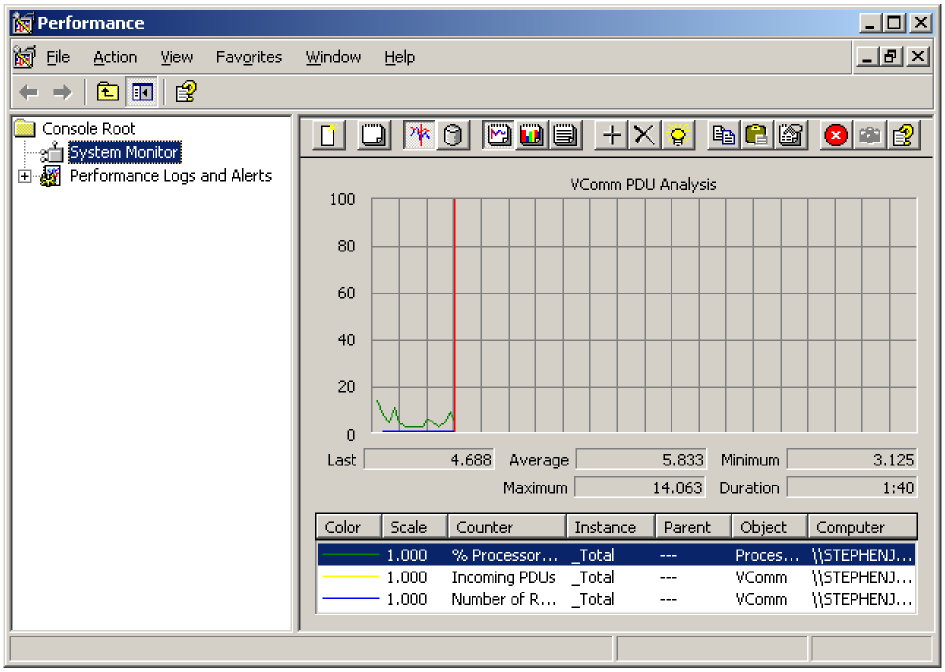


Figure 77, Performance Monitor

To use the VComm counters in Perfmon, open the Perfmon application as shown above, right-click on the display area, and select **Add Counters…**. This will activate a window shown in Figure 78. Click the drop-down list under **Performance Object** and select the VComm item. This activates the list shown below in the red circle.

Note: *V+ must be running in order for the VComm item to be available in the **Performance Object** list.*

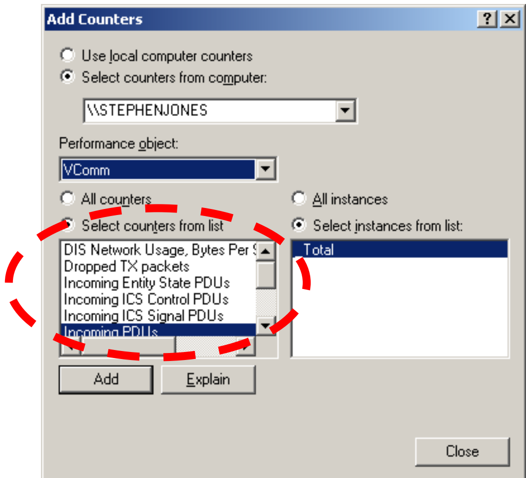


Figure 78, Performance Monitor Add Counter Window

The following counters can be displayed for VComm:

- Incoming PDUs
- Outgoing PDUs
- Dropped TX packets
- Incoming Transmitter PDUs
- Incoming Signal PDUs
- Incoming Entity State PDUs
- Number of Network Transmitters for First Radio
- DIS Network Usage, Bytes Per Second

24.1 Number of Network Transmitters for First Radio

This is a number used for internal diagnostics, and is the number of network transmitters that the first radio (execution order) in V+ has in its internal array of radios which it “sees” on the network.

24.2 DIS Network Usage, Bytes per Second Counter

With regard to the DIS Network Usage, Bytes Per Second counter, local PDUs being transmitted will also be counted as incoming packets. Unless the system is in Entity Attach Mode, entity state PDUs will not be counted, even though they may be present on the network.

