



RENDERHEADS



AVPro Video

*for Android, iOS, tvOS, macOS, WebGL
Windows Desktop, Windows Phone and UWP*

Unity plugin for fast and flexible video playback

Version 1.9.6

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1. Introduction

AVPro Video is the newest video playback plugin from RenderHeads. We previously developed the AVPro QuickTime and AVPro Windows Media plugins for Unity. In this next generation of plugins we aim to create an easy to use, cross-platform video playback system that uses the native features of each platform.

1.1 Features

- Versions for iOS, tvOS, OS X, Android, WebGL, Windows, Windows Phone and UWP
- One API for video playback on all supported platforms
- *NEW* Facebook Audio 360 and Android ExoPlayer support
- 8K video support (on supported hardware)
- VR support (mono, stereo, equirectangular and cubemap)
- Transparency support (native and packed)
- Unity Pro 4.6.x and above supported
- Unity Personal 5.x - 2018.1.x and above supported
- Free watermarked trial version available ([download here](#))
- Fast native Direct3D, OpenGL and Metal texture updates
- Linear and Gamma colour spaces supported
- Graceful fallback in editor
- Components for IMGUI, uGUI and NGUI
- Extensive PlayMaker support
- Easy to use, drag and drop components
- Desktop support for Hap, Hap Alpha, Hap Q and Hap Q Alpha
- Streaming and adaptive video from URL

1.2 Trial Version

We offer an unlimited trial version of AVPro Video for download from our website at <http://renderheads.com/product/avpro-video/>. The trial version has no missing features or time restrictions but it does apply a watermark to the rendered output. The watermarking does have a small performance impact which is only really noticeable on very high resolution videos.

1.3 Media Credits

BigBuckBunny_360p30.mp4 - (c) copyright 2008, Blender Foundation / www.bigbuckbunny.org

BigBuckBunny_720p30.mp4 - (c) copyright 2008, Blender Foundation / www.bigbuckbunny.org

SampleSphere.mp4 - (c) copyright Daniel Arnett, <https://vimeo.com/97887646>

2. System Requirements

- Unity 2018.x, Unity 2017.x, Unity 5.x Personal Edition, or Unity Pro 4.6 and above
- iOS 8.1 and above
- tvOS 9.0 (Apple TV 4th Gen) and above
- OS X 10.7 and above, 64-bit only
- Android 4.0.3 (Ice Cream Sandwich, API level 15) and above (ARM7, ARM8 and x86)
- Windows XP (SP 3) and above (32-bit and 64-bit)
- Windows 8.0 and above (32-bit and 64-bit)
- Windows Phone UWP 8.1 (32-bit and ARM)
- Windows Desktop UWP 8.1 (32-bit, 64-bit and ARM)
- Universal Windows Platform 10 (32-bit, 64-bit and ARM)
- WebGL compatible browser

2.1 VR / AR / MR / XR Headsets Supported

- Microsoft Hololens (UWP)
- Windows mixed-reality headsets (UWP):
 - Samsung Odyssey
 - Asus
 - HP
 - Acer
 - Lenovo Explorer
 - Dell Visor
- HTC Vive (Windows desktop)
- HTC Vive Pro (Windows desktop)
- HTC Vive Focus (Android)
- Oculus Rift (Windows desktop)
- Oculus Rift Go (Android)
- Oculus Gear VR (Android)
- Google Cardboard (Android)
- Google Daydream (Android)
- Pico Goblin & Neo (Android)
- StarVR (Windows desktop)
- Lenovo Mirage Solo (Android)

2.2 Platforms not Supported

- WebPlayer
- Linux desktop
- Tizen
- Samsung TV
- Game Consoles (XBox*, PS4 etc)

** XBox One may be supported using UWP build option. We have not tested this though.*

3. Installation

1. Open up a fresh Unity session (to clear any locked plugin files)
2. Import the **unitypackage** file into your Unity project. If prompted to upgrade some scripts click Yes.

3.1 Trial Version & Watermark Notes

3.1.1 Watermark

If you are using a trial version of the plugin then you will see a watermark displayed over the video. The watermark is in the form of a “RenderHeads” logo that animates around the screen, or a thick horizontal bar that move around the screen. In Windows if the GPU decoding path is used when the watermark isn’t displayed - instead every few seconds the video size will scale down.

