Audio for VATSIM
User Guide

0   Preface

0.1   Record of Amendments

Rev. No	Date Entered	Amended By
2	11 Oct 19	Simon Kelsey
3	13 Oct 19	Simon Kelsey
4	29 Oct 19	Simon Kelsey
5	27 Mar 20	Simon Kelsey

0.2   Revision Highlights

Revision 5, March 2020

3.1.2.2 Mac and Linux-based Pilot Clients
Revised to clarify that XSquawkbox now features AFV native integration for Mac users.

3.2.1.4 xSquawkbox for X-Plane
Revised to reflect native AFV integration in XSB 2.0+

Revision 4, October 2019

3.2.1.3 swift
Added line to clarify that FSUIPC is required if the AFV standalone is used with FS9/FSX/P3D.

3.2.1.5 Non-Supported Clients - Squawkbox 4 for FS9/FSX, FSINN
Added section to clarify that FSUIPC is required.

3.2.3 AFV Client Configuration
Added detail for 'Use FSUIPC with FS9/FSX/P3D' checkbox.

4.2.3 Amplitude
Corrected image and text.

4.4.3 SELCAL
Corrected SELCAL syntax in 4.4.3.2 VATSIM Implementation to clarify that a hyphen is required between the SELCAL letter groups.

5.3.5 UNICOM and Air to Air Communications
Clarified 122.800 MHz effective range.

5.4.3.1 VHF Aliasing
Clarified how VHF aliases work

6.3.1 Monitoring or Observing Other Stations
Added caution note regarding the XC button

Revision 3, October 2019

3.1 System Requirements
Added details of supported operating systems and requirement for .NET Framework 4.7.2.

3.2.1.3 Swift

Updated text to reflect AFV support now integrated in swift from v0.9.3.

Revision 2, October 2019

3.2 Installation

Amended to clarify that swift users will initially be required to use the AFV Standalone Client.

3.2.2 Controllers

Added detailed instructions for Euroscope, VRC and vERAM/vSTARS

FAQs – Controllers

Added FAQ "Can I use AFV during Sweatbox training sessions?"

3.2.1.3 Swift

Contents

1   Introduction

1.1   System Description

The Audio for VATSIM (AFV) system represents a step change in voice communication on the VATSIM network. For the first time, users can enjoy a high fidelity radio simulation encompassing Very High Frequency (VHF) and High Frequency (HF) communications, complete with realistic audio effects, range-based degradation and transceiver behaviour. Far more than just a simple codec change, AFV is a brand new voice system, built from the ground up with the aims of improving the clarity and intelligibility of VATSIM voice communications, minimising latency and increasing realism.

Audio for VATSIM removes the concept of 'Voice Rooms' where a controller hosts a specific channel on a specific server which all pilots tuned to their frequency automatically connect to. Instead, the system functions exactly like a real aeronautical radio. Pilots can tune to and transmit voice on any discrete frequency, regardless of whether a controller is available or not: the transmissions will be heard by any other station within radio range and tuned to the same frequency.

In turn, ATC stations rely on ground-based Air-Ground-Air (AGA) transceivers to communicate with pilots. Just as in reality, correct configuration and placement of these transceivers is essential in order to ensure reliable reception for pilots and controllers alike. In order that all pilots will receive a consistent experience when contacting an ATC unit, these transceivers will normally be pre-configured for each Flight Information Region (FIR) by locally-designated Facility Engineers, although there are provisions in place to ensure that controllers are able to provide service even if their region's transceivers have not been pre-configured.

This manual is intended to provide a comprehensive overview of the system's function and operation and serve as a reference for the development of further training materials.

1.2   Credits

1.2.1   The AFV Team

Gary Oliver
Project lead, clients, audio effects

Mark Barnes
Server development & architecture

Néstor Pérez
Web Artisan

Simon Kelsey
Documentation, audio effects, Facility Engineers

1.2.2   VATSIM Development Team

Aidan Stevens
VP Web Services

Matthew Cianfarani
VP Network Systems

Ross Carlson
vPilot, vSTARS, vERAM

Justin Shannon
xPilot

Gergely Csernák
EuroScope

Roland Roßgotterer
swift

1.2.3 Special Thanks

Matt Bartels

Gunnar Lindahl

Team Green – The AFV Core Beta Team

Adrian Bjerke	Jakob Arne Bronstad	Michael Benson
Alberto Manzoni	James Horgan	Morten Jelle
Alessandro	Johannes Beck	Mungo Spencer
Buscaglione	Jonathon Vaughan	Nathan Davies
Alessio Nola	Joshua Seagrave	Nathaniel Leff
Alex Beavil	Karl Brooker	Nicholas Cavacini
Andreas Manum	Kian Andrews	Nick Marinov
Andrew Doubleday	Kian Smith	Niels Voogd
Andrew Morkunas	Kenneth Haught	Norman Blackburn
Ben Cook	Krister Larsen	Phil Dowling
Ben Smith	Krikor Hajian	Philipp Schubert
Ben Wright	Kyle Bjorklund	Phillip Speer
Boaz Lev	Kyle Weber	Pranav Chandramouli
Bork Johnsen	Lance Harry	Raefn Webber
Chris Wilkinson	Layth Al-Wakil	Riyad McCollin
Ciaran Breen	Lee Roberts	Robert Shearman Jr
Ciaran Longmuir	Lewis Gilkes	Ryan Geckler
Dan Parkin	Liam Giles	Sam Nagy
Daniel Crookes	Lorenzo Nesta	Samuel James
Dave Roverts	Loui Ringer	Sebastian Rekdal
Dean Johnston	Louie Lister	Shane Vanhoven
Derek Troy	Luke Brown	Shehryar Ansari
Dhruv Kalra	Magnus Meese	Simon Irvine
Dominic Temple	Maius Wong	Simon Lund
Elliott Fowler	Mark Walsh	Steven Peterson
Ernesto Martinez	Martin Jacobsen	Thomas Parker
Fabrizio Pascucci	Martin Tornberg	Tim Barber
Fergus Walsh	Matheson Shenher	Tim Evans
Fraser Cooper	Mats Edvin Aaro	Tim Mitchell
George Barlow	Matt Bozwood-Davies	Tom Earl
George Peppard	Matt Smith	Tom Stian Bjerk
Harrison Grose	Matt Weddell	Tom Szczypinski
Hoo Jiong Sheng	Matthew Collier	Werner Rafteseth
Hubert Okon	Matthew Kramer	Wycliffe Barrett

2   Definitions

A/A	Air to Air
ACC	Area Control Centre
ACP	Audio Control Panel
AFV	Audio for VATSIM
A/G	Air to Ground
AGA	Air-Ground-Air
AGL	Above Ground Level
AM	Amplitude Modulation
AMSL	Above Mean Sea Level
APP	Approach Control
ARTCC	Air Route Traffic Control Centre
ATC	Air Traffic Control
ATM	Air Traffic Manager
ATCO	Air Traffic Control Officer
ATS	Air Traffic Service
ATSU	Air Traffic Service Unit
COM	Communications
CTAF	Common Traffic Advisory Frequency
CTR	Centre
DATM	Deputy Air Traffic Manager
DEL	Clearance Delivery
DEP	Departure Control
DTMF	Dual Tone Multi Frequency
FE	Facility Engineer
FIR	Flight Information Region
FL	Flight Level
FM	Frequency Modulation
FSS	Flight Service Station
ft	Feet

GCO	Ground Communication Outlet
G/G	Ground to Ground
GND	Ground
HF	High Frequency
Hz	Hertz
in	Inch(es)
kHz	Kilohertz
LOS	Line of Sight
m	Metres
MHz	Megahertz
MSFS	Microsoft Flight Simulator (i.e. FS9/FSX etc)
MSL	Mean Sea Level
NM	Nautical Miles
OACC	Oceanic Area Control Centre
OBS	Observer
PSTN	Public Switched Telephone Network
PTT	Push To Talk
RCAG	Remote Communication Air Ground
RCO	Remote Communications Outlet
RF	Radio Frequency
RTF	Radiotelephone or Radiotelephony
RTR	Remote Transmitter Receiver
RX	Receive (or Receiver)
SDK	Software Development Kit
SELCAL	Selective Calling
SiT	Simultaneous Transmissions
SNR	Signal to Noise Ratio
TWR	Tower
TX	Transmit (or Transmitter)
UHF	Ultra High Frequency

UNICOM	Universal Communications
USiT	Undetected Simultaneous Transmissions
vACC	Virtual Area Control Centre
VATSIM	Virtual Air Traffic Simulation Network
VCCS	Voice Communication Control System
vERAM	Virtual En Route Automation Modernization
VHF	Very High Frequency
VOIP	Voice over Internet Protocol
VRC	Virtual Radar Client
vSTARS	Virtual Standard Terminal Automation Replacement System

3 AFV Initial Setup and Configuration

3.1 System Requirements

3.1.1 AFV Standalone Client

3.1.1.1 Supported Operating Systems

The AFV Standalone Client requires .NET Framework 4.7.2 to be installed. This means that only the following operating systems are supported:

- Windows 7
- Windows 8.1
- Windows 10+

The .NET 4.7.2 runtime installer can be downloaded from
https://dotnet.microsoft.com/download/dotnet-framework/net472

Note that Windows 8.0 does **not** support .NET 4.7.2 and therefore AFV is not compatible with Windows 8.0.

Windows 8.0 users are recommended to upgrade to Windows 8.1 or Windows 10 in order to use AFV.

3.1.1.2 Non-Windows Users

Some success has been reported running the AFV Standalone Client under WINE using the following instructions:

1. Install brew (https://brew.sh/)

2. Download AFV installer and save it somewhere.

3. Install wine via brew (brew install wine)

4. Install winetricks via brew (brew install winetricks)

5. Create a wineprefix (mkdir ~/.wine/ && mkdir ~/.wine/afv && WINEPREFIX=~/.wine/afv wineboot --init)

6. Install .NetFramework 4.7.2 (WINEPREFIX=~/.wine/afv winetricks dotnet472) **Warning:** This might take a really long time, because it must first install previous versions.

7. WINEPREFIX= ~/.wine/afv wine <pathtoAFVinstaller>

8. Install normally.

9. WINEPREFIX= ~/.wine/afv wine pathtoinstalledAFV

Known bugs:

- You need to have the AFV Standalone window in focus in order to use keyboard PTT.

The workaround is to use a joystick button PTT which does not have this limitation.

3.1.2   Pilot Clients

3.1.2.1   Windows-based Pilot Clients

On Windows installations, the AFV libraries require .NET Framework 4.7.2 to be installed. Therefore all Windows-based AFV-compatible pilot clients are subject to the same system requirements outlined in 3.1.1 above for the standalone client.

3.1.2.2   Mac and Linux-based Pilot Clients

Mac and Linux users may run *XSquawkbox* or *swift,* both of which come with AFV native integration out of the box.

Refer to the *swift* and *XSquawkbox* system requirements page for details of the minimum requirements to run these programs with AFV integration under non-Windows operating systems.

https://dev.swift-project.org/w/help/installation/system-requirements/

https://xsb2-manual.readthedocs.io/en/latest/getting-started.html#system-requirements

3.2   Installation

3.2.1   Pilots

For the most part, AFV is entirely integrated in to your pilot client software (e.g. vPilot, xPilot, swift). If your client has been updated to support AFV then there are no specific installation instructions: simply ensure that you have updated your pilot client to the latest available version.

A list of pilot clients and the AFV installation required for each is detailed below.

3.2.1.1   vPilot

AFV is fully integrated with vPilot.

The only installation required, therefore, is to ensure you have updated vPilot to the latest version.

3.2.1.2   xPilot for X-Plane

AFV is fully integrated with xPilot for X-Plane.

The only installation required, therefore, is to ensure you have updated xPilot to the latest version.

3.2.1.3   swift

The latest Alpha version of *swift* has AFV fully integrated and is recommended.

3.2.1.4   xSquawkbox for X-Plane

AFV is fully integrated in xSquawkbox from v2.0 onward.

The only installation required, therefore, is to ensure that you have updated xSquawkbox to the latest version.

3.2.1.5 Non-Supported Clients - Squawkbox 4 for FS9/FSX, FSINN

AFV is **not** integrated with these clients.

In order to use AFV with Squawkbox 4 for FS9/FSX or FSINN, you will need to download and install a separate piece of software known as the **Audio for VATSIM Standalone Client,** available vai the website at https://audio.vatsim.net. You will also need FSUIPC, available from http://www.schiratti.com/dowson.html - the free version is sufficient unless you intend to run the AFV Standalone Client on a different PC to your simulator.

1. Download and install the Audio for VATSIM Standalone Client
2. Run Squawkbox 4/FSINN and connect to the VATSIM network
3. Run and configure the Audio for VATSIM Standalone Client (see 3.2.3 AFV Client Configuration), ensuring that 'Use FSUIPC with FS9/FSX/P3D' is selected.

Note that it may take a few seconds for the Audio for VATSIM Standalone Client to recognise you are connected to the VATSIM network: if the connection fails initially, wait ten seconds and try again!

Note: **Squawkbox 4 and FSINN are unsupported by their developers and are expected to be retired from use in the near future to enable further development of the wider network. Squawkbox 4 and FSINN users are strongly advised to switch to a supported client such as vPilot or *swift*.**

3.2.2 Controllers

3.2.2.1 General

AFV is **not** currently integrated with any VATSIM ATC software. As a result, controllers will need to download and run the **AFV Standalone Client** alongside their ATC software client.

3.2.2.2 Euroscope

In order to use Euroscope with Audio for VATSIM:

1. Download and install the latest version of Euroscope
2. Download and install the latest version of the Audio for VATSIM standalone client
3. Optionally download and install the AFV Bridge plugin (to sync your Euroscope text channels with the AFV-VCCS panel when using multiple frequencies)
4. Connect to the network in the normal way
5. Although every effort has been made to shut down the old voice servers in order to avoid issues, we recommend changing your voice servers in the Euroscope audio panel to something like 'novoice' in order to prevent Euroscope attempting to connect to the old voice system
6. Launch the Audio for VATSIM software and configure as necessary (see AFV Client Configuration)

3.2.2.3   VRC

In order to use VRC with Audio for VATSIM, you need to be using the latest version and download the Audio for VATSIM Standalone Client

Although at present all controller clients require the stand-alone client, we expect to be fully integrated shortly.