24.3 Latency Performance

One of the most important DIS/HLA voice communications equipment performance criteria is audio transport delay. This is the delay over a network from a given voice input, such as a microphone, to an output, such as a headset over a network. Typical VComm transport delays for an ordinary computer, network card, and network is 65ms. The screen shot in Figure 79 portrays a recording of a microphone on one computer followed by the headset output on another. The audio stream parameters for this test were as follows:

Encoding:	16 bit PCM
Sample Rate:	8,000 Hz
Buffer Size:	480 Samples

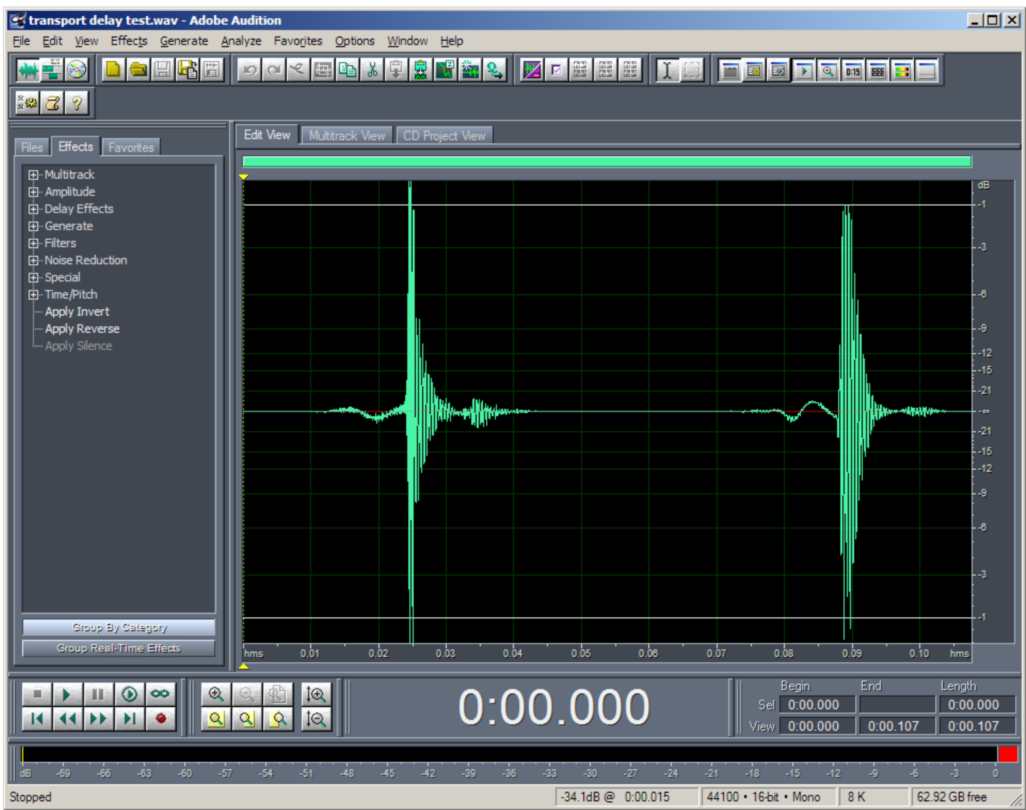


Figure 79, VComm Latency Performance

25 Initialization datapool

This section was installed in the system registry but has been moved to a Vdx datapool named "VComm Initialization Datapool" which is created from the XML fie, "VCommInitData.xml". Tis file can be edited by hand or via the Vdx application. The file contains the initial values. This file is used to initialize data in VComm when VComm is loaded. In V+ VComm is loaded each time the system is started. To edit data, stop V+, edit the initial value and restart V+. This datapool only affects initialized data.

