STUDIO ONNO

Instructions part 2:
Linking Dynamic Audio channels from Unity3D to Spatial Engine VR using Jack.

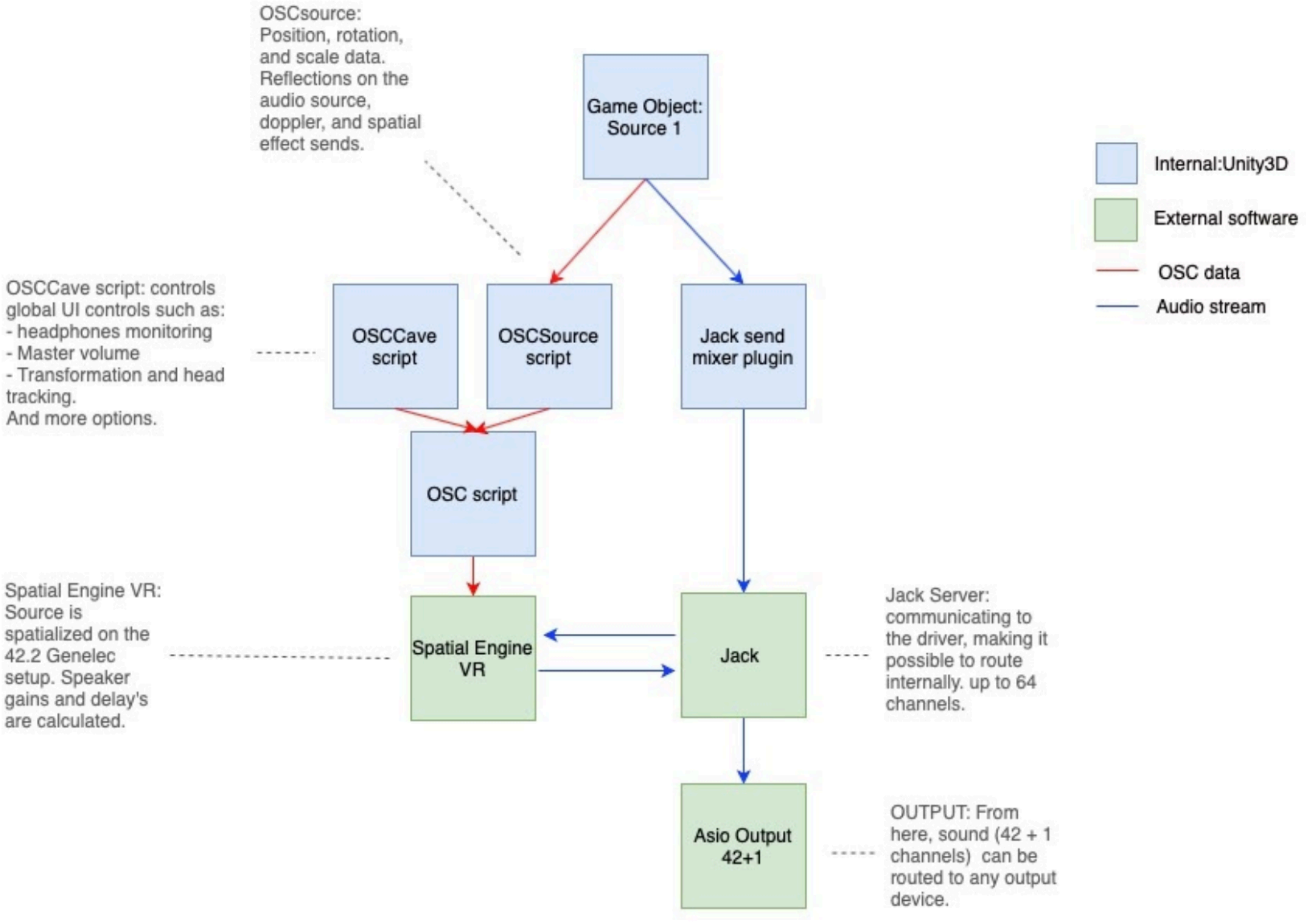
Platform: windows 10
Onno Spatial Engine VR
Jack Audio Connection Kit 1.9.11

Date: 10-12-2020

0: Objective:

> In this document we will go over the basics for creating a "HelloWorld" Setup.
> Set up a system for spatializing audio on the Genelec 42.2 system using Unity3D.
> 1 meter in Unity3D, equals 1 meter of sound movement in the real world.
> Building the Fundamentals for dynamically controlling up to 64 sources.

> The system we are building



OSCsource: Position, rotation, and scale data. Reflections on the audio source, doppler, and spatial effect sends.
Game Object: Source 1
Internal:Unity3D
External software
OSC data
Audio stream
OSCCave script: controls global UI controls such as: - headphones monitoring - Master volume - Transformation and head tracking. And more options.
OSCCave script
OSCSource script
Jack send mixer plugin
OSC script
Spatial Engine VR: Source is spatialized on the 42.2 Genelec setup. Speaker gains and delay's are calculated.
Spatial Engine VR
Jack
Jack Server: communicating to the driver, making it possible to route internally. up to 64 channels.
Asio Output 42+1
OUTPUT: From here, sound (42 + 1 channels) can be routed to any output device.

Before we begin

> Make sure Instructions part 1: “Installation and preparation" is successfully completed.

- Jack Audio Connection Kit is installed and working.
- Spatial Engine VR is installed.
- ASIO4All is installed.
- Visual C++ dist. is installed, and Spatial Engine VR is working.
- Bottom Up ASLR is disabled.

> All steps must be completed before moving on to the next step. The order is important.

> On the desktop there are now 3 Shortcuts:

1: Jack PortAudio
2: Jack Control
3: Spatial Engine VR

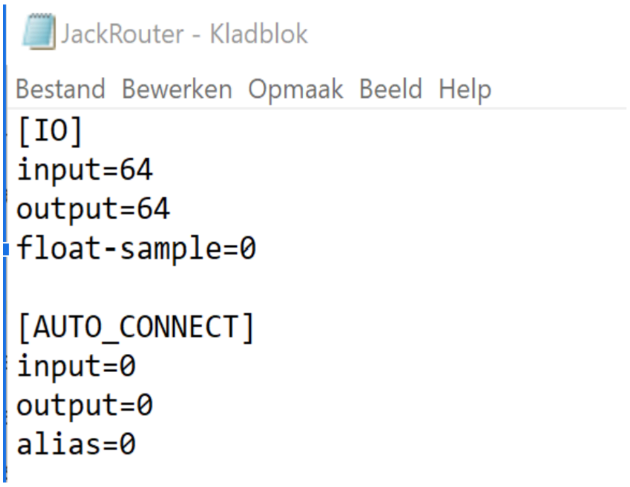
> It's best to reboot your computer and start from a clean slate.