1. Download and install the Latest version of VRC
2. Download and install the Audio for VATSIM standalone client.
3. Connect to the network using VRC in the normal way.
4. **IMPORTANT!** Set your communications panel as shown in the following graphic.

Ensure that your Vox Server and Vox Channel windows are **blank**. Additionally, only check the PRIM, TX, and RX boxes

5. Launch the Audio for VATSIM software, configure it using the settings button (see AFV Client Configuration) if using it for the first time, and connect!

3.2.2.4   vSTARS and vERAM

In order to use vSTARS and vERAM with Audio for VATSIM, you need to be using the latest version and download the Audio for VATSIM Standalone Client.

Although at present all controller clients require the stand-alone client, we expect to be fully integrated shortly.

1. Download and install the Latest version of vSTARS or vERAM
2. Download and install the Audio for VATSIM standalone client.
3. Connect to the network using vSTARS and vERAM in the normal way.
4. **IMPORTANT!** Set your RDVS or VSCS as shown in the following graphics.
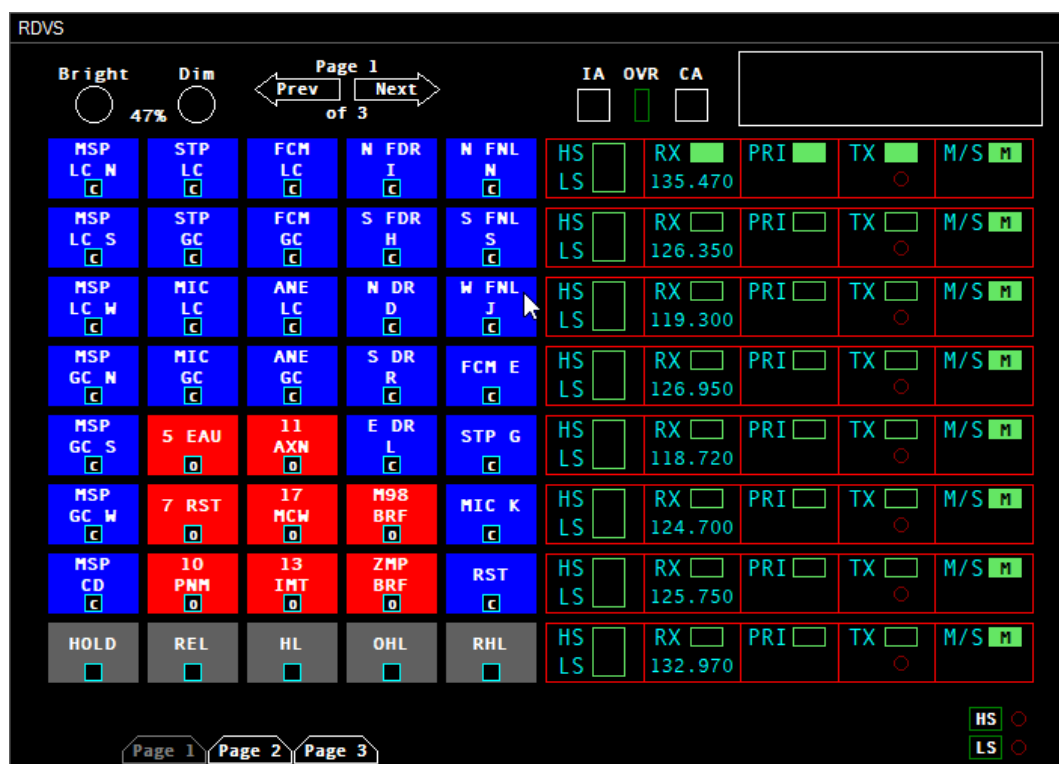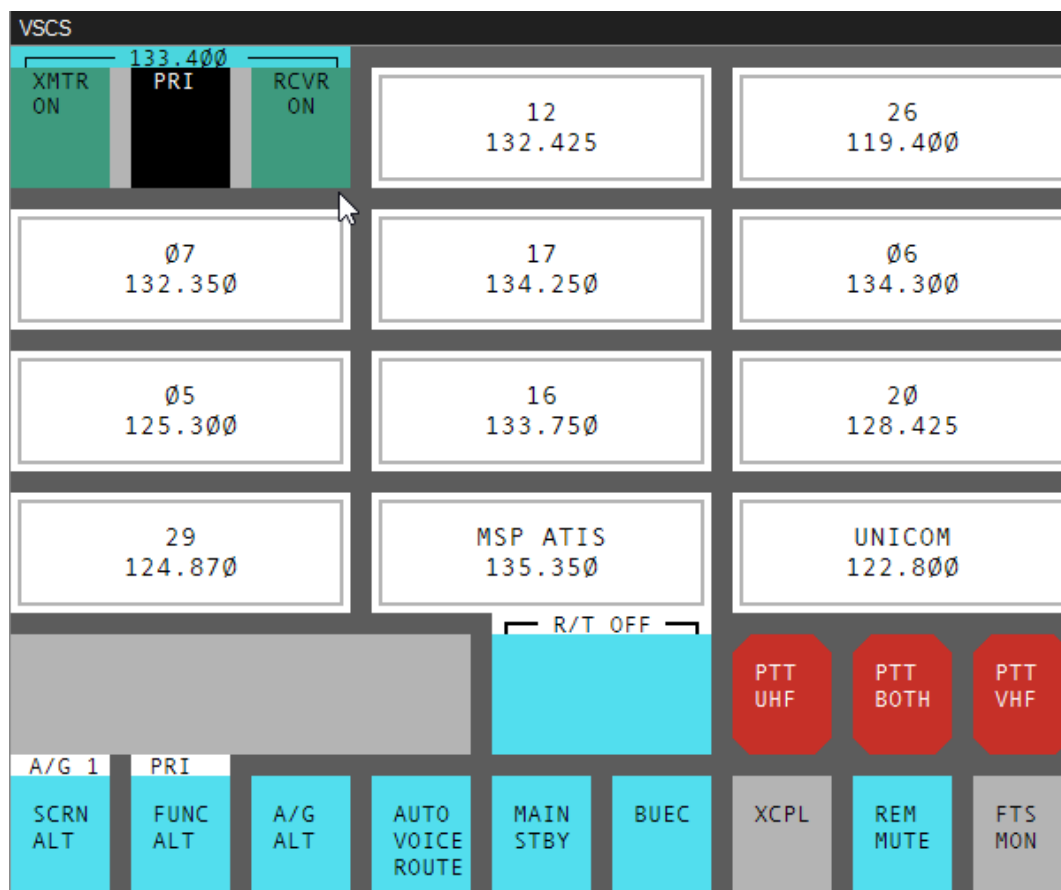
Ensure that only PRI, TX, RX, are selected on in the vSTARS RDVS and only XMTR ON, PRI, and RCVR ON are showing in vERAM VSCS.

In vERAM this can be accomplished by right clicking in the middle box, **do not left click** in the middle box

5. Launch the Audio for VATSIM standalone client, configure it using the settings button if using it for the first time (see 3.1.3 AFV Client Configuration), and connect!

3.2.3   AFV Client Configuration

Before connecting to the network it is necessary to configure your audio options with your desired audio devices, PTT key/button assignment and set your microphone and headset audio levels correctly (refer to your pilot client's documentation for the location of the audio options page).

VATSIM CID – self-explanatory (not displayed in vPilot or xPilot settings dialogues)

VATSIM Password – self-explanatory (not displayed in vPilot, xPilot or swift)

Audio Settings

Select the correct input (microphone) and output (headset/headphones/speakers) devices from the dropdown menus.

Output Volume

This slider controls the overall level at which you hear other users' transmissions.

Mic Volume

This slider controls the input level of your mic to AFV. **It is critically important that you spend a moment to check and adjust this in order to ensure that other users can hear you clearly and at the correct volume.**

To adjust the mic volume:

- Place your microphone in the normal position it will be in when you are flying and communicating with ATC

- Speak in a normal voice and observe the bar moving.
- Adjust the slider so that when you are speaking the bar is peaking mostly in the green area

You will **not** hear your own voice back during this process. This is deliberate because this is actually a very unreliable way of setting audio levels! The audio level meter method used produces much more consistent results.

For more information on optimising your audio quality, see 3.3 Optimising your Audio Quality.

Disable Realistic ATC Audio Effects

Unchecked (default): AFV will provide realistic VHF and HF audio effects, range degradation and voice equalisation and filtering. This is the recommended setting for a fully immersive and realistic audio experience!

Checked: All VHF and HF audio effects, including range degradation, background static, voice equalisation and filtering, are disabled. Communications will sound like a crystal-clear VOIP call! The mic 'squelch' noise heard when another user releases their PTT, however, remains.

Note that disabling realistic ATC audio effects **only** affects the way you hear others – it has no effect on how **you** sound to other users.

PTT Settings

To assign your Push To Talk (PTT) button or key, click the button labelled "Set New PTT Key or Button" and press the key or joystick button you wish to use as your PTT.

Clear current PTT assignment

Self-explanatory.

X-Plane IP Address

If you are using X-Plane with a pilot client that does not have native AFV integration, you **must** set the IP address of the computer where X-Plane is installed here to allow the AFV standalone client to connect to X-Plane for position and radio setting information.

If you are running the AFV standalone client on the s**ame PC as X-Plane**, click the "Single PC" button.

If you are running the AFV standalone client on a **different PC to X-Plane**, enter the IP address of the computer where X-Plane is running.

This step is **not required** if you are using a client with native AFV integration such as *swift* (alpha v0.9.3 onward), XPilot or xSquawkbox (v2.0 onward).

Use FSUIPC with FS9/FSX/P3D

If you are running the AFV Standalone Client with MSFS or P3D (only required if you are using a non-supported pilot client such as FSINN or Squawkbox) you will need to check this box and ensure you have FSUIPC installed in your simulator. The free version is sufficient if you are running the AFV Standalone Client on the same PC as your simulator.

FSUIPC can be downloaded from http://www.schiratti.com/dowson.html .

3.3 Optimising your Audio Quality

3.3.1 Microphone Selection

3.3.1.1 General

Whilst the Audio for VATSIM system is designed to be sympathetic to a wide range of equipment and maximise the intelligibility of all voice transmissions, the old adage of 'garbage in = garbage out' still holds true and there is only so much that can be achieved if the input quality is very poor and/or noisy!

As such, it is **strongly recommended** to use a headset with a boom microphone instead of a desktop microphone or microphone built in to a laptop or PC monitor/webcam etc. There is no need to buy an expensive headset: the AFV development team use Logitech H390 USB headsets priced at around $20 with outstanding results, and even cheaper headsets will provide perfectly acceptable audio quality: it is the microphone placement and headphone arrangement which is critical.

3.3.1.2 What are the advantages of using a headset?

There a numerous advantages to using a headset for VATSIM voice communications over a free-standing or desktop microphone, or worse a microphone built in to a laptop or PC monitor.

- **Microphone placement** – the microphone on a headset can be positioned optimally close to your mouth in order to maximise your voice signal, and even if you move your head around or lean back in your chair, the microphone will always stay in the optimum position.
- **Signal-to-Noise Ratio** – because a headset microphone will be positioned close your mouth, the overall level of gain required to pick up your voice to the appropriate level is much lower than for a free-standing microphone. This means that your voice will be much louder than any background noise.
- **Noise-cancelling** – even the cheapest PC headsets often incorporate noise-cancelling technology which further reduces background noise and makes your voice signal even clearer
- **Directional microphone** – even if your headset doesn't have active noise cancelling, the microphone will have been designed solely to pick up sounds from one direction only – another feature to cut down on extraneous sounds and ensure your voice is picked up as clearly as possible
- **Headphones** – these make it much easier to hear others' transmissions.

3.3.1.3 What's wrong with free-standing and built-in mics?

From an audio engineer's perspective – these are basically the opposite of everything written above! Microphones built in to laptop or PC monitors in particular are designed to have very wide audio pick-up patterns because you are likely to be a long way away from them – this unfortunately also means that they are liable to pick up every little background sound which can swamp your voice, especially when processed further down the chain.

3.3.1.4 But I've only got a free-standing/built-in microphone! Does this mean I can't use Audio for VATSIM until I get a headset?

Don't worry – it will still work and you can still use it. But we'd love to hear your beautiful voice more clearly one day ☺.

3.3.2   Microphone Placement

3.3.2.1   Headset Microphones

To obtain optimum audio quality, headset microphones should be positioned approximately **2 cm (0.75 in) below, and 2 cm (0.75 in) to the side of your lips.**

Ensure that the microphone **does not touch your lips**.

Never hold the boom of the microphone whilst transmitting

3.3.2.2   Desktop/Free-standing/Built-in Microphones

As previously discussed, a headset microphone will always give the best audio quality. However, if you are using a desktop, free-standing or built-in microphone, the optimal distance is generally around 6-8 inches from your lips (approximately a hand span). Try and locate the microphone so that it is well away from any speakers, reduce background noise in the room as much as possible and use headphones wherever possible for engine and AFV ATC sounds.

3.4   Transmitting Technique

The following guidance will assist in ensuring that your transmissions are clearly and intelligibly received.