Table 30, Initialization Datapool

Value	Description
useWasapi	This data is sued to select the input streaming system for Windows 7 to use MMI or WASAPI. 0 = Use MMI input streaming, 1 = Use WASAPI input streaming. The default is set to 1
useMMCSS	This variable is used to select the high performance mode of Windows 7 WASAPI streaming. 0 = Do not use MMCSS, 1 = Use MMCSS The default is set to 0
PCM16isBigEndian	Determines whether the 16-bit PCM compression scheme (4) uses Big or Little Endian byte order for audio in the signal PDU. The key is installed and set to 1 by default. If the datapool value is 0 or missing, the byte order will be set to Little Endian format. If the value is 1, the byte order will be set to Big Endian format. This is the default setting after installation.
DisFreqFilter	This key turns on or off the frequency filter for DIS radios. A frequency filter avoids processing of radios that VComm cannot receive by processing only those radios that have a frequency that falls within our receiver frequency +/- 4 times the radio receiver bandwidth. 1 = frequency filter active 0 = frequency filter inactive
HlaFreqFilter	This key turns on or off the frequency filter for HLA radios. A frequency filter avoids processing of radios that VComm cannot receive by processing only those radios that have a frequency that falls within our receiver frequency +/- 4 times the radio receiver bandwidth. 1 = frequency filter active 0 = frequency filter inactive

Table 30, Initialization Datapool

Value	Description
enableDithering	This key determines whether signal dithering is applied to incoming radio signals. If this value is 0 or missing from datapool, signal dithering is disabled. If this value is 1, signal dithering is enabled.
SquelchTailAtten	This is the value of the attenuation of the default squelch tail amplitude. This value is expressed in dB of attenuation. Therefore 100 would indicate that there would be an attenuation of 100 dB, which would result in virtually no squelch tail being generated. If this variable is missing from datapool, a value of 6 is used internally. Note that 6 dB will appear to be half volume and is the default value for the entry. This value is installed and set to 6 by the installation default.
cryptoTonesAtten	This is the value of the attenuation of the default crypto tones amplitude. This value is expressed in dB of attenuation. Therefore 100 would indicate that there would be an attenuation of 100 dB, which would result in virtually no crypto tones being generated. If this variable is missing from datapool, a value of 6 is used internally. Note that 6 dB will appear to be half volume and is the default value for the entry. This value is installed and set to 6 by default.
radioNoiseAtten	This is the value of the attenuation of the simulated radio background noise. This value is expressed in dB of attenuation. Therefore 100 would indicate that there would be an attenuation of 100 dB, which would result in virtually no background noise generated. If this variable is missing from datapool, a value of 0 is used internally. Note that 6 dB will appear to be half volume and is the default value for the entry. The radio background noise level is computed by a model and changes as a function of many variables. Be sure that you understand the model before reducing the background noise level. Note that ICS objects do not have simulated background noise at all. This value is installed and set to 6 by default.

Table 30, Initialization Datapool

Value	Description
RadioEntityCatagoryTypeFilter	This variable determines if VComm will filter incoming radios based on the content of the Radio Entity Type category field. If this value is 0 or missing from datapool then no filtering is performed on the Radio Entity Type category field. This is the default setting. If this value is non-zero, then filtering is performed on the Radio Entity Type category field. Only radios with a Radio Entity Type category of 1 or 3 will be received.
FilterOwnEntityPDUs	This variable determines if radio communications will be enabled between radios that have the same DIS Site, Application and Entity IDs and the same for HLA. If this value is zero (0) or missing from the VCommInitData.xml file, communication is enabled between radios on the same entity. This is the default setting. If this value is non-zero, then communications are not possible between radios on the same entity. This setting has no effect on simple intercoms as communications between simple intercoms on the same entity are always enabled. Typically an aircraft with multiple radios share the same entity ID value with the radios on that entity, such as aircraft with a VHF 1 and VHF 2, etc. If this value is set to one, transmitting on VHF1 will not be heard on VHF 2 in this example.
UseSignalQualityService	This variable determines which type of server VComm will use: terrain server or signal quality server. VComm uses different messages from the Remote Message Protocol defined in the VComm Signal Quality Service Specification based on the setting of this key. If this value is 0 or missing from datapool, VComm will use terrain server messages. If this value is non-zero, VComm will use signal quality server messages.
signalLossAtMUF	Loss in dBm at the maximum usable frequency for HF radios. The default value is -120 dBm.
applyAmInterference	This variable determines if AM/AM interference will be generated if conditions exist for this effect. If this value is 0 or missing from datapool, the effect will not be generated. This value is installed and set to zero at installation, turning off this effect by default.