1: Jack Audio Server configuration: Optimizing for Unity3D

1.1: Configure jack to run with 64 channels.

We need input channels, to receive audio from Unity3D, and at least 43 output channels to send to the Genelec speaker system. In this tutorial we will set up the server for maximum use: 64 channels IO.

> Navigate to your Jack 64 bit installation folder: *C:\Program Files\Jack\64bits*
> Open JackRouter.ini file as administrator.
> If the file can’t be edited: drag it out of the folder, and back in once edited.
> Set the number of inputs and outputs to 64 (maximum)
> Set auto-connections to 0 if you don't want jack to start making connections on it's own.



```
[IO]
input=64
output=64
float-sample=0

[AUTO_CONNECT]
input=0
output=0
alias=0
```

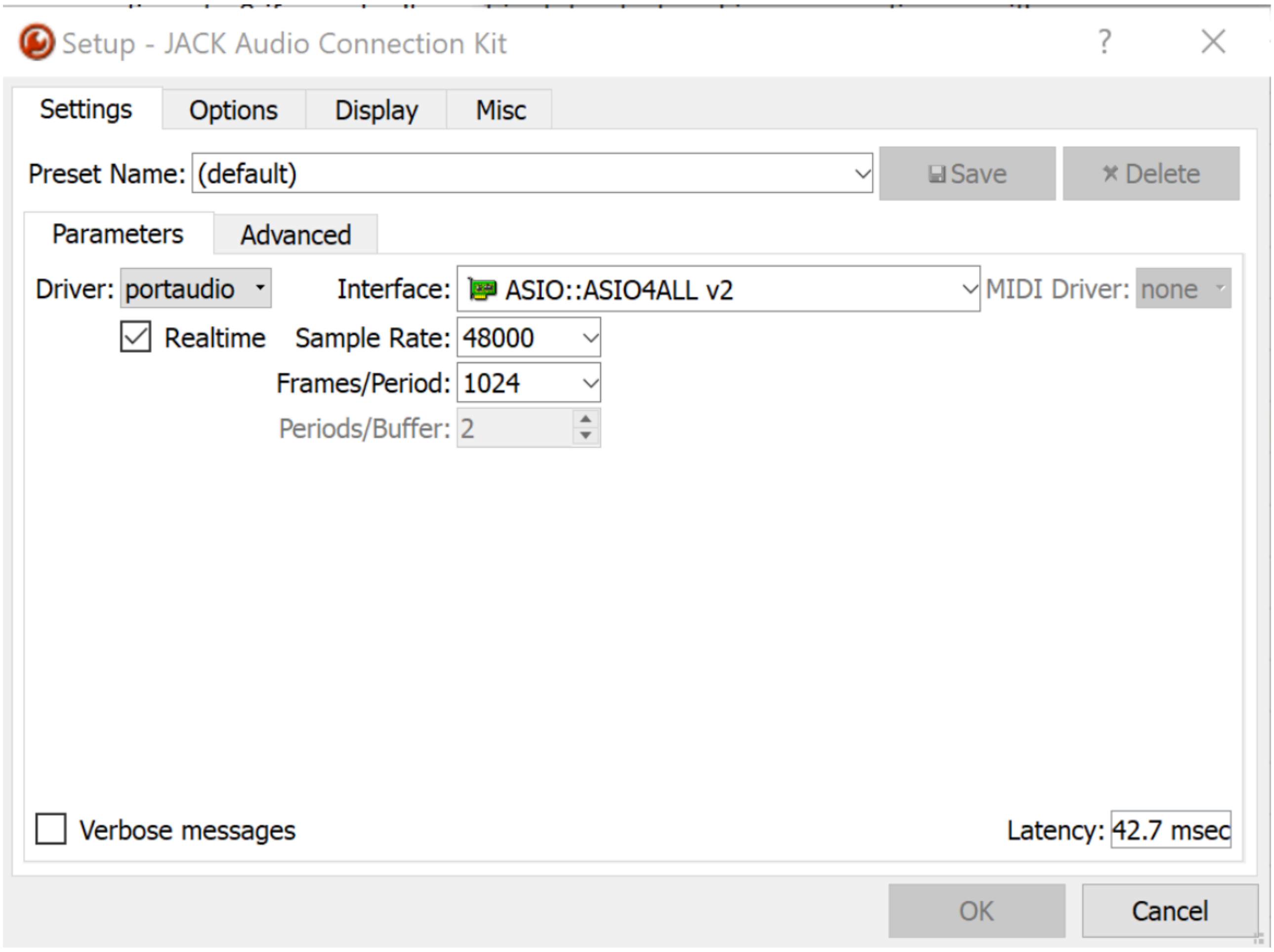
1.2 Start PortAudio

> Open Jack portAudio.exe

1.3: Configure the server using Jack Control

We have already set some backend parameters using the port Audio shortcut. Even without Jack Control, the server should boot in the right configuration. We will use Jack Control to make the connections and configure the server further.

> Open Jack Control.exe
> Navigate to “Setup".
> Match these settings:



Preset Name: (default)

Driver: portaudio

Interface: ASIO::ASIO4ALL v2

MIDI Driver: none

☑ Realtime

Sample Rate: 48000

Frames/Period: 1024

Periods/Buffer: 2

□ Verbose messages

Latency: 42.7 msec

Server settings can only be changed when the server is not running.