3.4.1   Before Transmitting

- Check the receiver volume is set at the optimum level by listening to the frequency and using the **Output Volume** slider
- Listen out on the frequency to ensure that you are not going to interfere with a transmission from another station.
- **Remember that you cannot receive and transmit simultaneously, i.e. you will <u>not</u> hear anyone else transmitting once you press the PTT, so you <u>must</u> listen out before transmitting and take great care to avoid 'stepping on' another user's transmission.**

3.4.2   Whilst Transmitting

- Follow the guidance above for positioning and use of microphones
- Depress the PTT switch fully before speaking. However, do **not** depress the PTT switch until you are **ready** to speak.
- Do not turn your head away from the microphone, and do not vary the distance between your mouth and the microphone, whilst transmitting
- Use a normal conversation tone
- Speak clearly and evenly
- Maintain an even rate of speech not exceeding 100 words per minute. If you know that the receiver is going to be writing down certain elements of your message, slow down slightly.
- Maintain your speaking volume at a constant level
- A slight pause before and after numbers will make them easier to understand
- Avoid using hesitation sounds such as 'er'
- Avoid excessive use of courtesies and entering in to non-operational conversations

- Be aware that the mother tongue of the person receiving the transmission may not be English – speak clearly and use standard radiotelephony (RTF) words and phrases wherever possible

- Messages should not contain more than three specific phrases, comprising a clearance, instruction or pertinent information. In cases of doubt, e.g. a foreign pilot having difficulty with the English language or an inexperienced pilot unsure of the procedures, the controller should reduce the number of items and if necessary these should be passed, and acknowledged, singly.

- Do not release the PTT switch until after you have finished speaking to avoid 'clipping' the end of your transmission

3.4.3   Stuck PTTs

A 'stuck' microphone button is at the least very inconvenient and in all cases highly irritating to others on frequency as with the AFV simulation it will severely hamper others' communication by 'blocking' transmissions.

Always ensure that the PTT is fully released after a transmission and ensure that the selected PTT button or key is in an appropriate place to avoid it being inadvertently switched on.

Never 'weight' your PTT key to give yourself an 'open' mic – not only will you be blocking everybody else's use of the frequency, you will not be able to receive any transmissions yourself!

3.4.4   After Transmitting

After a call has been made, if no response is heard a period of at least 10 seconds should elapse before making a second call. This should eliminate unnecessary transmissions while the receiving station is getting ready to reply to the initial call.

Further guidance on how the AFV system simulates real aircraft radio and how to maximise its use either as an Air Traffic Controller or as a pilot is found in the following chapters.

4 Radio Propagation Theory

4.1 Introduction

The heart of Audio for VATSIM is its realistic simulation of Very High Frequency (VHF) aeronautical radio. VHF radio communications form the core of domestic air-ground-air (AGA) communications in real life, and this has also been broadly the case on VATSIM since its inception. In addition AFV provides a High Frequency (HF) radio simulation for long-range Oceanic and remote continental communications, the first time this has been implemented on the VATSIM network.

To understand how AFV works and what you can expect from AFV when you are flying on the network, it is useful to gain an elementary understanding of how radio waves propagate and how this affects aeronautical communications.

This chapter provides a brief overview of the properties and characteristics of radio waves and the technology used for aeronautical communications, and how these are modelled by AFV.

4.2 Properties of Radio Waves

4.2.1 Wavelength

Radio waves are **electromagnetic waves** which travel at the speed of light (approximately 300,000,000 metres per second).

Wavelength is the distance between two 'peaks' or 'troughs' in the wave. It is measured in metres and represented by the Greek letter *lambda* (λ). The shortest wavelengths are just fractions of the size of an atom, whilst the longest wavelength currently studied by scientists is larger than the diameter of the Earth.
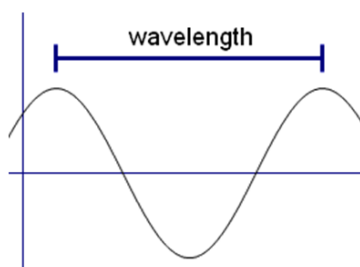
4.2.2 Frequency

The **frequency** of an electromagnetic wave is defined as the number of waves that pass a fixed point in a given amount of time. It is measured in Hertz (Hz), where 1 Hz is equal to one wave passing a fixed point in one second.

Since the speed of light is constant, the frequency of a wave and its wavelength are inextricably linked. The higher the frequency the shorter the wavelength, and vice-versa.

Frequency

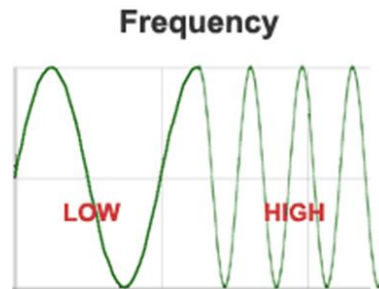The VHF band is defined internationally as the range of frequencies between 30 MHz and 300 MHz. VHF aeronautical voice communications take place in the band between 118 and 137 MHz.

The HF band is defined internationally as the range of frequencies between 3 MHz and 30 MHz.

4.2.3 Amplitude

The **amplitude** of a wave is the 'vertical' distance between the peak and the wave axis.
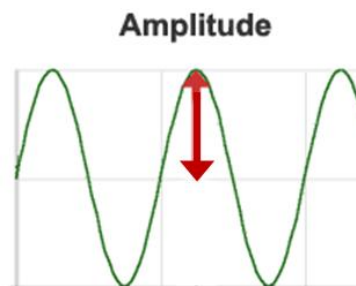
Amplitude

Generally speaking, the amplitude of the wave reflects the signal strength.

4.2.4 Modulation

Modulation is the process by which information is 'added' to radio waves in order for it to be conveyed from one location (the transmitter) to another (the receiver).

The **carrier wave** will have a constant periodic waveform – effectively a 'blank' wave at a given frequency and amplitude, say for instance 125 MHz. To add information – for instance, a voice signal – to this 'blank' waveform, it must be modified by a device called a **modulator**.

The two most common methods of modulation in use are **Amplitude Modulation (AM)** and **Frequency Modulation (FM).** Most people will be familiar with these terms because they are used in analogue commercial radio broadcasting.

In amplitude modulation, as the name suggests, it is the amplitude of the carrier wave which is varied in relation to the message signal. In frequency modulation, the frequency of the carrier wave is varied in relation to the message signal. The image below shows how the same voice signal (the **modulating wave**) is combined with the constant carrier wave in both AM and FM modulation methods.
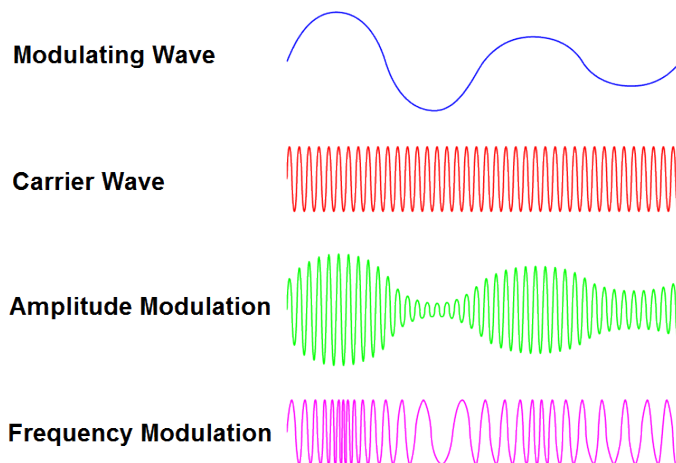
Whilst FM is generally used for broadcast radio (hence the term 'FM radio') because of its efficiency, robustness against noise and interference and its ability to carry a stereo signal, aeronautical communications use AM.

Whilst AM is more prone to picking up noise than FM, it offers a number of advantages over FM for aviation applications. This is mainly because AM does not suffer from the 'capture effect' found in FM (where if there are two simultaneous transmissions on the same frequency the receiver will 'lock on' to the strongest signal and completely disregard the weaker signal). Therefore:

- Stronger stations can override weaker or interfering stations
- Even if a pilot is transmitting, a controller can 'talk over' the transmission and other aircraft will hear a garbled mix of both transmissions instead of just one or the other
- If both transmissions are received with near-identical signal strength a **heterodyne** 'squeal' will be heard

No such indication of a blockage or crossed transmissions would be evident in an FM-based system.

4.2.4.1 AFV-AM

Audio for VATSIM broadly uses AM principles but some minor modifications have been necessary to accommodate VATSIM use; this model is referred to as 'AFV-AM'.

The main accommodation is to allow for ATC stations to transmit and receive audio on the same frequency from multiple overlapping transceivers. In reality this could lead to effectively blocking one's own transmission; the AFV logic prevents this from occurring, allowing ATC sectors to use multiple transceivers to achieve the required coverage on a single frequency.

In addition, at present a heterodyne will be heard every time two or more transmissions received by the same transceiver on the same frequency cross over. It is hoped that a future update will allow for signal-strength-based handling of crossed transmissions.

4.3   Characteristics of VHF Radio Communications

4.3.1   Propagation

VHF transmissions are essentially **line-of-sight**, which means that the signal will be interrupted by buildings, high terrain and the curvature of the Earth. These will cause **radio shadows** and communication with objects or stations in these shadow areas is not possible.
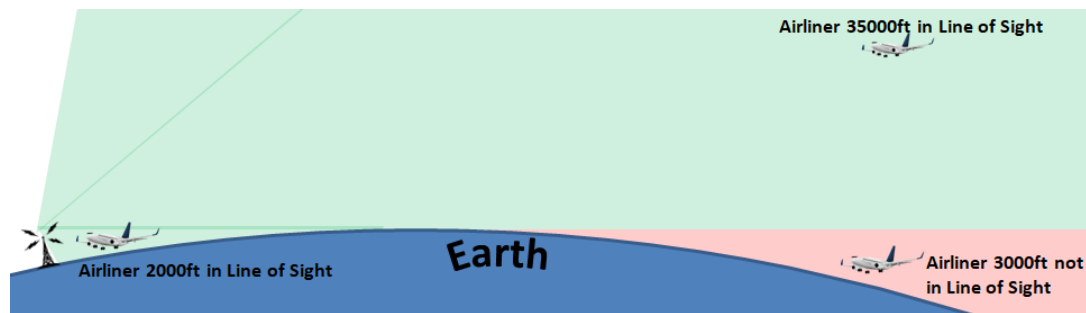
VHF radio communications operate on a line-of-sight basis

AFV does not currently model the effects of high terrain, but the effect of the curvature of the Earth is modelled well. Bearing in mind the curvature of the Earth, the higher an aeroplane is flying, the greater the distance at which communications are possible. An approximate maximum distance in nautical miles at which communication with an aircraft may be possible is given by the formula:

$$Range = 1.23\sqrt{height}$$

Where the height is in feet.

Example 1

How far away can communications with an aeroplane flying at 5,000 ft be established, assuming the terrain is flat and there is no obstruction?

$$Range = 1.23\sqrt{height}$$

$$Range = 1.23\sqrt{5000}$$

$$= 1.23 \times 71$$

$$= 87\ NM$$

If the aeroplane is flying at 10,000 ft AMSL, the effective range is much greater:

$$Range = 1.23\sqrt{height}$$

$$Range = 1.23\sqrt{10000}$$

$$= 1.23 \times 100$$

$$= 123\ NM$$

4.3.1.1 Increasing Radio Range

VHF radio range may be increased by siting the radio antenna at a high elevation, so that it is raised above nearby obstacles and able to 'see' further around the curvature of the Earth. The range at which communications with an aircraft can be established by a radio station sited well above a flat surface can be approximated by the formula:

$$Range = 1.23\sqrt{height\ of\ ATC\ radio\ antenna} + 1.23\sqrt{height\ of\ aircraft}$$

Example 2

How far away can communications be established with an aeroplane flying at 5,000 ft AMSL over flat terrain with no obstructions, if the ATC transmitter is elevated 150 ft above mean sea level?

$$Range = 1.23\sqrt{height\ of\ ATC\ radio\ antenna} + 1.23\sqrt{height\ of\ aircraft}$$

$$Range = 1.23\sqrt{150} + 1.23\sqrt{5000}$$

$$= 102\ NM$$

Here we can see how raising the ATC transceiver a mere 150 ft has increased the maximum communication range at 5,000 ft by a radius of approximately 15 NM.

4.3.2 AFV Implementation

4.3.2.1 VHF Radio Range

AFV uses the line-of-sight formula above to calculate the range of airborne and ground-based transceivers.

Remember that when considering the range at which two stations are able to communicate the ranges are summative, as shown in Example 2. This means that an ATC transceiver will have a much larger effective range for aircraft flying at high altitude compared to aircraft flying at low altitude.

This can be visualised by drawing a circle around the aircraft or ATC transceiver. The radius of the circle is the distance calculated through the basic formula shown in example 1, and the area inside the circle represents the area in which communication with the station would be possible at sea level. Naturally as an aircraft climbs, for example, the radius of the circle will become larger.