26 Registry Settings

A number of registry entries are used by VComm and are documented below. Use caution when editing registry variables. The operating system determines where these keys are located. Some entries have been moved to Vdx datapools.

26.1 Native Platform Registry Key

Note that this is a different parent key than the previous sections.

1. Windows XP Win32 Professional
   Windows 7 Win32 Professional
   a. HKEY_CURRENT_USER\SOFTWARE\SimPhonics\VComm\MISC\
2. Windows 7 Win64 Professional
   a. HKEY_CURRENT_USER \SOFTWARE\Wow6432Node\SimPhonics \VComm\MISC\

Table 31, Native Platform Registry Key

Entry	Type	Description
enableLogFile	DWORD	This value determines if the V+ Run-time system logs the message window to a log file. If the value is greater than 0 then the log file is created and logged, if the value is 0 then the log file is not created and logged. See the V+ User Manual for details. This key is installed with V+ installation and turned ON (00000001) by default.

26.1.1 VPLus Key

This key is located at the following location depending on the operating system. Note that this is a different parent key than the previous sections.

1. Windows 7 Win32 Professional
    a. HKEY_LOCAL_MACHINE\SOFTWARE\SimPhonics\VPLus\
2. Windows 7 Win64 Professional
    a. HKEY_LOCAL_MACHINE\SOFTWARE\Wow6432Node\SimPhonics\VPLus\
3. Windows XP Win32 Professional
    a. HKEY_LOCAL_MACHINE\SOFTWARE\SimPhonics\VPLus\

Table 32, Network Registry Key

Entry	Type	Description
HlaEnableSwitchDefault	DWORD	This value determines if the V+ Run-time system starts with the HLA Join at Startup switch active or inactive in the Configure menu, Networked Audio tab. This does not affect the HLA Join at Startup state when loading a .vne file. If the value is greater than 0 then the HLA Join at Startup switch will be active *(checked)*, otherwise the HLA Join at Startup switch will be inactive *(unchecked)*. This key is not installed with V+ installation kit. To use it, the user must create the key and set the value.
MAK13ExtInstalled	DWORD	This key determines which HLA DLLs will be used by VComm when VComm is executing in V+. This key is installed by the SimPhonics software, HLA 1.3 Extensions and set to one which signals VComm to use the RTI vendors HLA DLLs. If set to zero or not installed, VComm will use HLA DLLs that are part of V+ only to satisfy the need link to them.

27 Wavefile PTT Analysis Utility

This application is a command-line utility that analyzes wavefile recordings of voice transmissions from a receiver and produces a file of comma delimited data representing Push-To-Talk) PTT information which shows the PTT events discovered in the wavefile along with the duration of each transmission event. This data can be useful for determining a number of criteria, including the frequency utilization and congestion.

27.1 Command line usage

The "Wavefile Path" is required. The output text file name will be the same as input wavefile filename with a ".txt" extension appended to the end. For example, if the source file is named REC3.WAV, the output text file will be REC3.WAV.TXT. The command-line syntax is simple. The name of the tool, WAVTOPTT is followed by the complete pathname of the wav-file as shown in Figure 80.

Figure 80, Wavefile PTT Analysis Tool

The input file must be recorded in 16-bit PCM MONO format as any other format will cause an error. The wavefile shown in Figure 81 will produce a text output file shown in Figure 82. The first column in the text file is the start time of a transmission. The second column is the length of the transmission. The units for both of these columns are in seconds.