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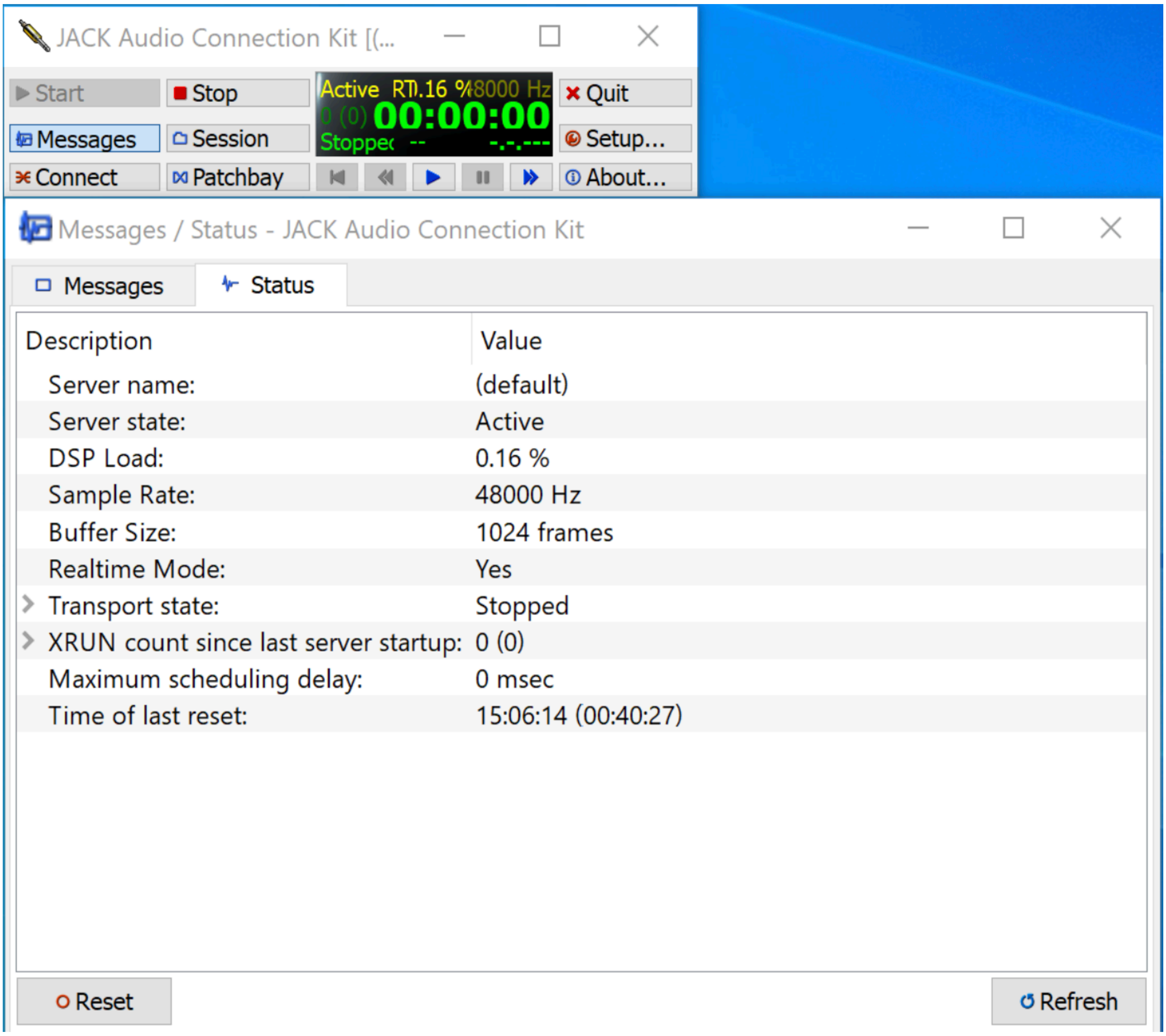
1.4 Start the server

When the server is running, Jack Audio will present itself as a driver on your computer. This virtual driver allows for loopback communication.

> In Jack Control: click "Start".
> Navigate to "Messages" > Status to see the realtime server configurations.
> Status window should look like this:
> It is important that the server is running on 48000 Hz, 1024 frames.



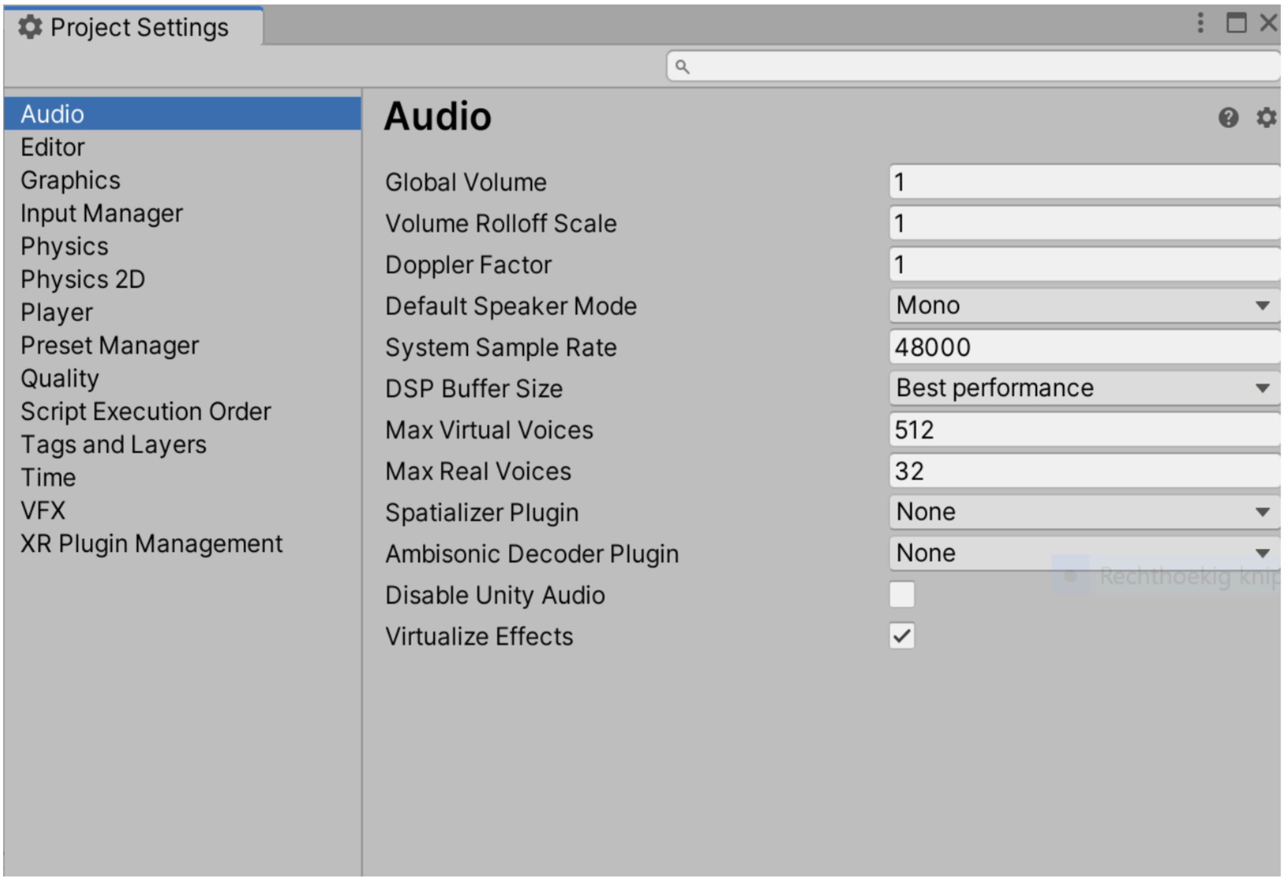
Description	Value
Server name:	(default)
Server state:	Active
DSP Load:	0.16 %
Sample Rate:	48000 Hz
Buffer Size:	1024 frames
Realtime Mode:	Yes
Transport state:	Stopped
XRUN count since last server startup:	0 (0)
Maximum scheduling delay:	0 msec
Time of last reset:	15:06:14 (00:40:27)