If the range circles of two stations intersect, communication is possible.
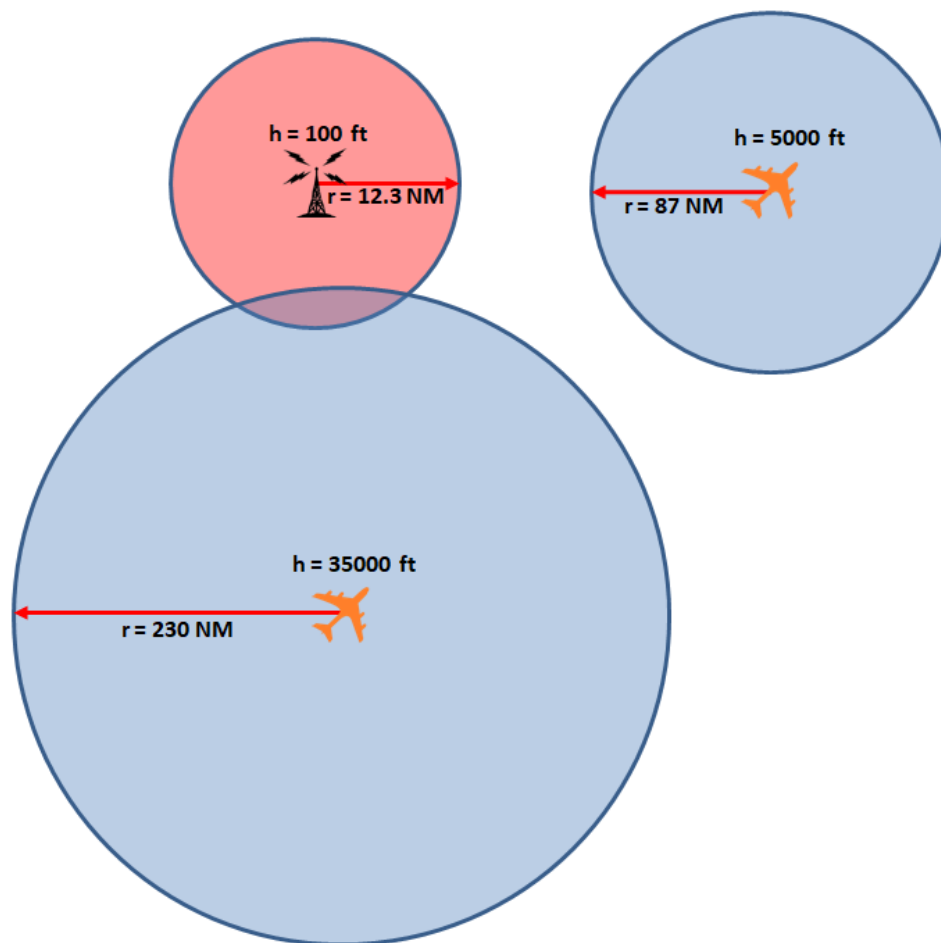
Line of sight example. The aircraft at 35000 ft is able to communicate with the ATC station which has a transceiver antenna at 100 ft AMSL as their range rings intersect, but the second aircraft at 5000 ft can communicate with neither the ATC station or the other aircraft as its range ring does not intersect either (diagram not to scale)

4.3.3   Channel Spacing

At present the vast majority of Flight Simulator clients natively support 25 kHz channel spacing for VHF communications, which was the standard spacing used in aeronautical communications across the world until very recently.

Whilst in reality some jurisdictions have moved to 8.33 kHz channel spacing in order to increase the number of available channels, at present there is no practical means of tuning (or extracting via the available interfaces such as Simconnect or FSUIPC) 8.33 kHz spaced channels for the majority of simulators.

For this reason, VATSIM continues to use 25 kHz frequency spacing as standard and it is likely that this will remain the case for some time. The AFV system is agnostic on this matter: the system will accept any frequency that can be fed to it from a simulator via a VATSIM pilot client and should a method to extract 8.33 kHz frequencies elegantly from the full range of simulator software supported by the VATSIM network be developed in future, AFV will support this with no changes required.

4.4   Characteristics of HF Radio Communications

4.4.1   Introduction

Whilst the clarity of VHF transmissions makes them ideal for AGA communication use, the line-of-sight requirement outlined above means that, for practical purposes, the maximum radius within which a ground station can communicate with an aircraft at typical airliner cruising levels is in the region of 250-280 NM.

For most domestic ATC applications where multiple remote radio transceivers can be located around a land mass, this limitation is not a factor. However, over the oceans and very remote areas of land, building a network of VHF transceiver sites is very difficult, if not impossible. An alternative solution is therefore required.

The answer is found through the use of High Frequency (HF) radio. HF uses lower frequencies (from 3 MHz to 30 MHz) than VHF, and even with the development of satellite and datalink technology remains the predominant primary means of establishing ATC communications over remote and oceanic areas.

4.4.2   Propagation

HF uses lower frequencies (from 3 MHz to 30 MHz) than VHF. These lower frequencies in turn have longer wavelengths than VHF transmissions, and as a result instead of carrying on in a straight line through the atmosphere in to space can be **reflected** by the Earth's atmosphere, permitting 'over the horizon' communication.

This allows HF communication to be effective over extremely long ranges, as much as 8,000 NM or even more if conditions are good.

HF transmissions can 'skip' off the Earth's ionosphere to allow 'over the horizon' communication
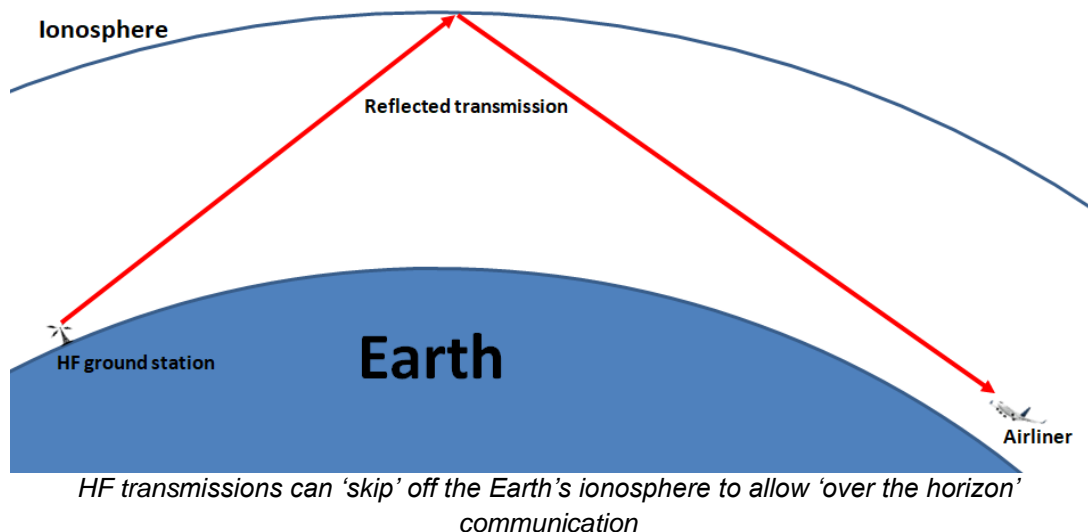
HF transmissions can propagate by **ground waves** and **sky waves**. Ground waves are received over shorter distances nearer to the transmitter.

Sky waves, however, can travel much greater distances. At the wavelengths used in HF communications, the transmitted radio waves can interact with an electrically-charged layer of the Earth's atmosphere known as the **ionosphere**. The waves are reflected back toward Earth by the ionosphere. The signal can often be reflected multiple times, 'bouncing' between the surface of the Earth and the ionosphere, and as a result can travel many thousands of miles.

The maximum range of HF transmissions is heavily dependent upon atmospheric conditions, the angle at which the signal meets the ionosphere and the frequency of the transmission. For example, at night the ionosphere is generally lower than during the day. This means that the angle at which transmissions reach it is shallower and therefore they will 'skip' further.

Skywaves can make multiple 'skips' to travel large distances
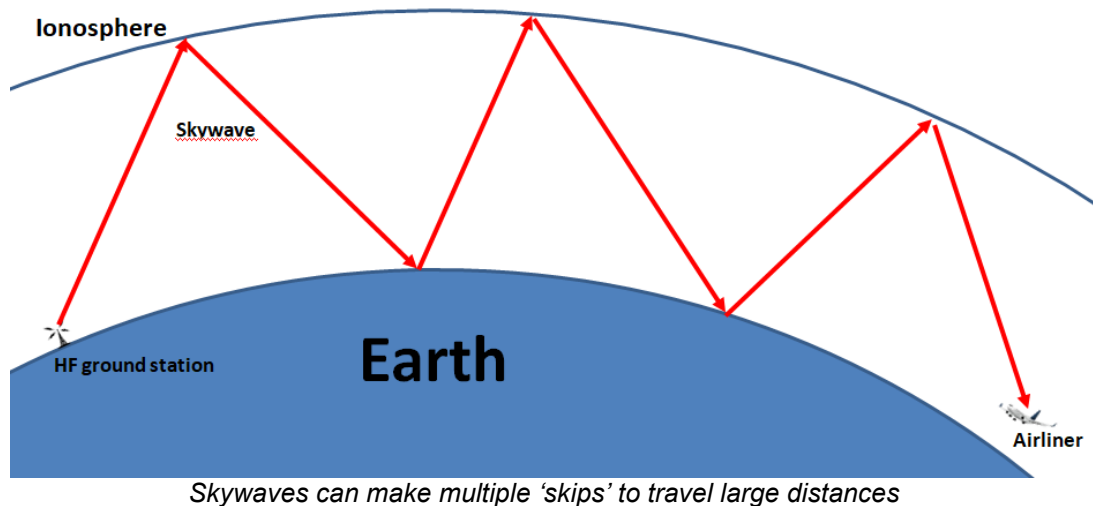
The frequency of the transmission also has a bearing. As a general rule of thumb, higher frequencies (10-30 MHz) work better during daylight, and lower frequencies (2-10 MHz) are better at night.

4.4.3   SELCAL

4.4.3.1   Background

One of the drawbacks of HF communication is that it is very prone to picking up noise and interference – hardly surprising given the nature of how the waves propagate! This results in a lot of static interference which can be fatiguing to listen to.

As a result, a system known as **SELCAL (Selective Calling)** is in common use. Each aircraft is assigned a four-letter code, written or transmitted in two pairs (e.g. AB-CD). A valid SELCAL code:

- Can only use the letters A to S (excluding I, N and O)
- Cannot have repeated letters
- The letters in a given pair must be in alphabetical order (e.g. CD-AB is acceptable, but not DC-AB).

Each letter designates a specific audio frequency, similar to how tone dialling operates on a DTMF telephone.

To send a SELCAL request, the radio operator enters the aircraft's code in to an encoder. The encoder converts the code in its four designated audio tones, and these are broadcast on the selected frequency in sequence. The first pair of tones are transmitted simultaneously, there is a brief pause (of about 0.2 seconds) and then the second pair of tones are transmitted simultaneously. When the SELCAL decoder connected to an aircraft's radio receiver detects a signal containing its own SELCAL code, it alerts the crew by sounding a chime, activating a light, or both. This allows the crew to turn the volume of the HF receiver down until they are required to respond to a transmission, provided that they have first checked with the controller that the SELCAL system is working correctly.

4.4.3.2   VATSIM Implementation

On VATSIM currently a SELCAL is sent by ATC using the syntax <selcal <code>>, for example to send a SELCAL to an aircraft with code AB-CD the controller would transmit via text:

   selcal AB-CD

(Note that no "." is entered prior to the "selcal" – also the hyphen between the letter groups **is** required).

This will cause an alert to be displayed and sound played through the receiving user's pilot client.

4.4.4   AFV Implementation

4.4.4.1   General

AFV has, for the first time, implemented a basic HF simulation to allow for a realistic communications experience in Oceanic and remote continental airspace.

At present, the HF model is relatively basic and does not take in to account many of the propagation factors listed above. However, a realistic HF audio simulation and long-range communication capability is provided, and it is hoped that future development will refine the HF model further.

4.4.4.2   Tuning

As there is currently no native means for a VATSIM pilot client to extract an HF frequency from the majority of flight simulators on the market, AFV uses an aliasing system to allow HF frequencies to be tuned via a VHF radio.

All HF stations must be configured by a local Facility Engineer, who will assign the position both an HF frequency based on real-world allocations and a VHF alias.

When the pilot client detects that an HF station is online and in range, tuning the relevant VHF frequency on the VHF COM radio will cause AFV to tune to the aliased HF frequency and operate in HF mode. This allows all VATSIM users to take advantage of HF communications regardless of hardware or simulator software.

4.4.4.3   Addon Developers

AFV provides a software development kit (SDK) to allow aircraft addon developers to directly tune AFV HF stations via their own HF radio communications gauges. Full details of the protocol can be found in Appendix 1 – Technical Information for Developers.

5 Flying with AFV

5.1 Introduction

The Audio for VATSIM system provides a never-before experienced level of immersion for pilots. In addition to realistic VHF and HF audio effects, the system provides extremely low latency, realistic radio operating characteristics, the ability to transmit voice on any frequency at any time and a range-based degradation model.

This also means that there are a number of differences that pilots and controllers should be aware of when using the AFV system compared to the voice room model that many will be familiar with. These chapters aim to highlight the new features of AFV and the differences to the old voice system.

5.2 AFV and your aircraft's Audio Control Panel

Like any radio, AFV requires that you have set your aircraft's audio control panel (ACP) up correctly to ensure you can receive and transmit!

Ensure that on your aircraft's instrument panel:

- The microphone selector is selected to the COM radio you wish to transmit on
- The volume selector for the COM radio you are is turned on and the volume turned up

For more information on how to achieve this check your addon aircraft's documentation.

5.3 VHF Operation

5.3.1 General

AFV functions like a real aircraft radio. It removes the concept of voice rooms and as a pilot you can transmit voice on any selected frequency.

As outlined in the chapter on Radio Propagation Theory, your VHF radio range is primarily dependent on your height above mean sea level. The higher you climb, the larger the radius within which you are able to receive transmissions, and your transmissions be received.

5.3.2 Signal Degradation

Just like a real radio, the signal strength of AFV VHF transmissions degrades based on how far away the source is from your Line of Sight (LOS) coverage. This means that as you get further away from another aircraft or ATC transceiver, or as you descend and your LOS distance reduces, you will hear more static and eventually as you go out of range the other transmission will fade away and become unreadable.

Because your LOS distance on the ground is very limited, you may find that ATC stations with transceivers located a long way from the airport you are at may be a little (or a lot!) crackly, and as you descend stations which were clear at altitude may start to become more crackly. This is normal and reflective of how real VHF communication works.

5.3.2.1 Airports outside VHF Radio Coverage

Just like in real life, it is possible that some uncontrolled airfields which do not have a nearby ATC transceiver will be outside radio coverage and you will not be able to contact the controller via voice when you are on the ground. Don't panic! This is normal, and realistic.

The procedures to be followed in this case will be region-specific and you should follow the advice published by the local VATSIM ATC division, but in general terms if you are in an area (such as the USA) where it is necessary to obtain an IFR clearance before departure but are at an airfield without radio coverage you have two main options:

1. If weather conditions are suitable, depart under Visual Flight Rules (VFR) and contact ATC for your IFR clearance once you are airborne and at a high enough altitude to be able to contact ATC
2. Send a private message to the controller via text requesting clearance (akin to using a phone as would be the case in real life).