The full version of AVPro Video has no watermarks for any platforms. If you use one of the platform specific packages (eg AVPro Video for iOS, or AVPro Video for Windows) then you will not see the watermark on the platform you purchased for, but you will see the watermark on the other platforms. For example if you purchased AVPro Video for iOS then you will still see the watermark in the Unity editor as this is running on Windows/OS X, but the videos played back when you deploy to your iOS device will be watermark-free.

3.1.2 Updating from Trial Version

If you are upgrading from the trial version, make sure you delete the old /Assets/Plugins folder as this contains the trial plugin and could conflict. You may need to close Unity first, delete the files manually and then restart Unity and re-import the package (because Unity locks native plugin files once they are loaded).

You can check which version you have installed by adding an MediaPlayer component to your scene and clicking on the ‘about’ button in the Inspector for that component. The version number is displayed in this box.

3.2 Installing Multiple Platform Packages

If you are not using the full all-in-one AVPro Video package and instead have opted to purchase multiple individual platform packages then the installation must be done carefully, especially when upgrading to a new version.

If you have installed the iOS package then it will also contain plugins for all of the other platforms but with the watermark enabled. This means that if you then try to install another

AVPro Video package it may not override the plugins correctly. Here is how to resolve this using the iOS and Android package as examples:

1. Open a fresh Unity instance (this is important as otherwise Unity may have locked the plugin files which prevents them from being upgraded)
2. Import the iOS package
3. Import the Android package, but make sure that you have the iOS native plugin file unticked (so that it is not overwritten)

A similar process can be applied for other package combinations.

List of native plugin files:

- Android
 - Plugins/Android/AVProVideo.jar
 - Plugins/Android/libs/armeabi-v7a/libAVProLocal.so
 - Plugins/Android/libs/arm64-v8a/libAVProLocal.so
 - Plugins/Android/libs/x86/libAVProLocal.so
- macOS
 - Plugins/AVProVideo.bundle
- iOS
 - Plugins/iOS/libAVProVideoiOS.a
- tvOS
 - Plugins/tvOS/libAVProVideotvOS.a
- WebGL
 - Plugins/WebGL/AVProVideo.jslib
- Windows
 - Plugins/WSA/PhoneSDK81/ARM/AVProVideo.dll
 - Plugins/WSA/PhoneSDK81/x86/AVProVideo.dll
 - Plugins/WSA/SDK81/ARM/AVProVideo.dll
 - Plugins/WSA/SDK81/x86/AVProVideo.dll
 - Plugins/WSA/SDK81/x86_64/AVProVideo.dll
 - Plugins/WSA/UWP/ARM/AVProVideo.dll
 - Plugins/WSA/UWP/x86/AVProVideo.dll
 - Plugins/WSA/UWP/x86_64/AVProVideo.dll
 - Plugins/x86/AVProVideo.dll
 - Plugins/x86_64/AVProVideo.dll

4. Usage Notes

4.1 Platform Notes

Most graphics APIs are supported:

	D3D9	D3D11	OpenGL	GL ES2.0	GL ES3.0	Metal	Vulkan
Android	N/A	N/A	N/A	Yes	Yes	N/A	No
iOS / tvOS	N/A	N/A	Yes	Yes	Yes	Yes	No
macOS	N/A	N/A	Yes	N/A	N/A	Yes	No
Windows	Yes	Yes	Yes	N/A	N/A	N/A	No
UWP	N/A	Yes	N/A	N/A	N/A	N/A	No

N/A = not applicable

4.1.1 Android

- Supported systems are arm-v7a, arm64-v8a and x86
- Under the hood we're using the Android MediaPlayer API and ExoPlayer 2.8.4 API
- This plugin requires a minimum Android API level of 15 when using the MediaPlayer API, and API level 16 when using ExoPlayer (due to its use of MediaCodec).
- If you want to support streaming don't forget to set the "Internet Access" option in Player Settings to "require"
- For rendering we supports OpenGL ES 2.0 and OpenGL ES 3.0
- Multi-threaded rendering is supported
- The only 3rd-party libraries used are:
 - ExoPlayer 2.8.4
<https://github.com/google/ExoPlayer>
 - Facebook Audio 360 1.6.0
<https://facebook360.fb.com/spatial-workstation/>