- *The server must be running first, otherwise clients cannot connect to it.*
- *XRUN Count should be 0: an Xrun error occurs when a package could not be delivered in time, resulting in stuttering audio.*
- *Transport functions are for synchronizing a midi-clock to other programs, for example when working with a shared timeline.*
- *Sessions can be used to save the current configuration of the audio setup in a preset.*
- *Patch-bay: create custom socket connections for applications with build-in jack support.*

> For more information about Jack: https://github.com/jackaudio/jackaudio.github.com/wiki

2,1: Unity project audio settings

> Start a new Unity3D project.
> Navigate to: Edit > Project settings > Audio.
> Match these settings:



Audio

Global Volume	1
Volume Rolloff Scale	1
Doppler Factor	1
Default Speaker Mode	Mono
System Sample Rate	48000
DSP Buffer Size	Best performance
Max Virtual Voices	512
Max Real Voices	32
Spatializer Plugin	None
Ambisonic Decoder Plugin	None
Disable Unity Audio	☐
Virtualize Effects	☑

- *The default block size for Unity3D is 1024 samples This is equal to "DSP buffer size: best performance mode”.*
- *Default Speaker Mode is set to mono because Jack sources are mono.*
- *The default System Sample Rate for Unity3D is 48000 hz. Our JackServer is running at this rate. it is important these numbers match.*
- *We don't need a spatializer plugin because we are doing the spatialization outside of Unity3D.*

2.2 Import Unity Package

> Navigate to Assets > Import package > Custom Package.
> Import Onno_spatial.unitypackage

Package contents:

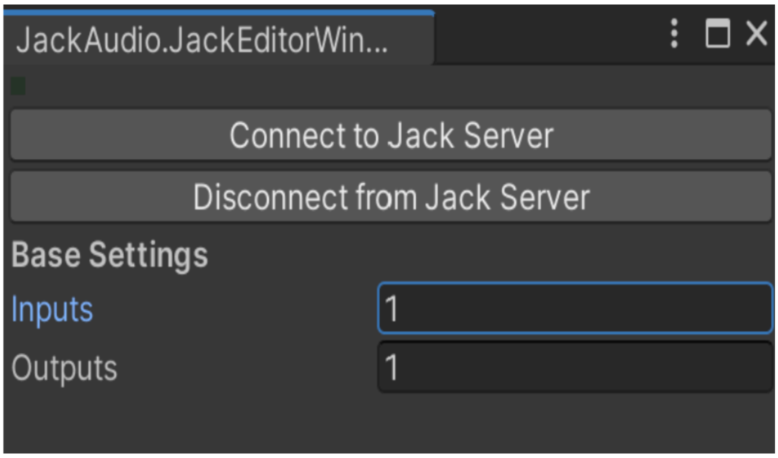
- Jack Audio for Unity mixer Plugin.
- OSC Scripts: For communication with Spatial Engine VR.
- Example Scenes

2.3 Connect Unity3D to Jack

> In Unity3D: Navigate to: Window > Jack.

> Set the number of inputs and outputs and click: "Connect to Jack Server"

> For the "helloWorld" example, we are just using 1 source.



Base Settings

Inputs 1

Outputs 1

> Unity3D now appears in: Jack Control > Connect.

2.4 Load example scene

> Navigate to: Assets > Scenes.

> Open the HelloWorld.unity example scene.

"HelloWorld" Example scene content

<u>AudioSource GameObject "Source 1”</u>

> Audio clip, sending audio to Mixer group 1

> OSC Source script: Spatial audio source params: position, scale(uniform), rotation(y axis), and more.

<u>Empty GameObject: "Cave Audio Master”</u>

> OSC script: Sends OSC data packages to Spatial Engine VR.

> OSC Cave script: Control Spatial Engine VR UI params such as: Volume, headphones mode, Transformation, head-tracking and more.