In the USA many such airfields in real life have a Ground Communications Outlet (GCO) which allows the pilot to contact ATC via a normal PSTN landline. GCOs are not currently simulated in AFV but options for future development are under consideration.

5.3.3 Scenarios

Because AFV accurately models VHF range for all stations – both aircraft and ATC, who in many cases will have their sectors configured by a local Facility Engineer with real-world transceiver locations – it is important to remember that situations can arise where it is not possible to hear everybody on the frequency.

Let's take the image from Chapter 4 as an example:
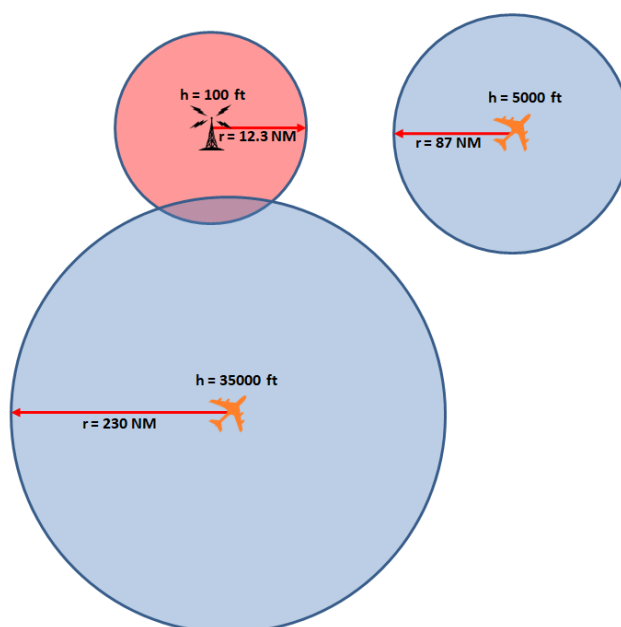
Here, we can see how the aircraft at 35,000 ft will be able to communicate with the controller because their line of sight range rings overlap. However, the aircraft at 5,000 ft can neither hear nor be heard by either the controller or the other pilot until they climb higher.

In another example:
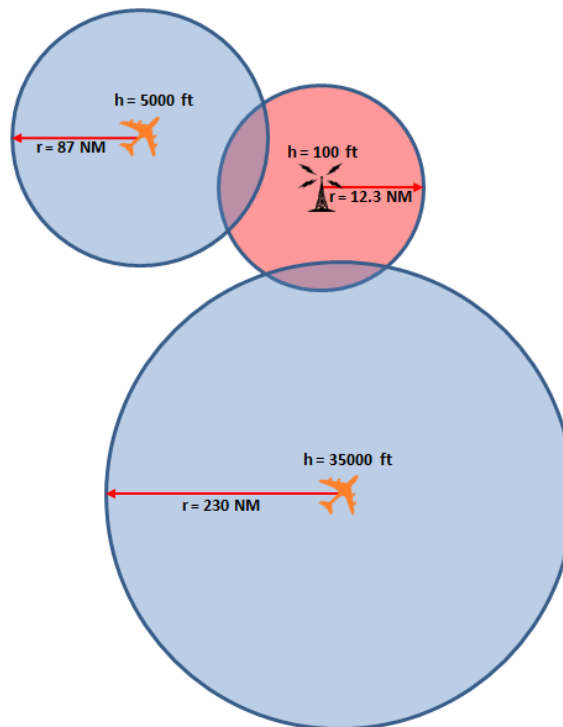
Here again we have two aircraft, one at 5,000 ft and another at 35,000 ft, plus an ATC station. This time we can see that both pilots can hear and be heard by the controller, but neither will hear the other.
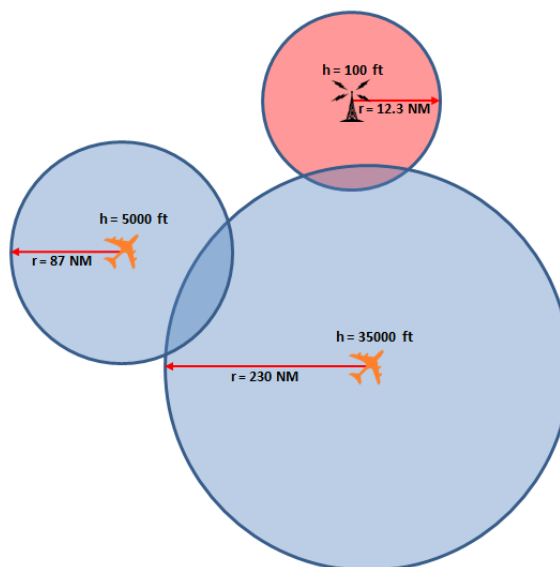

This is an interesting example: here, both pilots can hear each other but only the aircraft at altitude can hear ATC. If the pilot at lower level were trying to contact the controller, for example, it might be possible for the higher aircraft to take advantage of its greater radio range at altitude to relay messages, just as in real life.

It should be noted that the ranges involved in these examples have been exaggerated somewhat and in practice because line of sight distance increases rapidly with increased

altitude and controllers have the ability to 'cross-couple' frequencies together to rebroadcast transmissions, it is unlikely to pose a regular problem in day to day VATSIM operations. Pilots should remain aware of the possibility, however – and that it can often be a real life issue too!

5.3.4   Transmitting and Receiving Behaviour

5.3.4.1   Half-Duplex Operation

AFV replicates real-world radio behaviour in that it is **half duplex** – that is to say, you cannot simultaneously receive and transmit.

This is because the laws of physics simply do not allow for you to be able to simultaneously receive and transmit on the same frequency – you can do one or the other but not both together! So-called 'full duplex' (simultaneous TX/RX) behaviour would require *two* separate frequencies -- one for transmitting on, and a second for receiving on.

In practical terms, this means that any time your PTT is pressed you **will not** hear any other radio traffic – your receiver is effectively muted. So take care to listen out and not step on anybody else's transmission!

> **Real-world Tip:**   With AFV, just like in real life, if you are listening carefully you can hear when somebody else has pressed their PTT switch as you will hear a short burst of static. Be alert as you prepare to key your microphone!

5.3.5   UNICOM and Air to Air Communications

The global UNICOM frequency continues to be 122.800 MHz. Voice communications are available and recommended. However, in order to reduce frequency congestion where there are multiple airports within close proximity, the maximum transmit/receive range on 122.800 MHz is artificially limited to a radius of 15 NM for each aircraft for a total effective range of approximately 30 NM (15 NM for aircraft A + 15 NM for aircraft B).

5.3.5.1   CTAF

AFV does allow for the possibility of using discrete Common Traffic Advisory (CTAF) frequencies at each airport. However, in order to ease the transition and support pilots in easily locating appropriate frequencies, some additional background work is required and under way. Until this additional work is completed, please continue to use 122.800 MHz.

5.3.5.2   Other Air to Air Frequencies

Because AFV provides voice transmission on all channels with real radio range characteristics it is **very important** that users **only** transmit on:

- Active ATC frequencies, or:
- Air-to-Air communications frequencies specifically designated for such use by VATSIM (e.g. 122.800) and only for the purposes for which those frequencies are designated.

This is to avoid inadvertently causing interference to other stations, perhaps several hundred miles away, who may be legitimately using a frequency which otherwise appears 'clear'.

5.3.6   Simultaneous (Blocked) Transmissions

5.3.6.1   Introduction

A common problem in both real-world and VATSIM communications is that of **simultaneous transmissions (SiT)** where two or more stations on the same frequency transmit at the same time.

During AFV testing, the number of SiTs experienced during major events was significantly lower than during events with comparable traffic levels on the 'old' voice system, primarily because of the dramatic reduction in latency offered by AFV. However, simultaneous transmissions can and do still occur, both in real life and on VATSIM.

5.3.6.2   Scenarios

There are three main scenarios related to the occurrence of simultaneous radio transmissions:

1.   Two pilots transmitting simultaneously:
     a.   On the same frequency with one ground receiver (known as a 'stepped on' transmission)
     b.   On the same frequency with two or more ground receivers which use a system to select the best signal (also known as 'call swamping')
     c.   On two frequencies which are cross-coupled by the controller (known as 'call blocking').

2.   Simultaneous transmissions by the controller and a pilot (known as 'stepped on' transmissions)
     a.   On a single frequency
     b.   On frequencies which are cross-coupled by the controller (the pilot makes a transmission on a coupled frequency whilst the controller is transmitting to all frequencies in the group)

3.   Radio 'dead zones' where one or more pilots are unable to receive transmissions from certain other pilots and/or from the controller

All three of these real-world scenarios have relevance in the Audio for VATSIM system also.

5.3.6.3   Detecting Simultaneous Transmissions

As outlined in 4.2.4 Modulation, real-world aviation communications use AM in order to reduce the impact of simultaneous transmissions, and this is simulated by AFV.

When two or more stations transmit simultaneously, all other stations within range on the same frequency will hear a somewhat garbled mixture of both transmissions, along with a **heterodyne** 'squeal' or tone caused by the mixing of the two transmissions.

Remember that when you are transmitting, you cannot also be receiving – so you will not hear any other transmission during the time your PTT is pressed.

5.3.6.4   Undetected Simultaneous Transmissions

Undetected Simultaneous Transmissions (USiT) occur when two or more transmissions overlap in such a way that the controller and/or pilot is not aware that more than one transmission has occurred.

This could happen, for example, if a pilot makes a transmission after the controller has depressed their PTT – the controller will not have heard the other pilot's transmission, but other pilots on the frequency will hear a heterodyne and/or a garbled mix of the two transmissions.

5.3.6.5 Avoiding Simultaneous Transmissions

To minimise the risk of simultaneous transmissions:

- Listen out carefully on frequency before transmitting
- Be alert for any static received just before you press your PTT – this is a sign that somebody else has started a transmission
- Don't jump in to the middle of a conversation – if a controller has just issued an instruction, wait for the other pilot to read it back before you start transmitting
- Inform the controller of any blocked transmissions you hear *(ICAO phraseology: "Transmission blocked, Bigjet 123.")*

5.4   HF Operation

5.4.1   General

High Frequency (HF) communications are used in areas where it is impractical or impossible to provide sufficient VHF coverage such as Oceanic or remote continental airspace.

AFV provides a basic HF simulation at present and there are certain differences to VHF communications that you will need to familiarise yourself with.

5.4.2   HF Range

HF provides communications over very long distances, up to several thousand nautical miles.

5.4.3   Tuning an HF Station

There is currently no native means of extracting details of HF radios installed in MSFS/P3D or X-Plane. Add-on developers may make use of the techniques detailed in Appendix 1 – Technical Information for Developers in order to integrate AFV HF tuning in to their own custom HF radio gauges and audio control panels, and it is hoped that in time many will choose to do so.

However, the majority of users you will need to use AFV's VHF 'aliasing' function to tune appropriately HF ATC stations.

5.4.3.1 VHF Aliasing

ATC stations which use HF such as Shanwick Oceanic (EGGX_FSS) are pre-configured by local Facility Engineers to have both an HF frequency and a VHF aliasing frequency.

In your pilot client you will currently see **only** the VHF 'alias' frequency to which you will tune your VHF COM radio.

When an HF station is online and within range, AFV will detect when you have tuned to its VHF alias frequency (131.800 in this instance), automatically switch in to HF mode and tune itself to the correct HF frequency. There is currently no direct indication to the pilot of the tuned HF frequency.

5.4.3.2   Native Tuning

If you happen to have an add-on aircraft which has an HF gauge **and** it has been programmed by its developer to use the AFV SDK for HF tuning, you can tune the HF frequency directly.

Remember that you will need to configure your aircraft's ACP appropriately -- select the mic selector to the appropriate HF radio and ensure the volume is selected on and turned up!

5.4.4   AFV HF Features

5.4.4.1   Sound Effects

The first thing you will notice about HF communications is the background static! Although HF provides the range required for long-range communication, the frequencies involved and the nature of the propagation means that it is very prone to picking up background noise and the signal-to-noise ratio is generally very low.

5.4.5   HF Radio Operating Techniques

5.4.5.1   General

As many VATSIM users will not have experience of 'real' HF communications, this section provides some general tips and advice for using the HF radio. Further, and more specific, guidance may be found in local documentation and, for North Atlantic operations, NAT Doc 007.

5.4.5.2   Transmitting Technique

Follow the general guidance provided in 3.4 Transmitting Technique and particularly remember that you should make every effort to speak slowly and clearly given the reduced reception quality.

5.4.5.3   Phraseology

It is customary on initiating (or re-initiating) contact with an HF station to state the name of the station you are calling twice, as well as the HF frequency upon which you are calling. This is because in real life HF radio operators normally monitor several different frequencies simultaneously, and may need to adjust their equipment in order to optimise reception for the specific frequency you are calling on. For example:

"**SHANWICK RADIO, SHANWICK RADIO, SPEEDBIRD 123, POSITION ON 8831.**"

For the same reason it may take a few moments whilst the radio operator is making the appropriate selections before you get a response, so be patient!

5.4.5.4   SELCAL

The static on HF can be fatiguing to listen to for long periods of time. SELCAL (Selective Calling) is a system which allows pilots of suitably-equipped aircraft to keep the HF volume low until they are alerted through SELCAL that ATC wishes to speak to them.

SELCAL functionality is available through your pilot client: check your pilot client's documentation for details.

It is **essential** that you perform a successful SELCAL check with ATC **before** turning the volume down – if the SELCAL check fails or you are not SELCAL equipped, you **must** maintain a continuous listening watch on the frequency!

A SELCAL check is normally performed on first contact with the relevant station and when changing frequency (e.g. from Shanwick to Gander at 30W or vice-versa). For example:

> **"GANDER RADIO, AIRLINE 123, SELCAL CHECK, SHANWICK NEXT"**
>
> **"AIRLINE 123, GANDER RADIO, HF PRIMARY 5616 SECONDARY 2899, AT 30 WEST CONTACT SHANWICK RADIO HF PRIMARY 8891 SECONDARY 4675, (SELCAL TRANSMITTED)"**
>
> **"GANDER RADIO, AIRLINE 123, SELCAL OKAY, HF PRIMARY 5616 SECONDARY 2899. AT 30 WEST CONTACT SHANWICK RADIO, HF PRIMARY 8891 SECONDARY 4675"**
>
> *(From NAT Doc 007 6.1.10)*

A full description of SELCAL can be found above at 4.4.3 SELCAL.