4.1.2 iOS / tvOS

- Supported systems are armv7, arm64
- The iOS simulator is supported on x86 and x86_64
- Under the hood we're using the AVFoundation API
- If you want to support streaming you need to enable HTTP downloads explicitly. For iOS this is an option in newer versions of Unity, but for Mac OS X and older versions of Unity you have to do this explicitly by editing the plist file. There are notes below on how to do this.
- For rendering we support OpenGL ES 2.0, OpenGL ES 3.0 and Metal
- Multi-threaded rendering is supported
- No 3rd-party libraries are used in the iOS / tvOS binaries

4.1.3 macOS

- Only 64-bit (x86_64) builds are supported (Apple dropped 32-bit support back in 2012 when launching OS X 10.8).
- Under the hood we're using the AVFoundation API
- If you want to support streaming you need to enable HTTP downloads explicitly. For iOS this is an option in newer versions of Unity, but for Mac OS X and older versions of Unity you have to do this explicitly by editing the plist file. There are notes below on how to do this.
- For rendering on Mac OS X we support OpenGL Legacy and OpenGL Core and Metal.
- Multi-threaded rendering is supported
- The only 3rd-party libraries used in the macOS binaries are:
 - Hap
<https://github.com/Vidvox/hap>
 - zlib
 - <http://zlib.net/>

4.1.4 Windows Desktop

- Under the hood we're using the Media Foundation and DirectShow API's. Media Foundation is used for Windows 8 and above while DirectShow is used as a fallback for Windows 7 and below.
- For rendering we support Direct3D 9, Direct3D 11 and OpenGL Legacy.
- Multi-threaded rendering is supported.
- Windows N / KN edition notes:
 - There are some editions of Windows (N and KN) that ship with greatly reduced built-in media playback capabilities.
 - It seems like these editions don't include MFPlat.DLL, but do include some basic DirectShow components. This means the Media Foundation playback path will not work.
 - These editions of Windows require either a 3rd party codec installed (such as the LAV Filters for DirectShow), or the Microsoft Media Feature Pack:
 - Media Feature Pack for Windows 7 SP1
<https://www.microsoft.com/en-gb/download/details.aspx?id=16546>
 - Media Feature Pack for Windows 8.1
<https://www.microsoft.com/en-gb/download/details.aspx?id=40744>
 - Media Feature Pack for Windows 10
<https://www.microsoft.com/en-gb/download/details.aspx?id=48231>
 - We found that MJPEG DirectShow codec still works on these editions without installing the Media Feature Pack
- The only 3rd-party libraries used in the Windows Desktop binaries are:
 - Hap
<https://github.com/Vidvox/hap>
 - Google Snappy

- <https://github.com/google/snappy>
- GDCL Mpeg-4
<https://github.com/roman380/gdcl.co.uk-mpeg4>
- GLEW
<http://glew.sourceforge.net/>
- Facebook Audio 360 1.6.0
<https://facebook360.fb.com/spatial-workstation/>

4.1.5 Windows Store / UWP / Hololens

- For best compatibility and performance add

appCallbacks.AddCommandLineArg("-force-d3d11-no-singlethreaded");

To your MainPage.xaml.cs/cpp or MainPage.cs/cpp. You should call this before the `appCallbacks.Initialize()` function.

- For streaming video don't forget to enable to "InternetClient" capability option in Unity's Player Settings. If you're streaming video from a local server / LAN then you need to enable the "PrivateNetworkClientServer" option.
- No 3rd-party libraries are used in the WSA / UWP binaries

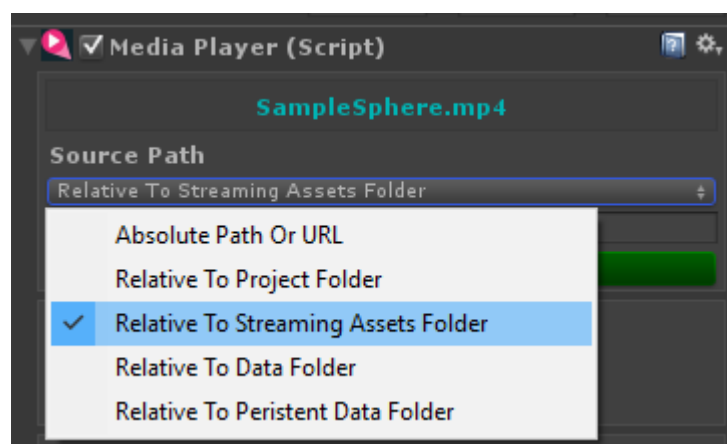
4.1.6 WebGL

- The supported formats and features is dependant on the web browser capabilities
- For best compatibility you can always force WebGL 1.0 instead of 2.0 which is the default. This is done by going to Player Settings > Other Settings > Auto Graphics API and removing WebGL 2.0. We have tested successfully with the following browsers
 - macOS
 - Safari 9.1
 - Safari 10 (WebGL 1.0 seemed to work better than WebGL 2.0)
 - Safari 11.0.1
 - Windows
 - Microsoft Edge 38.14393.0.0
 - Mozilla Firefox 51.0
 - Google Chrome 56.0 - 62.0
- The following browsers are not supported:
 - Internet Explorer 11 (any version), instead use the Microsoft Edge browser