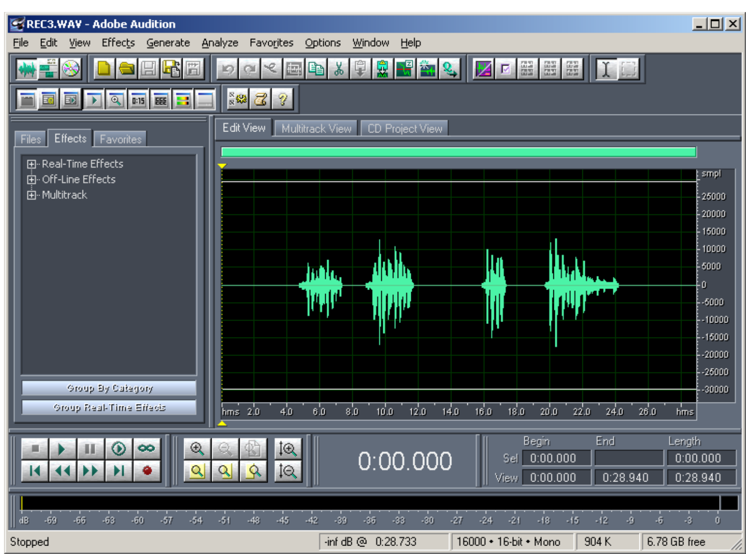


Figure 81, Wavefile Input

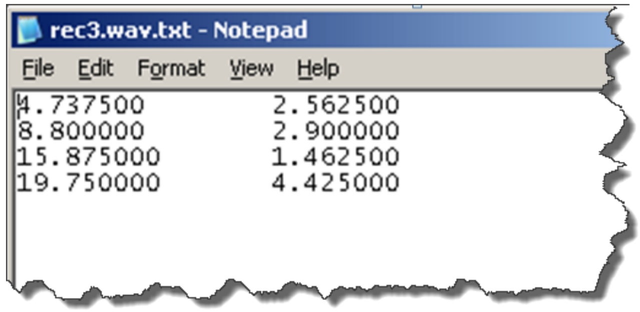


Figure 82, Wavefile PTT Analysis Tool Output File

28 Miscellaneous Notes

28.1 Radio Handle

The RADIO HANDLE output on most VComm radios is an internally generated number and is unique for each radio. Objects that require a radio handle input should be connected to this output. The value present on the pin at run-time is not the same as radio ID.

28.2 Transmitter PDU Padding

Padding fields are always set to zero by VComm. Other vendors may fill these values and should be ignored. For example, on vendor inserts the ASCII values of “AST” or “PCV” in the last three padding bytes of the transmitter PDU depending on the equipment just before the modulation parameters. Padding fields should be set to zero according to the DIS standard. VComm sets padding fields to zero on transmit and ignore the padding fields on receipt.

28.3 Troubleshooting

Be sure to have the latest version of VComm. There have been many problems corrected in VComm over time. To view the problems that have been corrected, interoperability issues, and new features that have been added, see the V+ Release Notes clicking
Start » Programs » V+ » Docs » V+ Release Notes.

1. Sound Card Settings

    a. If VComm is not being used with SimPhonics' SMx system and you're using a sound card, most problems are associated with the settings of the sound card. Ensure that you can record and playback your microphone audio by using the Windows recorder (click ***Start » Programs » Accessories » Entertainment » Sound recorder*****).** Before you can use VComm you must be able to record and playback an audio file using your intended headset and microphone. Most problems are with the settings of the microphone in the recording section of the Windows Audio Mixer. If the audio is OK, then check the network. With VComm running with your radios active, run the VComm Monitor program and verify that it can "see" your radios on the network. Be sure to run VComm Monitor on all computers where the trouble is experienced.

2. Radio Static Value "Send To Network, wrong value

    a. VComm can be used for DIS, HLA or both by setting the VComm Radio Send to Network mask. This value determines which of these networks or "modes" the radio will use. Be sure to check this value when loading a sample or a design someone else has created. If the radio is being used for a sample or test in DIS, the value must be 1. If it is setup for HLA, one could easily miss the correct value and try to connect to DIS, only to find that nothing happens when V+ is started as the radio is waiting on an RTI.

3. Radio Identifiers Not Unique

    a. One common error is to assign two radios the same Radio Identifier (*Site Number, Application Number, Entity Number, and Radio ID*) on two different computers which will result in neither radio working. Do not assign IDs unless you have to, since these will be generated automatically if left at zero. Often in large exercises radios from many independent sites are operating, and in these cases multiple radios sometimes have the same Radio Identifier.