6   Controlling with AFV

6.1   Introduction

AFV is designed to enhance the VATSIM controller's experience. Crisp, ultra-low-latency voice communications will make it easier for you to work more traffic more effectively, whilst immersion is enhanced both through realistic VHF effects and transceiver coverage, as well as the ability to operate multiple cross-coupled frequencies in a realistic manner.

However, the more realistic system does mean some changes which it is important for controllers to familiarise themselves with.

6.2   Setup

6.2.1   General

At present, AFV is not integrated in to any ATC client software. Until ATC client integration occurs, it will be necessary for controllers to download and install the AFV Standalone Client. Full details of the installation and configuration process can be found in 3 AFV Initial Setup and Configuration.

6.2.2   Logging on to an ATC Position

Once you have configured the AFV Standalone Client according to the instructions above, you are ready to connect to the network. Ensure your ATC client has been updated to the latest version.

Connect your ATC client in the normal manner.
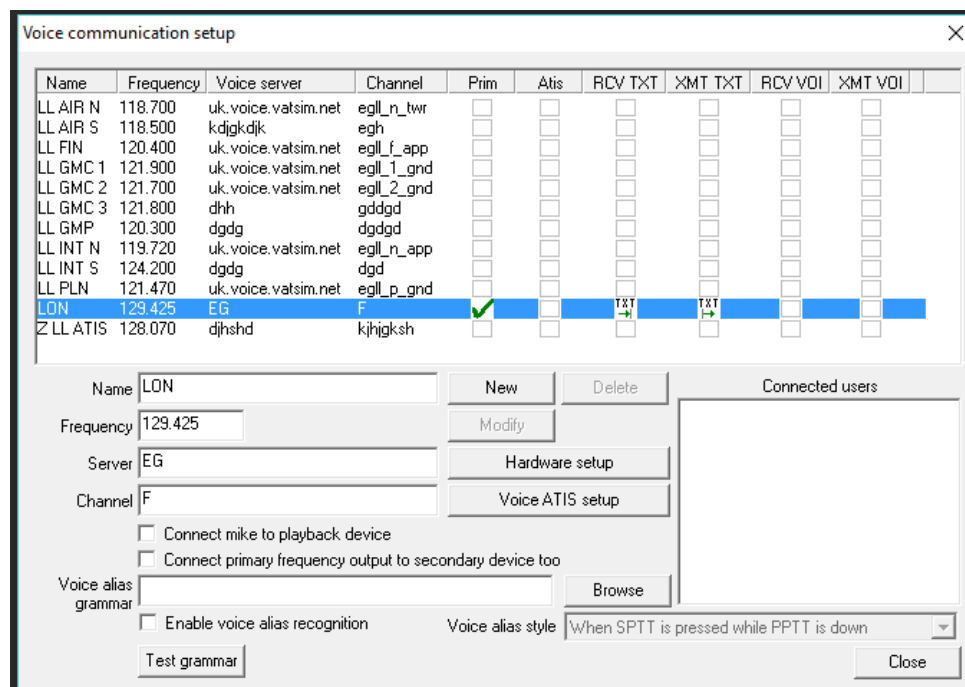
'Prime' your main frequency (for further discussion of cross-coupling and multiple-frequency operation, see 6.5 Multi-Frequency Operation and Cross-Coupling) and ensure you are transmitting and receiving text(!).

You can now connect the AFV Standalone Client. Simply click the 'Connect' button and the client will identify that you are connected to the VATSIM network and configure your transceiver settings appropriately.
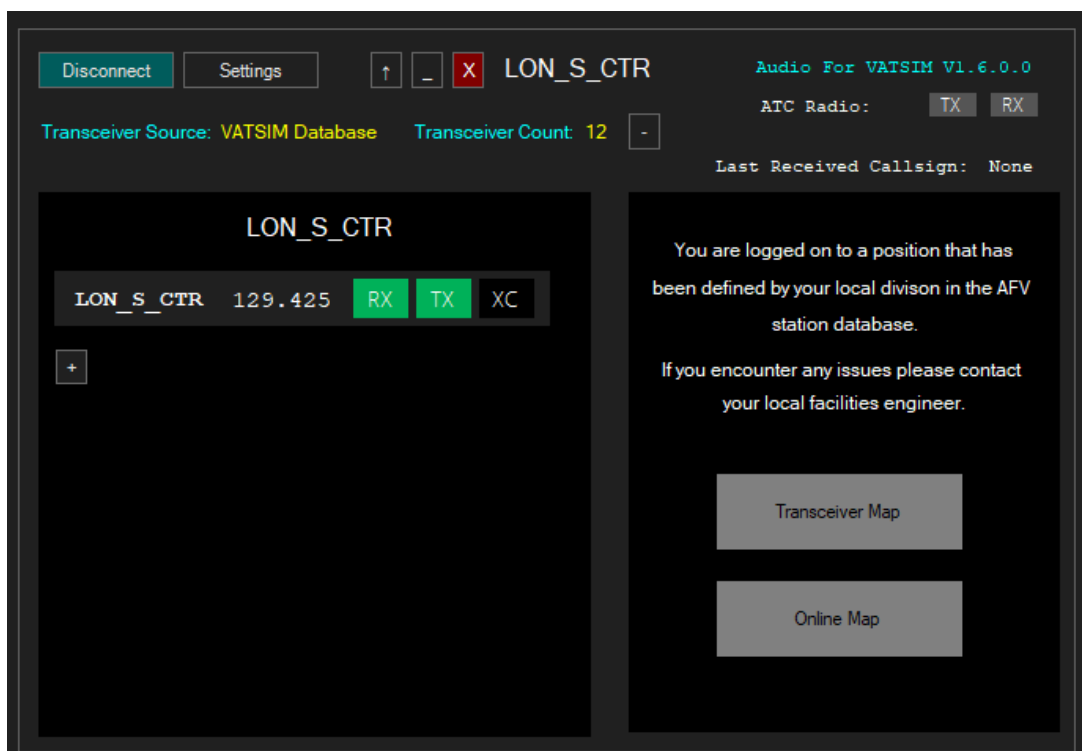
Above is the client window that will be displayed when you initially connect.

6.3 The AFV VCCS Panel

The area on the left-hand side serves as your Voice Communication Control System (VCCS). Here you will see a list of available stations and frequencies as defined for the position by your local Facility Engineer (FE).

The topmost line will always display your primary frequency and position as set in your controller client.

6.3.1   Monitoring or Observing Other Stations

If you wish to monitor or observe a station which is not already available in the VCCS, click the + icon, and enter the callsign of the station you wish to add:
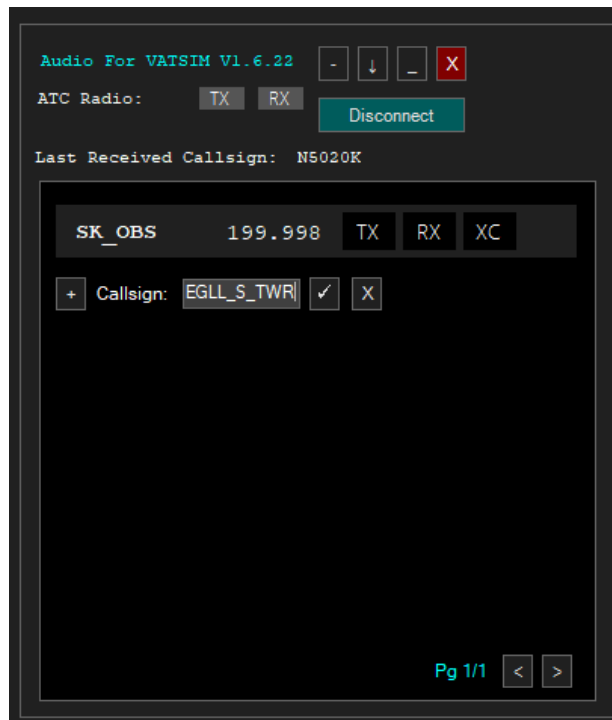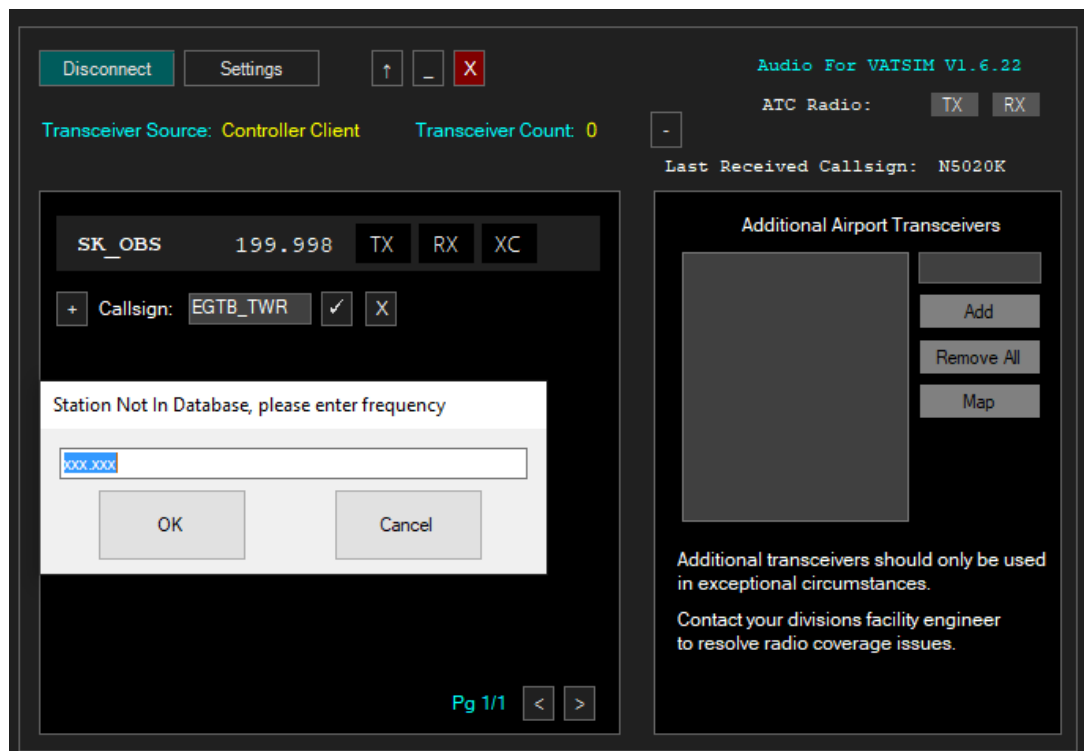

Click the tick or press Return.

If the callsign is defined in the Facilities Database, its full VCCS panel will be added to your VCCS list. This is particularly useful if you are logging on to take over a position from another controller.
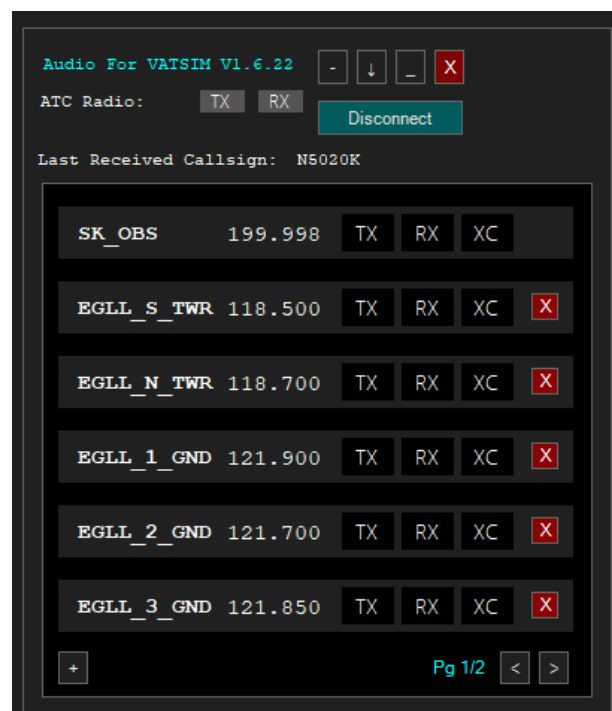
If you wish to add an **airport** positon that is **not** defined in the facilities database, you will be asked to enter a frequency:

Enter the frequency of the position you want to add and click OK. A transceiver will be added at the co-ordinates of the airport entered (e.g. EGTB for EGTB_TWR above).

A full description of transceivers as applicable to ATC positions is found below.

To **Receive** on a frequency, click the **RX** button so that it lights up green (as shown above).

To **Transmit** on a frequency, click the **TX** button so that it lights up green (as shown above).

The **XC** button allows you to add a frequency to a cross-couple group (only relevant for positions with multiple frequencies and >2 transceivers). For more information see 6.5 Multi-Frequency Operation and Cross-Coupling.