<u>Audiomixer Asset “Jack"</u>

> Master Bus

> Mixer group receiving audio from "source 1”

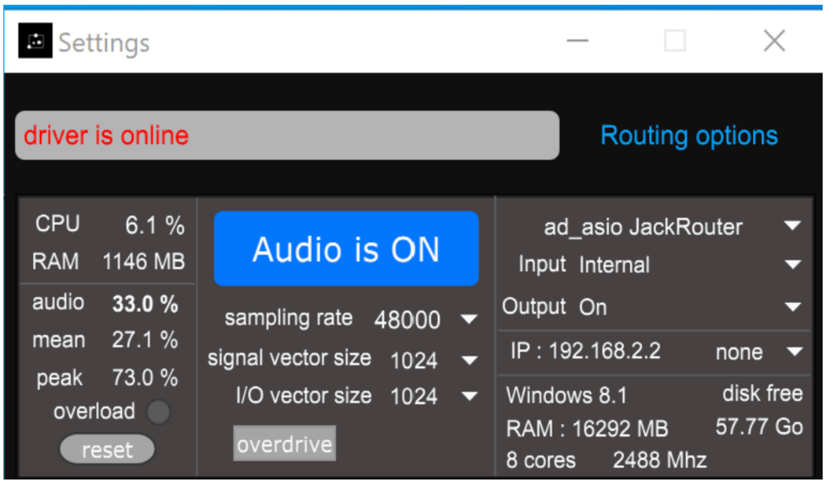
> Jack Send audiomixer Plugin: Sends audio to the first input channel in Jack audio.

<u>Spatial Listener</u>

> All source positions are relative to the spatial listener

> Display the loudspeakers as a static grid around the player.

> Make sure visual C++ dist. Kit is installed (follow Instructions part 1: Installation).
> Open Spatial Engine VR
> Navigate to “Settings".
> Set "ad_asio JackRouter as the audio driver”.
> Sample Rate and Buffer Size will automatically synchronize.
> You may need to click: "audio is on" to reinitialize the DSP.
> Your setup should look like this:



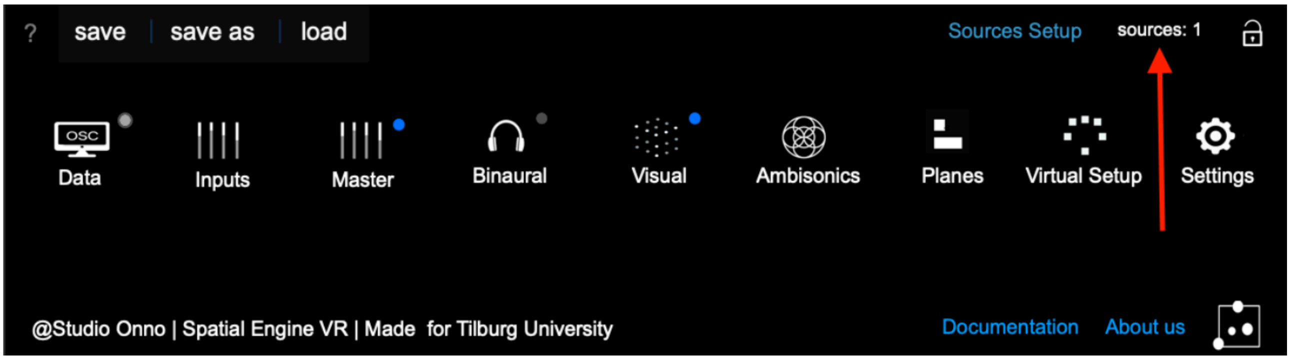
driver is online

CPU 6.1 %
RAM 1146 MB
audio 33.0 %
mean 27.1 %
peak 73.0 %
overload ○

sampling rate 48000
signal vector size 1024
I/O vector size 1024

ad_asio JackRouter
Input Internal
Output On
IP : 192.168.2.2 none
Windows 8.1 disk free
RAM : 16292 MB 57.77 Go
8 cores 2488 Mhz

Spatial Engine VR will remember audio driver settings and default to the last used driver if it's available.



Make sure the app is working correctly on your system.
In the upper right corner: the number of DSP sources is displayed. If this number displays: "off" something is wrong:

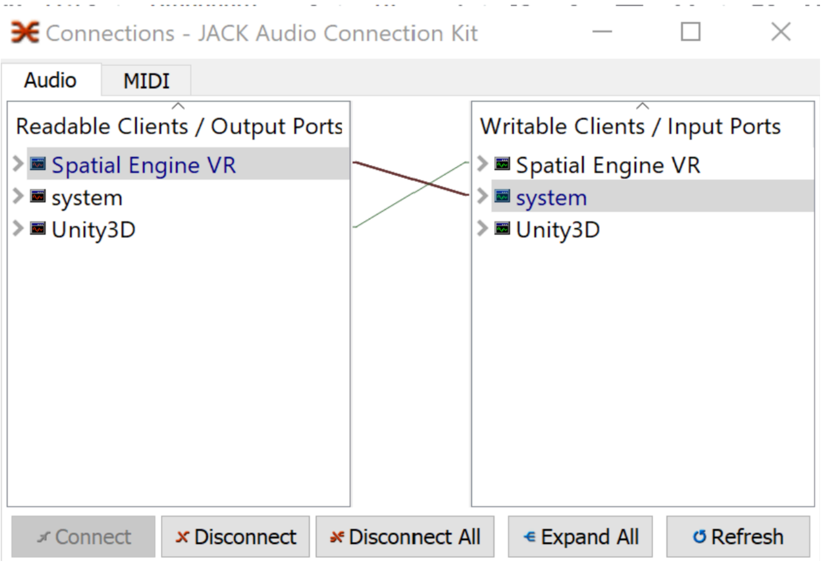
1: The audio driver is off.
2: Visual C++ Dist. Kit is not installed correctly.
3: A problem connecting to the driver. (reload it)

Most common problems:
Trying to connect to a corrupted audio driver may result in a crash. It is very important that Jack audio Server is running correctly before connecting to it. Check Jack PortAudio to see if there are any errors displayed when connecting either Unity3D or Spatial Engine VR. In any case, Jack is most likely to cause problems.