4. Setup Common Settings

    a. Set the encoding scheme to mu-law (1) and a sample rate to 8000 Hz. if you're having problems with incoming or outgoing audio being noisy or distorted. Some vendor applications do not covert sample rates properly or simply ignore the compression scheme and interpret the audio in the way the equipment is setup. In these cases you have to experimentally determine the best encoding scheme.

5. Try talking to Yourself

    a. If you can't communicate with another application or computer, try talking to yourself using two radios on the same computer. The SimPhonics web site has a number of

VComm samples that will work in this case. If you can talk to yourself but not to another computer, then there may be a network problem.

6. Need at Least One Audio Device

    a. VComm requires at least one audio device to operate. If no audio devices are found during pre-execution of V+, the system will not start and issue an error that the device number does not exist.

7. One Ethernet Connection is Required

    a. In order to VComm to send and receive networked audio, there must be a network attached to a Network Interface Card on the computer. In cases where there is no network cable to connect to the computer, and your using the computer to test VComm components, you must have an active network connection. Setting up a loopback IP address will not work. The NIC must be active with a valid IP address.

8. More than one Ethernet Connect can be a Problem

    a. If VComm receives two identical packets an echo, or other problem may occur. Two Ethernet cards can cause this.

9. Automatic Radio Identifier

    a. If you notice that radio identifiers are large numbers (i.e. around 65000) then these are most likely automatically generated by VComm.

10. An Echo is heard

    a. If an echo is present it is likely a radio is receiving your own transmission. The microphone signal is being routed back to the system headset or speaker via the network.

    b. Two identical network packets arriving at the computer can cause an echo or other problems. Two identical packets could be caused by multiple network cards (multi homed computer) transmitting or receiving on the network could cause echoes.

11. Audio is pitch shifted up or down (Donald Duck or Mickey Mouse Sound)

    a. This is caused by some vendor equipment that does not properly convert incoming digital audio correctly. Some vendors do not correctly convert the incoming digital audio sample rate from VComm and attempt to decode the audio with the sample rate set on their GUI rather than what the signal is telling their system. This is a known problem with some vendor equipment. You must change VComm to send them a sample rate that their equipment can receive. A sample rate of 8,000 Hz and using Mu law, is a sample rate and encoding scheme that all systems must support according to the DIS IEEE 1278.1 standard.

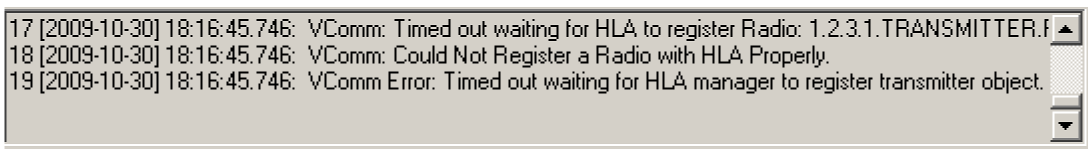
12. Our transmissions are much louder than others to some receivers

   a. This is a common problem that is caused by some vendor equipment setting their audio levels too low for transmission. This problem will not occur with VComm incoming audio since VComm levels the audio automatically. Other vendor equipment may not level the audio correctly. When this occurs decrease the transmitter audio level by reducing the gain of the microphone. (audio input) This can be done with the onboard mixer of off the shelf sound cards, or via the SMx AI to WI mixer.

13. Cannot Communicate with via HLA

    a. The most common cause of HLA problems are RID file parameters being set wrong. See section 28.3.1 Sample HLA MAK RID File and use that file for your initial testing.

    b. Read the V+ Run-time system message window or see the log file. Most errors are reported here if possible. The following error is an object that did not register with the RTI, due to the ID being the same as another radio.



14. A Short Burst of noise is heard at the beginning of the reception.

    a. This is caused by the timing difference between receiving a Transmitter PDU indicating that the Transmitter is on and transmitting and the reception of a Signal PDU audio stream. If this time delay is great than 60ms, a burst of noise will be heard at the onset of a signal coming in. If the source cannot correct the problem, a newer version of VComm, Build 368 has a new feature that will correct this. A potential problem exists however. If the incoming signal is a simulated noisy signal, the first part of the incoming signal will be muted even though it should be noisy.