CAUTION: **It is very important that if you wish to monitor another controller's frequency you ONLY select that frequency for RX, not TX and certainly never XC! If you select the XC button you will be relaying all transmissions from YOUR frequency on to the other frequency, and vice-versa, with predictably confusing results.**
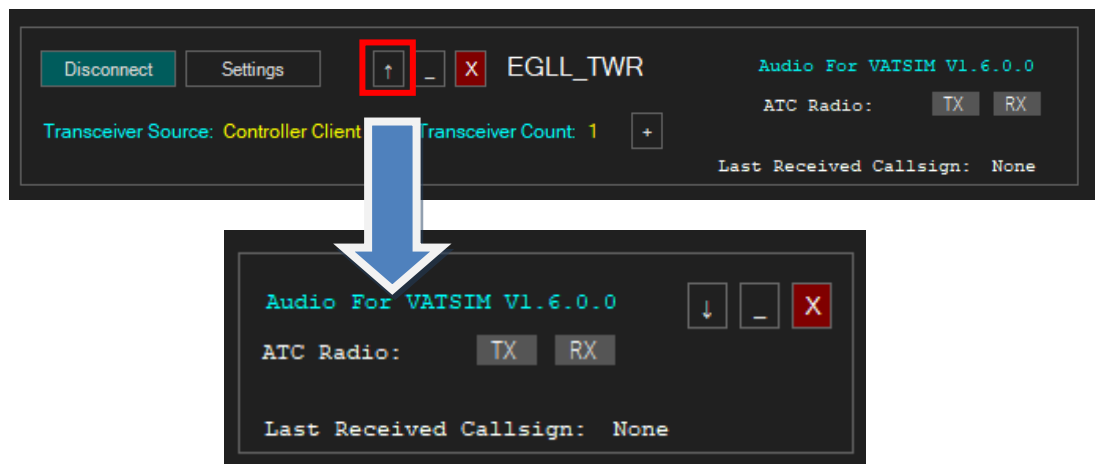
6.3.2   Standalone User Interface

The standalone client user interface can be 'collapsed' to take up less screen space and, if desired, sit 'always on top' of your ATC client window.

Click the minus sign next to the Transceiver Count to collapse the VCCS panel:
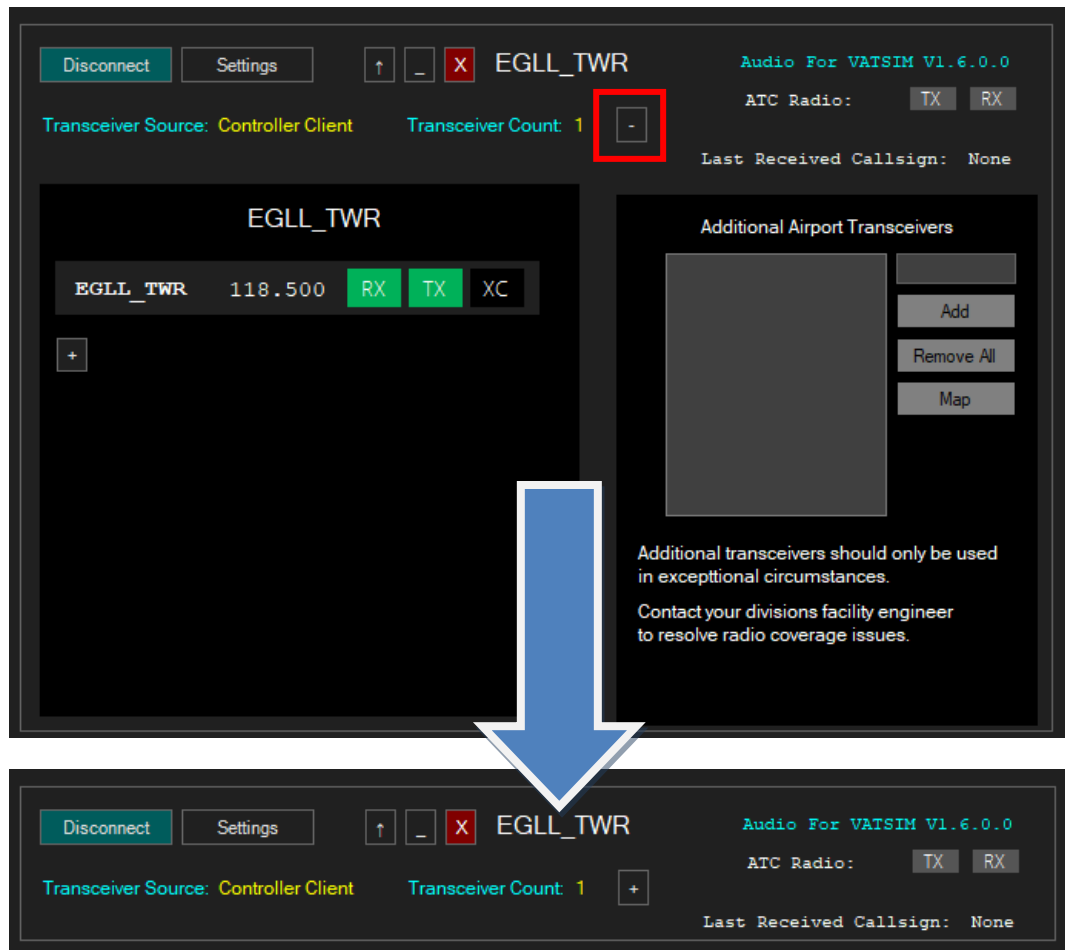
You can also collapse the UI further in to 'mini mode' using the up arrow button:

6.4   Transceivers

6.4.1   Introduction

There are two means by which transceivers are set for an ATC position depending on whether the position has been defined in the Facilities Database or not.

#### 6.4.1.1   Facilities Database Defined Positions

If the position **has** been defined in the Facilities Database, the standalone client will automatically download the appropriate transceiver locations and you will see **Transceiver Source: VATSIM Database** in the client window.

You **cannot edit** transceiver locations for a position which has been defined in the database. This is to ensure consistent results for pilots who would become very confused if one day there is radio coverage in a particular location and the next there is not! Should you have any problems related to radio coverage, you should contact your vACC/ARTCC's Facility Engineer who will be able to advise further.

In many cases the transceiver locations will have been set up based on real-world transceiver locations and sector assignments.

6.4.1.2   Undefined Positions

If the callsign you are logging in to has *not* been defined in the Facilities Database, the AFV client will instead use your ATC client radar visibility centres to locate your transceivers. You will see **Transceiver Source: Controller Client** in the client window.
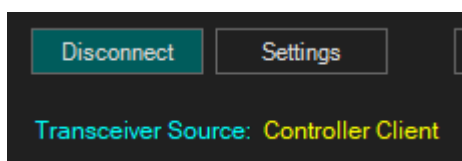
You can configure up to four 'main' visibility points in your ATC client. If extra coverage is required at ground level (i.e. for top-down coverage outside the range of the main visibility centres at ground level) the controller can also specify up to five additional airport ICAO codes where small 'top down' transceivers will be placed.
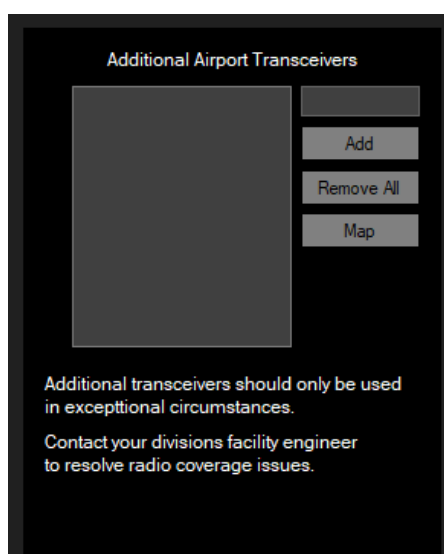
The height of transceivers is set based on the type of transceiver (main visibility point or additional airport transceivers) and the position type (DEL, GND, TWR, APP, CTR or FSS)

Position	Transceiver Type	Transceiver Height	Approx Max Range at Sea Level	Approx Max Range at FL350
Additional Airport	**Additional**	30 ft	7 nm	236 nm
DEL, GND, TWR	**Vis Point(s)**	30 ft	7 nm	236 nm
APP	**Vis Point(s)**	100 ft	12 nm	242 nm
CTR	**Vis Point(s)**	1200 ft	42 nm	272 nm
FSS	**Vis Point(s)**	1500 ft	48 nm	278 nm

As a controller if you are logged on to a position which has not been defined in the Facilities Database it is important that you ensure your radar client visibility centre is located in an appropriate location. This is particularly important for GND or TWR positions which are less likely to be defined in the database.

For details of how to configure visibility points, refer to your ATC client's documentation.

If you are operating a local position such as GND, TWR or DEL it is not recommended to add multiple visibility points as you may inadvertently end up interfering with another station's radio transmissions!

6.5   Multi-Frequency Operation and Cross-Coupling

6.5.1   Introduction

Cross-coupling is the means by which a controller (both in reality and through AFV) is able to operate two or more frequencies simultaneously. AFV supports three different cross coupling methods:

- **Single-Frequency Coupling**
- **Simplex Coupling**
- **Duplex Coupling**

An overview of each variant along with advantages and disadvantages is shown below.

IMPORTANT NOTE: At the present time there is no means of displaying non-primary frequencies to other pilots and controllers. For this reason it is recommended that the use of non-primary frequencies is limited to avoid confusion with pilots being asked to switch to a frequency they cannot see in their ATC list!

6.5.2   Cross-Coupling Methods

6.5.2.1   Single-Frequency Coupling

This is a simple, but in most cases unrealistic, method of enabling pilots who are out of radio range of each other, but each in range of two **different** ATC transceivers, to hear each other.

Take the example overleaf:
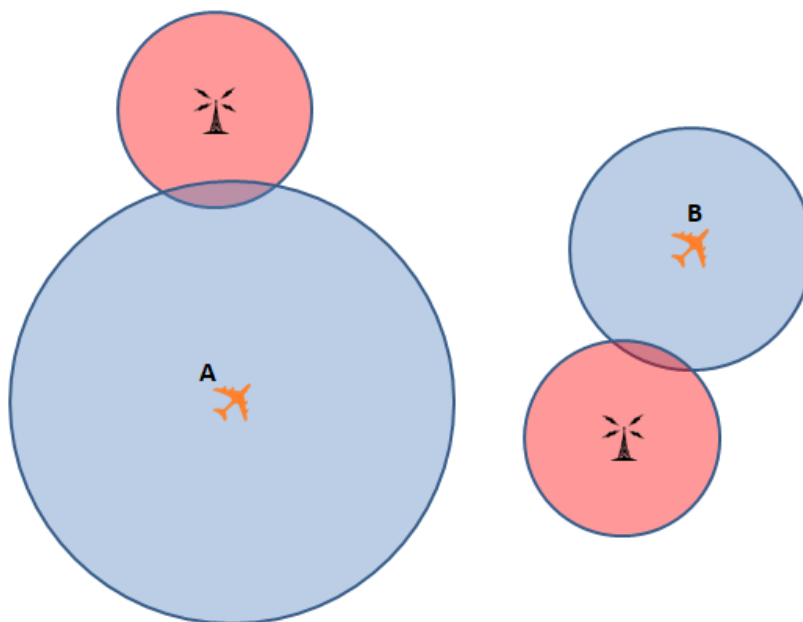
Here we have an example of a simple sector with two transceivers, whose sea-level range is shown by the red circles, both operating on the same frequency.

Both pilots (labelled A and B) will be able to hear and be heard by the controller as they are each in range of an ATC transceiver. However, Pilot A would be unable to hear Pilot B's transmissions and vice-versa – because they are not in range of *each other*. This could lead to them unknowingly transmitting over each other, for example.

Single-frequency cross-coupling solves this: when a transmission from Pilot B is received at the ATC transceiver, the received audio is fed to the other transceiver and re-broadcast so Pilot A will hear it.

Note that single-frequency cross-coupling can **only** work across **unique** transceivers: if we take this example:
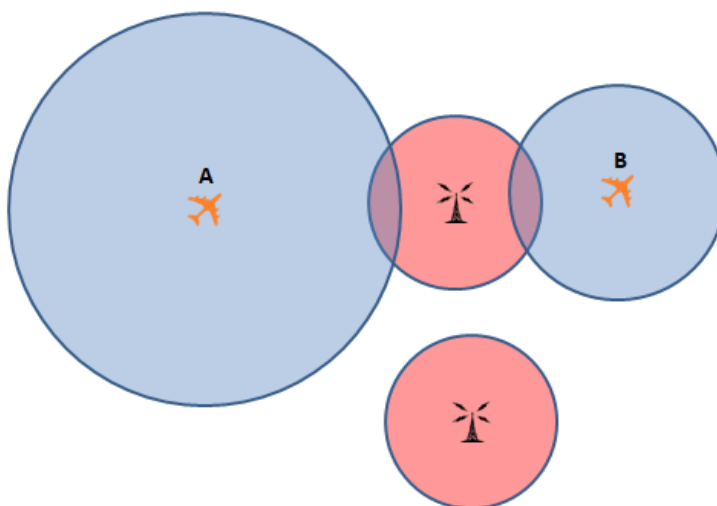
Here we are back in the same situation as if there were no cross-coupling: Pilot A and Pilot B will not be able to hear each others' transmissions as the ATC transceiver cannot cross-couple to itself!

6.5.2.1.1   Controller Client Selections & Indications

To enable single-frequency cross-coupling on a station with more than 2 transceivers, all the controller needs to do is select their primary frequency to **RX/TX** and enable **XC**:
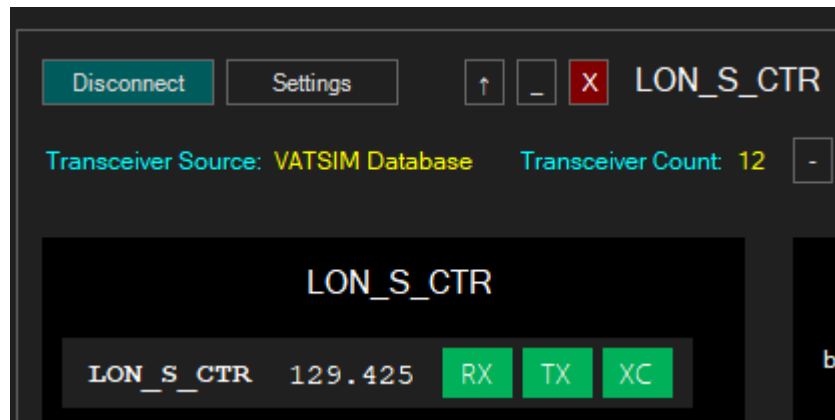

All 12 transceivers on 129.425 are cross-coupled together

6.5.2.2   Simplex Coupling

Simplex coupling is the most basic form of multiple-frequency operation. The controller receives and transmits simultaneously on all selected frequencies, but there is no rebroadcasting of transmissions between frequencies – so a pilot on Frequency 1 will not hear transmissions by pilots on Frequency 2.