4.1 Connecting jack

5: Start the “Hello World” example scene

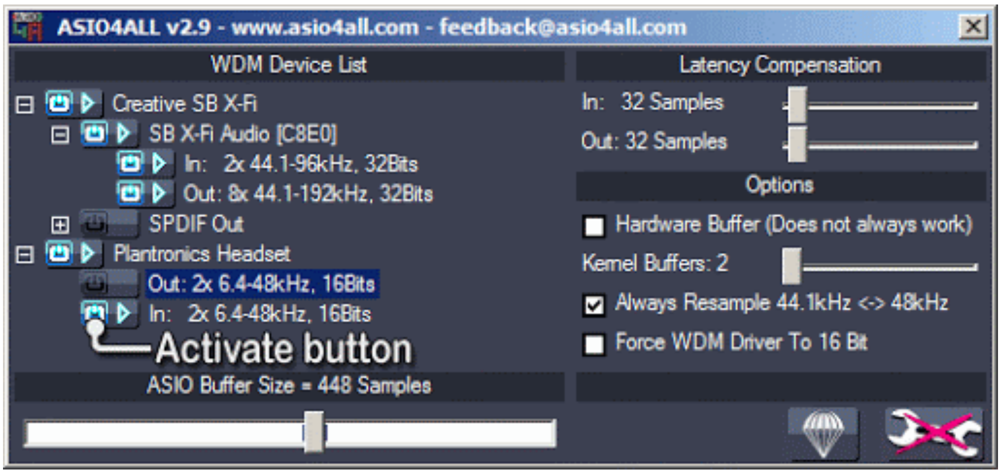
> Go to Jack Control.
> Click: “Connect".
> Connect Unity3D to Spatial Engine VR.
> Connect Spatial Engine VR to system output.



Attention: Be careful not to create any feedback loops when routing audio internally

4.2 System output device.

> Open the ASIO4ALL Control panel
> Enable your preferred output device.
> Be careful not to change fundamental parameters while Jack is running.


ASIO4ALL v2.9 - www.asio4all.com - feedback@asio4all.com

WDM Device List
- Creative SB X-Fi
  - SB X-Fi Audio [C8E0]
    - In: 2x 44.1-96kHz, 32Bits
    - Out: 8x 44.1-192kHz, 32Bits
  - SPDIF Out
- Plantronics Headset
  - Out: 2x 6.4-48kHz, 16Bits
  - In: 2x 6.4-48kHz, 16Bits

Activate button

ASIO Buffer Size = 448 Samples

Latency Compensation
In: 32 Samples
Out: 32 Samples

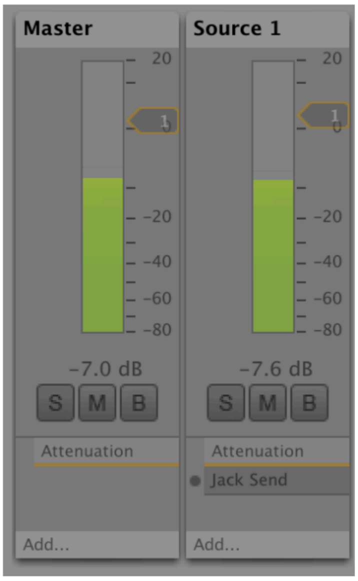
Options
□ Hardware Buffer (Does not always work)
Kernel Buffers: 2
☑ Always Resample 44.1kHz <-> 48kHz
□ Force WDM Driver To 16 Bit

Please be aware: ASIO4ALL is not the most efficient way to drive your interface. is only meant for tutorial purposes. We advice to switch to a dedicated Asia driver once your hardware setup is definitive. In order to do so, You must target the dedicated Asia driver in Jack PortAudio. Follow: Part 1: Installation and preparation

5.1 Audio stream from Unity to Spatial Engine

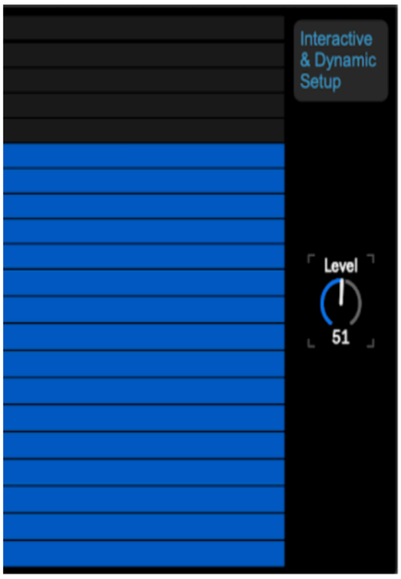
> Click the play button in Unity3D.
> Sound should now be streaming in to Spatial Engine VR: Source 1.
> In Spatial Engine VR, Navigate to "Inputs". There should now be sound streaming in.
> A volume adjustment in the Unity3D Mixer should be affecting the RMS meter in Spatial Engine VR.

Unity3D output



Jack Send (index 0)

Spatial Engine Input



Spatial Engine VR (source 1)