15. Using remote desktop

    a. In general use caution when remotely controlling a VComm based system as the audio devices can be reassigned at runtime. Remote Desktop has been known to cause VComm to hang or crash for no apparent reason.

    b. Leave the audio devices at the remote computer This is set to “Bring to this computer” by default and will cause the sound resources to be exposed on the machine that is starting the remote desktop session and not on the remote computer.

16. Cannot Communicate with via HLA

The most common cause of HLA problems are RID file parameters being set

28.3.1 Sample HLA RID File

Here is a sample RID file that should get you going. Be sure to read the RTI Vendor User Manual sections for the RID file parameters. These variables are RTI specific although some are common across RTI vendors. Refer to the RTI vendors’ reference materials for more information on RID file variables, and their default values.

```
;;///////////////////////////////////////////////////////////////////
;;
;; SimPhonics, Inc. RID File, Basic Setup for Testing
;;
;;///////////////////////////////////////////////////////////////////

(setqb RTI_checkFlag                                    1)
(setqb RTI_destAddrString                "255.255.255.255")
(setqb RTI_useRtiExec                                   1)
(setqb RTI_internalMsgReliable                          0)
(setqb RTI_fomDataReliable                              0)
(setqb RTI_udpPort                                   4000)
(setqb RTI_enableInteractionAdvisory 1)
(setqb RTI_enableClassAdvisory 1)
(setqb RTI_tcpForwarderAddr "127.0.0.1")

(setqb RTI_enableRtiexecGUI 1)
(setqb RTI_enableRtiexecGUIConsoleLog 0)
(setqb RTI_enableLrcGUI 1)
(setqb RTI_enableNetworkMonitoring 1)
(setqb RTI_logNetworkMonitorStatistics 0)

;; Diagnostic Configuration

(setqb RTI_notifyLevel 2)
(setqb RTI_logFileName "HlaLrcRtiLog.log")
(setqb RTI_reuseLogFile 1)
(setqb RTI_dumpFed 0)
(setqb RTI_enablePopUpErrorMsgs 0)       ;; This must be set to 0 to avoid
                                         ;; popup error windows requiring a
                                         ;; user mouse click to continue.
```

28.4 Known Problems

SimPhonics continuously strives to provide trouble free software. During the course of software development new features are being added and reported problems are being corrected in each build. VComm is constantly being improved which means that as of this writing, VComm has been released many times. The following section lists known problems. Contact SimPhonics if you are experiencing a problem and SimPhonics engineering will assist in determining if this is a real issue requiring the generation of a problem report. Table 33 shows the known problems.

Table 33, Known Problem

Problem Report Number	Description of Problem
VCOMMPR 358-001	**Problem** Radio or ICS will not transmit after the Exercise ID or Frequency is set to zero and back to valid value while PTT is active.

	Detailed Description The exercise ID or frequency of radios or ICS objects cannot be set to zero and back to a valid value when the PTT is active or the radio or ICS will not transmit. While in this mode the PTT has to be cycled off and back on in order for the transmitter to become active again. This is a known problem.
	Workaround The workaround is to not allow the exercise or frequency pins to go to zero, or not allow the PTT to be active when this occurs.
	Example For example, this problem is most obvious when ICS objects are used between two operators and one of the operators is switching between channels that are being monitored by the other operator. The physical switch allows a zero when switching from one channel to another while the operator microphone is in hot mic mode. In this situation the ICS object for the operator with the switch will stop transmitting until the PTT is cycled when switching between channels.

1. A Short Burst of noise is heard at the beginning of the reception.

   a. This is caused by the timing difference between receiving a Transmitter PDU indicating that the Transmitter is on and transmitting and the reception of a Signal PDU audio stream. If this time delay is great than 60ms, a burst of noise will be heard at the onset of a signal coming in. If the source cannot correct the problem, a newer version of VComm, Build 368 has a new feature that will correct this. A potential problem exists however. If the incoming signal is a simulated noisy signal, the first part of the incoming signal will be muted even though it should be noisy.