This form of coupling is used in some real-world facilities where it is technically not possible to add a particular frequency to the cross-couple group (one real-world example might be where a Tower position is operating both a VHF frequency for civilian traffic and simultaneously a UHF frequency for military traffic). However it is far from ideal!

Simplex coupling is achieved in AFV by the controller selecting two or more frequencies to RX and TX, but **not** selecting the XC button.
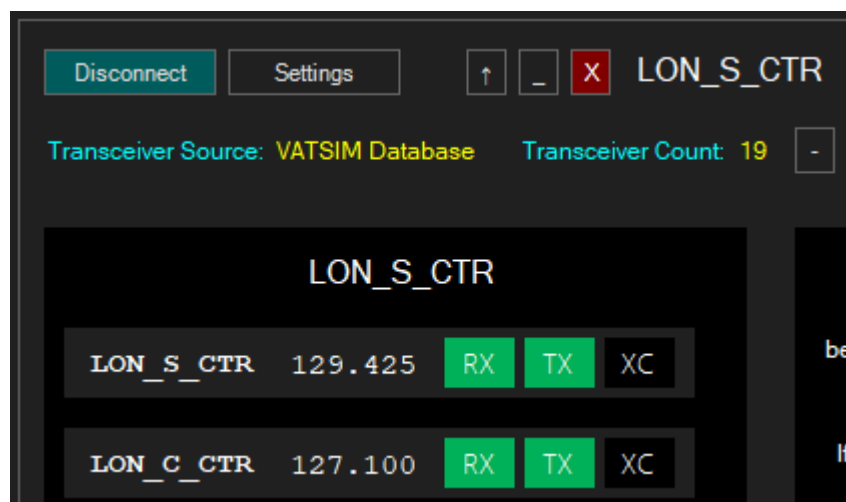

The controller is transmitting and receiving on 129.425 and 127.100 simultaneously from the transceivers associated with each station, but there is no coupling on the frequencies either individually or between 129.425 and 127.100

6.5.2.3   Duplex Coupling

Duplex coupling is where a controller has two or more discrete frequencies selected and added to a cross-couple group.

Transmissions by a pilot received by ATC on Frequency 1 are rebroadcast to Frequencies 2 and 3 and vice-versa so that all pilots can hear each other. ATC transmissions are broadcast on all selected frequencies simultaneously.

Controllers enable duplex cross-coupling via the VCCS by selecting **all** frequencies they desire to add to the cross-couple group to **RX/TX** and **XC**.
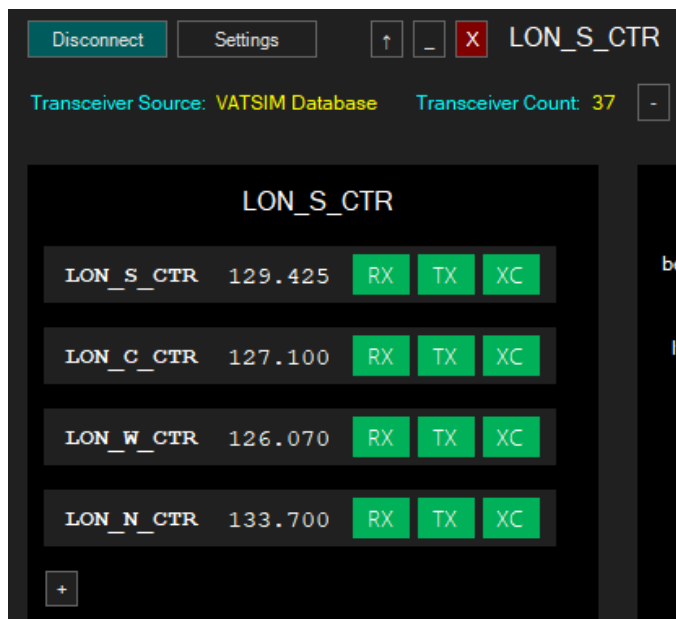
All four frequencies are cross-coupled so that all pilots should hear each other irrespective of which of the above frequencies they are tuned to

Currently in AFV all duplex-coupled frequencies will also automatically be single-frequency coupled on their own frequency.

6.5.3   Range Effects with Cross-Coupling

Cross-coupling has an impact on signal degradation between pilots in the cross-coupled group.

The degradation effect is summative – because the transmission received by ATC will be imperfect. This imperfect transmission is then rebroadcast and will degrade further.

As an example, if Pilot A's transmission is received by its best ATC transceiver at a quality level of 0.8 (with 1 being perfect quality and 0 being no reception), and this is rebroadcast to Pilot B whose quality level from their 'best' ATC transceiver is 0.4, the resulting quality of Pilot A's transmission as heard by Pilot B will be 0.8 x 0.4 = 0.32. There is no effect on how ATC hear either pilot's transmissions.

6.5.4   Monitoring Text

It is **extremely important**, especially before ATC client integration is completed, to ensure that any frequency selections you make on the AFV VCCS panel are mirrored on your ATC

client's communications panel so that you are also receiving and transmitting text on those frequencies.

For Euroscope users, a plugin to synchronise the Euroscope communications with the AFV VCCS panel is available.

6.5.5   Cross-Coupling Considerations

6.5.5.1   Limitations

A maximum of **15** distinct positions may be monitored and/or cross-coupled simultaneously via the VCCS panel. **This is a limit not a target, and in practice it is impractical for a single controller to operate more than four or so frequencies simultaneously at the most. Cross-coupling operation comes with numerous significant drawbacks in real-world systems, many of which are also present in AFV and controllers should familiarise themselves carefully with the following notes.**

6.5.5.2   Simultaneous Transmissions

Controllers should be aware that in cross-coupled operation the likelihood of blocked and unheard transmissions (Undetected Simultaneous Transmissions) is increased.

If, for example, two aircraft transmit simultaneously on different cross-coupled frequencies or transceivers, you may hear a garbled mixture of the two transmissions or your **may** only hear the first aircraft to transmit (as your transceivers on the other frequency will have switched in to TX mode and therefore are unable to receive the other pilot's transmission).

This is a realistic scenario: see the section on USiT. This is a **very good reason** to be sensible about the number of cross-coupled frequencies you have in operation!

6.6 ATIS

6.6.1 Euroscope

In order to put an AFV ATIS up with Euroscope, you only need to connect a text ATIS. The AFV ATIS server will synthesise the voice ATIS from the generated ATIS text.

Do not "Start multiple record playback" in the voice ATIS setup dialogue.

In the voice communications dialogue, you only need the ATIS box checked. The XMT/RCV VOI boxes should not be checked.

6.6.2 vATIS

vATIS users do not need to do anything different to post an AFV ATIS – simply configure vATIS as normal and that AFV ATIS server will synthesise the voice ATIS from the ATIS text.

Recorded ATIS is not currently supported.

6.7 Simultaneous (Blocked) Transmissions

6.7.1 General

Section 5.3.6 Simultaneous (Blocked) Transmissions provides an overview of the general considerations around SiT.

As a controller, remember:

- Your radio (along with all pilots' radios) is half-duplex (see 5.3.4.1 Half-Duplex Operation) and you cannot receive at the same time as you are transmitting.
- Managing the frequency is an important ATC skill. If you are aware of two stations transmitting at the same time do inform the pilots that the transmission was blocked (as they are unlikely to be aware) and take pro-active steps to control the order of calls (e.g. "Two stations at once, BAW123 first...") – you should generally be able to make out a mixture of both calls.
- Be aware of the risks around Undetected Simultaneous Transmissions (USiT) and particularly the possibility that one of your own transmissions may be blocked or stepped on without your knowledge.

7   Frequently Asked Questions

7.1   General

Will AFV work with my audio routing solution (e.g. Virtual Audio Cable)?

As Audio for VATSIM is just a change to the codec you should still be able to use an audio routing program as you currently do. However the AFV team will not provide support for them.

Do I need a new microphone/headset?

Not if it currently works with VATSIM. As voice quality is much higher, you may desire one so we can hear your beautiful voice more clearly!

Another user just asked me to adjust my microphone. What does that mean?

Audio for VATSIM requires you to calibrate your microphone within the client you are using. Please go to the settings and adjust the microphone gain slider until you can talk with most of your speech within the green band.

Why can't I hear my voice back during the microphone calibration?

Playing your voice back to yourself is actually not a very reliable way of setting audio levels. Ensuring your speech is peaking mostly in the green area of the meter is by far the most reliable way to ensure consistent results.

Why are some pilots/controllers louder than others?

AFV Simulates VHF ranges, so the further away from another pilot or controller you are, the less you may be able to hear them or the more static you may hear in a transmission. If you believe you are sufficiently in range, they have not set up their volume correctly. You could advise them to change it in the settings.

Are 8.33 kHz frequencies supported?

Audio for VATSIM has the capability to support 8.33 kHz but unfortunately Simconnect for FS9, FSX, and P3D does not. Should that change in the future we will certainly implement it!

I am an add-on developer and I want to integrate AFV into my software.

Contact vpdev@vatsim.net

I love Audio for VATSIM and I want to do something in return.

As with everything on VATSIM this is totally free to the users. Just enjoy the experience and if you really want to give something, consider donating to one of the WorldFlight team charities in November.

7.2   Pilots

Why can't the controller hear me/why can't I transmit?

Have you selected "COM1" in your radio panel? Are your batteries on? AFV Requires you to properly configure your radios!

Some addon aircraft may also require your COM1 MIC button on the Audio Control Panel in the cockpit to be selected ON as well.

I am on a frequency with ATC, but why is it completely silent?

Either no one is transmitting, or someone is transmitting, but you cannot hear it. Double check you are not actively transmitting or having an open mic and that your radio volume knob is turned up in the cockpit.

I've done all this and I still can not hear the controller and he still can not hear me.

You may actually be in a radio dead zone where your aircraft is not in the range of any of ATC's radio towers. Private message the controller to verify this and if you are, request further instructions from ATC over private message. As you climb your radio range will increase and once high enough your radio range will be within that of an ATC radio tower.

I can hear other pilots but not the controller, and the controller can't hear me either. What's going on?

See above. It is possible that you may be too low to be in range of an ATC transceiver but you may still be in range of other nearby aircraft.

Why don't I hear a blocking tone when I transmit over somebody else, or somebody else transmits over me?

Radio is half-duplex, so you either receive or transmit. Anyone else on the frequency will hear the blocking tone if two or more people transmit at the same time. Please be mindful of this before speaking on frequency.

Why don't I hear other people transmitting when I am?

Aviation radios are half-duplex. You cannot receive at the same time as transmitting. Be mindful of this when you start to transmit and make sure you listen carefully to ensure you are not going to step on somebody else's response to a transmission.

Why can I transmit on any frequency?

Frequencies do not "open" or "close". They are used or unused, and you can always transmit voice on any frequency. To figure out which frequency to transmit to, check the ATC in your area and which frequency they are using. If there is no ATC in your area, use UNICOM (122.800).

If all frequencies are available, why can't I use the local frequency for my airport when no ATC is online?

To ease the transition to Audio for VATSIM, we are sticking with the legacy UNICOM (122.800) to start. Moving to discrete (local) Common Traffic Advisory Frequencies is in our future plans.

Can I use the new voice codec to chat with my friends?

As before, bandwidth and server capacity on the VATSIM network are donated resources. Do not use radios for anything other than ATC communication or traffic coordination when no ATC is online. Unauthorized use of the frequencies could lead to certificate actions under VATSIM Code of Conduct A1.

7.3   Controllers

Which clients can I use to connect once AFV is launched?

All currently supported clients are available but must be used with the AFV Client. Special shortcuts are available on the beta website so you don't interfere with the live network. *Soon™* ATC clients will be updated to use AFV without the extra client.

Do I need to update my sector files for AFV to work?

No

The RDF-Plugin for Euroscope is no longer working, what should I do?

The RDF Plugin Uses data from a source that doesn't work with AFV.

Do I need to bandbox multiple DEL/GND/TWR/APP Frequencies?

Your Facility Engineer (FE) will know more, but there should be no need to transmit any differently than the way you already do pre-AFV.

I've logged in as GND/TWR/APP but aircraft seem really crackly/I can't hear aircraft on the ground/on the ILS even though they should be well within range…

The default visibility centre in your sector file may be somewhere other than your airport. Try forcing the radar visibility centre to your airport in order to update your transceiver location.

My Transceiver doesn't cover the entire airspace I'm controlling, what should I do?

Contact your local Facility Engineer (if you are a Facility Engineer who needs help, please reach out to the team leader).

How do I set my transceiver locations?

This will depend on whether your local ARTCC/vACC has a Facility Engineer who has configured your airspace.

If the position you are logging on to has been pre-configured, your transceivers will be automatically downloaded from the AFV facility database and you will not be able to edit these -- this is to ensure consistent results for pilots and minimise the likelihood of frequency clashes with adjacent facilities.

If the position you are logging in to has not been pre-configured, your transceivers will automatically follow your controller client visibility points. You can add up to four 'main' transceivers by adding radar visibility points, and you can add smaller 'top down' transceivers for airports outside of the coverage of your main transceivers using the AFV ATC client.

What is the range of my radio transceivers?

This will depend on the height of your transceiver, the height of the receiving aircraft and to a lesser extent whether your sector has been pre-configured by your local Facility Engineer or you are using controller client visibility centres. If you are using controller client visibility centres, your own transceiver height is set based on the type of facility you are connecting as.

All 'top down' transceivers added through the ATC client have the same specifications as DEL, GND and TWR transceivers.

The circles displayed on the AFV ATC client represent the range of each transceiver at sea level.

Can I use AFV during Sweatbox training sessions?

Not at this time. Please use an alternative means of voice communication (e.g. Teamspeak/Discord) whilst conducting Sweatbox sessions to avoid disrupting the live network.

8　　Appendix 1: Technical Information for Developers

Further details of the Audio for VATSIM SDK will be released at a later date. If you are a developer who is interested in working with us, please reach out to us via the Audio for VATSIM Support Forum.