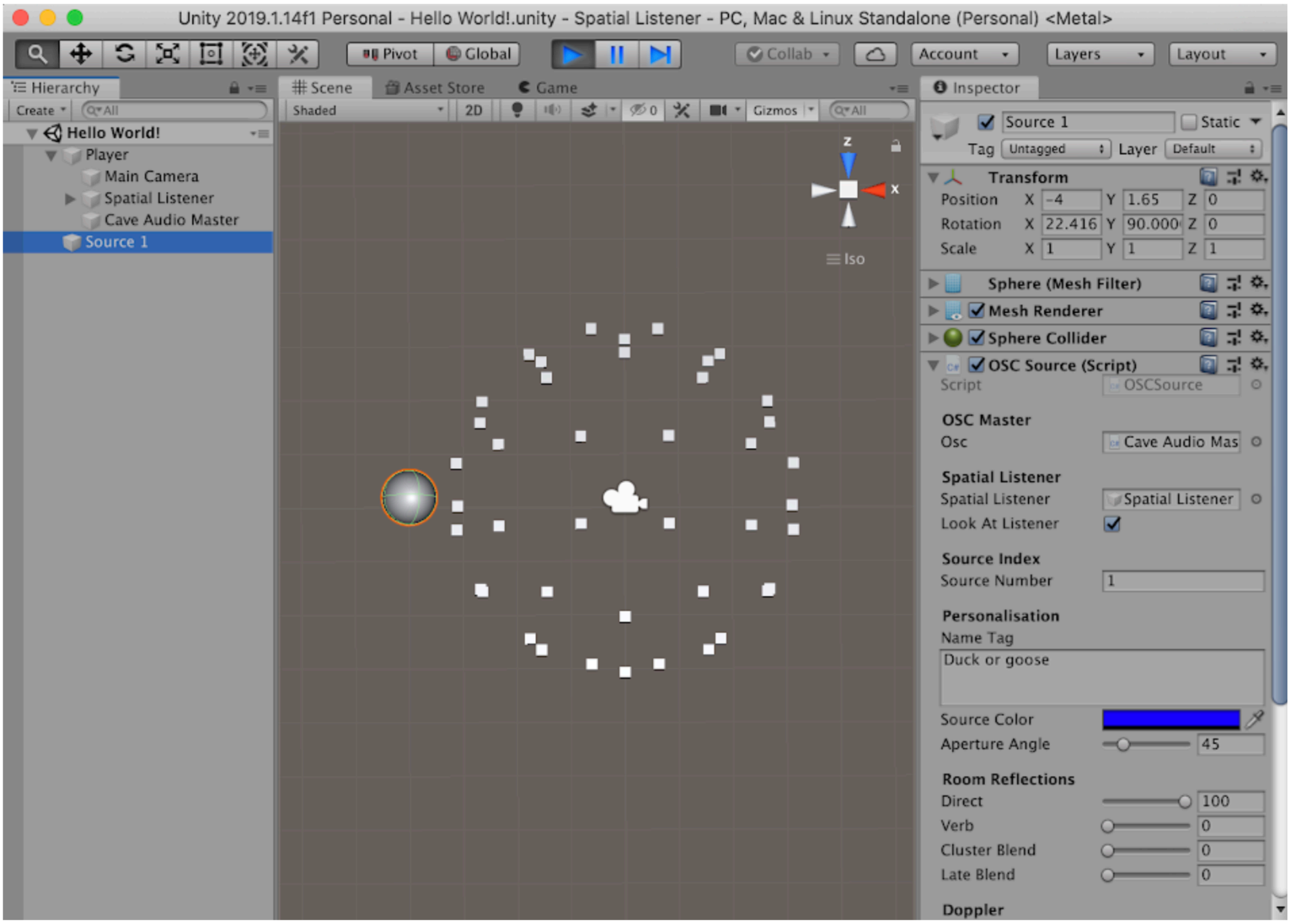
> To hear the sound: make sure either the Cave Output, or Headphones Monitoring is turned on in Spatial Engine VR.

IMPORTANT: Contrary to Unity3D's audio mixer, which lets you mix up to 20db+. Jack Audio will clip the signal on 0db, resulting in audible distortion. It is therefore important not to send any sound louder than 0db.

Still no sound?
> Make sure Jack audio is running, and everything is connecting
> Make sure Unity3D audio mixer has the “Jack Send” plugin inserted
> ASIO4ALL should be routed to a valid audio output

5.2 Moving the audio source (using OSC params)

> In Spatial engine VR: Open the Visualizer to see the system in action. Use WASDQZ to move around in the cave.
> Click "Data" to see the live OSC data coming in.
> In Unity3D: Move game object "source 1" to position the audio source in the cave.
> Scale the object to set the amount of spread over the loudspeakers (omnidirectional)
> Rotate the object (y axis only)



Unity 2019.1.14f1 Personal - Hello World!.unity - Spatial Listener - PC, Mac & Linux Standalone (Personal) <Metal>

Hierarchy:
- Hello World!
  - Player
    - Main Camera
    - Spatial Listener
    - Cave Audio Master
  - Source 1

Inspector:

☑ Source 1 □ Static
Tag Untagged Layer Default

Transform

	X	Y	Z
Position	-4	1.65	0
Rotation	22.416	90.000	0
Scale	1	1	1

Sphere (Mesh Filter)
☑ Mesh Renderer
☑ Sphere Collider
☑ OSC Source (Script)

Script: OSCSource

OSC Master
Osc: Cave Audio Mas

Spatial Listener
Spatial Listener: Spatial Listener
Look At Listener: ☑

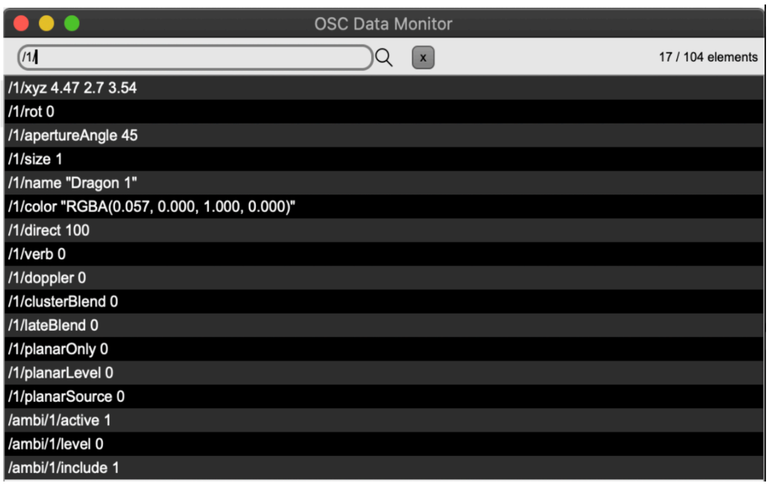
Source Index
Source Number: 1

Personalisation
Name Tag: Duck or goose
Source Color
Aperture Angle: 45

Room Reflections
Direct: 100
Verb: 0
Cluster Blend: 0
Late Blend: 0

Doppler

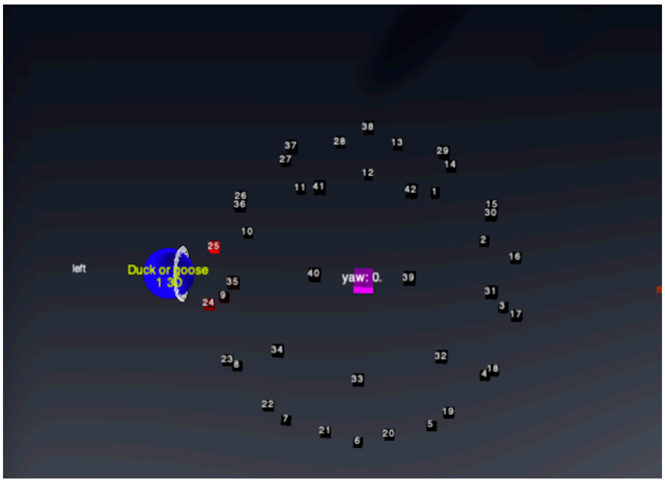
> Move the player around, the source will adjust position relative to the listener.
> In Spatial Engine: the source will follow the exact transform position:



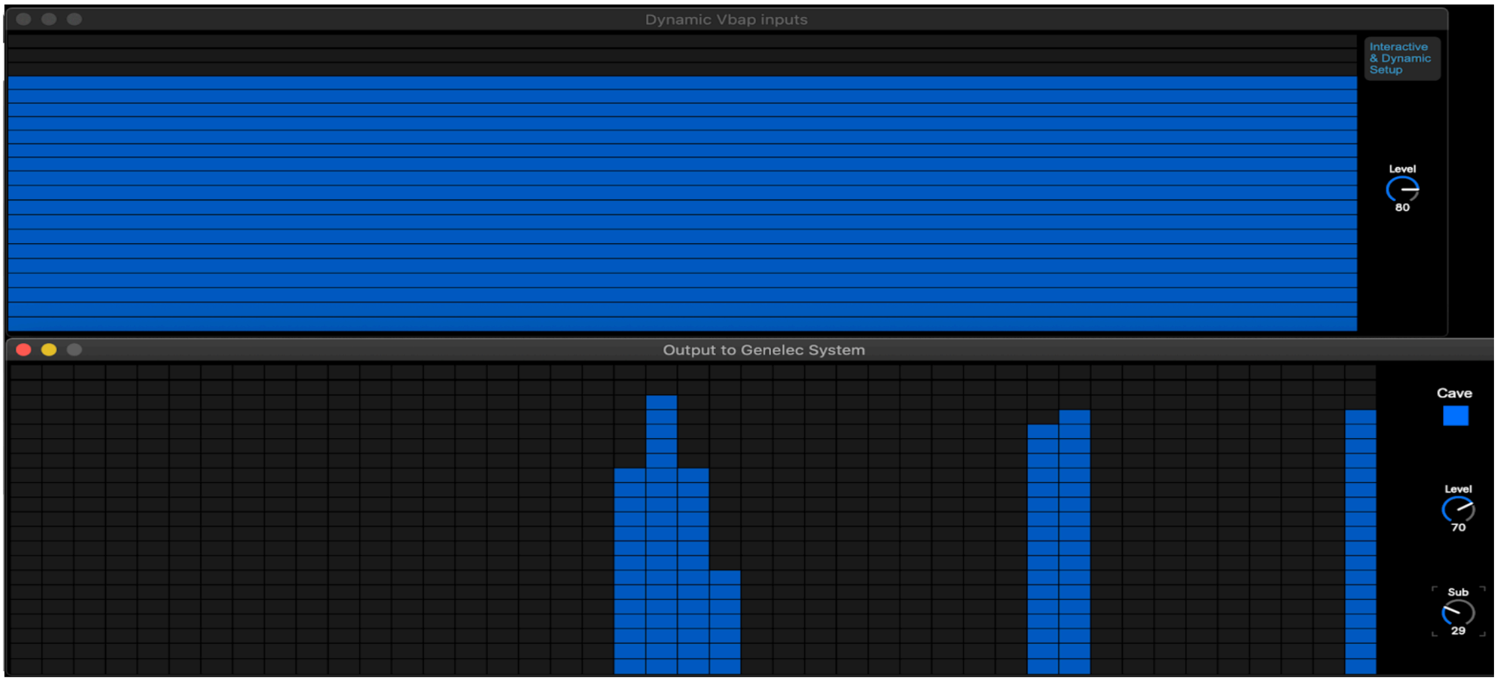
OSC Data Monitor

/1 17 / 104 elements

```
/1/xyz 4.47 2.7 3.54
/1/rot 0
/1/apertureAngle 45
/1/size 1
/1/name "Dragon 1"
/1/color "RGBA(0.057, 0.000, 1.000, 0.000)"
/1/direct 100
/1/verb 0
/1/doppler 0
/1/clusterBlend 0
/1/lateBlend 0
/1/planarOnly 0
/1/planarLevel 0
/1/planarSource 0
/ambi/1/active 1
/ambi/1/level 0
/ambi/1/include 1
```

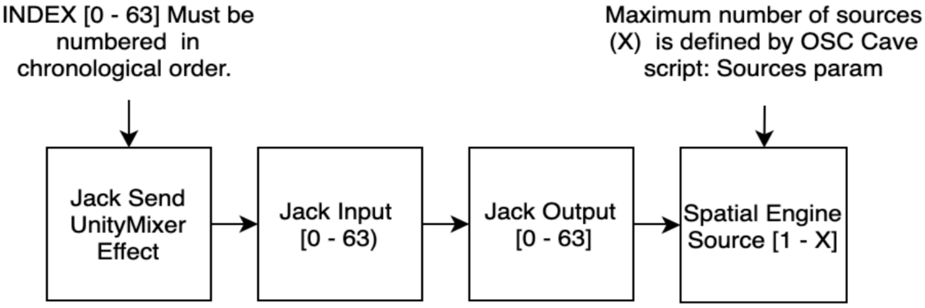


In spatial Engine: There is one input, 42 outputs + subwoofer channel. Speaker levels and phase differences are calculated based on the position of the source relative to the loudspeakers using Vbap3D.



5.3 Multiple audio sources

Unity3D: Go to Window > Jack, and change the number of IO to your desired number. hit "connect to jack Server"
> Add more Audio game objects, and assign them to mixer groups.
> Add OSCSource scripts to all new AudioSource GameObjects. Set a new SourceNumber for every object. [1, 2, 3, etc].
> Add the Jack Send plugin to all mixer groups, then assign a new index to every Jack Send plugin [0, 1, 2, 3, etc].
> OSCCave script: Change the number of sources. wait for the app to load new configuration. (audio will stop for a few seconds).
Jack Control: Make sure everything is connected.


INDEX [0 - 63] Must be numbered in chronological order.
Maximum number of sources (X) is defined by OSC Cave script: Sources param
Jack Send UnityMixer Effect
Jack Input [0 - 63)
Jack Output [0 - 63]
Spatial Engine Source [1 - X]

Hello World Complete!