29 Definition of Terms

Table 34 provides a list of terms used in this document and describes their meaning. Some of the descriptions are hyperlinks to web sites that have complete descriptions and are printed in color as a light blue.

Table 34, Definition of Terms

Term	Description
ADPCM	Adaptive Differential Pulse Code Modulation
AGC	Automatic Gain Control
ANDVT	Advanced Narrowband Digital Voice Terminal
API	Application Programming Interface
AWACS	Airborne Warning And Control System
AERP	Average Effective Radiated Power
CAF DMO	Combat Air Force Distributed Mission Operations
CCITT	Comité Consultatif International Téléphonique et Télégraphique
CCTT	Close Combat Tactical Trainer

Table 34, Definition of Terms	
Term	**Description**
CECOM	Communications and Electronics Command
CNR	Combat Net Radio
CODEC	Coder/Decoder; Compressor/Decompressor
CPU	Central Processing Unit
CVSD	Continuous Variable Slope Delta
dB	Decibel
dBm	Decibel milliwatts
DEM	Digital Elevation Model
DHCP	Dynamic Host Control Protocol
DIS	Distributed Interactive Simulation
DLL	Dynamic-Link Library
DMSO	Defense Modeling and Simulation Office
DOD	Department Of Defense
DSP	Digital Signal Processor
DTED	Digital Terrain Elevation Data
ECEF	Earth Centered Fixed Cartesian
EPM	Electronic Protection Measures
FED	Federation Execution Data (HLA Specific File)
FOM	Federate Object Model (HLA Specific Term)
FMT	Frequency Managed Training
GPS	Global Positioning System
GSM	Global System for Mobile communications
GUI	Graphical User Interface
GUID	Globally Unique Identifier
HLA	High Level Architecture
HHT	Hand Held Terminal
HQ	HAVE QUICK
Hz	Hertz
I/O	Input/Output
ISA	Industry Standard Architecture
IP	Internet Protocol
JETDS	Joint Electronics Type Designation System
KHz	Kilohertz
KTB	Thermal Noise
LOS	Line of Sight
LRC	Local Runtime Component (HLA Specific Component)
MFC	Microsoft Foundation Classes
MHz	Megahertz
Mbps	Megabits Per Second
ms	Milliseconds
MUF	Maximum Usable Frequency
MONO	Monographic
MWOD	Multiple Word-Of-Day
NIC	Network Interface Card
NEXTCOM	Next Generation Communications System
NSVE	Narrow Spectrum Secure Voice
PCM	Pulse Code Modulation
PDU	Protocol Data Unit
POTS	Plain Old Telephone System
PTT	Push-To-Talk
RF	Radio Frequency
RID	RTI Initialization Data (HLA Specific File)
RMS	Root Mean Square

Table 34, Definition of Terms	
Term	**Description**
RPR	Real-time Platform Reference
RTI	Run Time Infrastructure
Sidetone	Sidetone in a radio (or intercom) is the effect of sound being picked up by a headset's microphone and reproduced in the headphones of the same headset, acting as feedback indicating that the radio is actually transmitting.
SINAD	Signal to Noise and Distortion
SINCGARS	Single Channel Ground and Airborne Radio System
SINCGARS ICOM	SINCGARS Integrated Communications Security
SISO	Simulation Interoperability Standards Organization
SND	Signal to Noise Distortion
SNR	Signal to Noise Ratio
SSB	Single Sideband
TBD	To Be Determined
TCP	Transmission Control Protocol
TOD	Time-Of-Day
TTL	Time-To-Live
µs	Microseconds
UDP	User Datagram Protocol
UTC	Universal Time Coordinated
USB	Universal Serial Device
VCRMI	VComm Remote Management Interface
VNE	VPLus Native platform Executable
VQ	Vector Quantization
VoIP	Voice over Internet Protocol
VOX	Voice Operated Switch
VSF	VComm Signal File
VTP	Variable Transmitter Parameters
VTS	VComm Terrain Server
WGS84	World Geodetic System 84
WOD	Word-Of-Day
WSVE	Wide Spectrum Secure Voice
Z	Impedance

30 Index