4.2 Video File Location

Video files can be played in almost any location, however we recommend placing video files in the **/Assets/StreamingAssets/** folder in your Unity project as this is the easiest folder to get started with. StreamingAssets is a special folder that Unity copies to the build without processing. Files copied elsewhere will require manual copying to the build location.

The MediaPlayer component allows you to browse for video files and specify them relative to a parent folder:



The Video Location field specifies the master location of the video file while the Video Path field specifies where to locate the file relative to the Location.

For example if your file is stored in “Assets/StreamingAssets/video.mp4” you would set the Location to “Relative To Streaming Assets Folder” and set the Video Path to “video.mp4”.

Sub-folders are also supported so a video located at “Assets/StreamingAssets/myfolder/video.mp4” would have it’s Video Path set to “myfolder/video.mp4”.

You can also specify absolute paths, URLs or paths relative to other locations:

4.2.1 Relative To StreamingAssets Folder

This is the best and most common location for video files. This folder is located at “Assets/StreamingAssets/” and you must create it if it doesn’t exist. Files copied to this folder will not be imported or processed by Unity but they will be copied with the build automatically.

On Android though this folder isn’t ideal for massive files, as they are memory mapped and so we’ve seen some devices have memory issues. For Android this folder is fine for small-medium files (up to about 800MB depending on the device types you’re targeting), but beyond that it’s better to copy or download the file into the persistent data folder and load it from there.

4.2.2 Absolute Path or URL

Here you can specify a full URL or absolute path to the video file. A URL could be in the form “http://myserver.com/myvideo.mp4” or “rtsp://myserver.com:8080/mystream.rtsp” depending on the platform support and streaming service used.

An absolute path would look like:

- *C:/MyFolder/AnotherFolder/MyVideo.mp4 (Windows)*
- */Users/Mike/downloads/MyVideo.mp4 (Mac/Linux)*
- */Storage/SD/Videos/MyVideo.mp4 (Android external SDCARD)*
- */Storage/emulated/0/MyFolder/MyVideo.mp4 (Android local file system)*

Using absolute paths can be useful for testing but isn't useful when deploying to other machines that don't necessarily have the same file structure.

4.2.3 Relative To Project Folder

The project folder is the folder of your Unity project, so the folder containing the Assets, Library and Project Settings sub-folders. Specifying files relative to the project folder can be useful when you don't want to include the video files in your Unity Assets folder but want to keep them within the project folder structure. Often making a sub-folder called "Videos" is useful. One possible problem of using this location is that when making a build your video files will not be copied automatically to the build destination so they require manual copying. For builds this folder should be located:

- Windows - at the same level as your EXE
- Mac - at the same level as the Contents folder in your app bundle
- iOS - at the same level as the AppName.app/Data folder
- Android - not accessible due to APK packaging unless you build the APK manually.

4.2.4 Relative To Data Folder

The data folder is specified by Unity here:

<http://docs.unity3d.com/ScriptReference/Application-dataPath.html>

It isn't that useful to put video files into this folder directly as they would then be processed by Unity into VideoClip's or MovieTexture's and will bloat your project size. If you want to stop Unity processing the video files simply rename the extension to something Unity doesn't understand, so "myvideo.mp4" could be renamed to "myvideo.mp4.bin". Files within the data folder (Assets folder in the editor) are not copied automatically to builds so you would have to manually copy them.

4.2.5 Relative to Persistent Data Folder

The persistent data folder is specified by Unity here:

<http://docs.unity3d.com/ScriptReference/Application-persistentDataPath.html>

For UWP platforms this would resolve to "ms-appdata:///local/"

4.3 Streaming Notes

AVPro Video supports several streaming protocols depending on the platform:

	HTTP Progressive Streaming	HLS	MPEG-Dash	RTSP
Windows Desktop	Yes	Yes (Windows 10 only)	Yes (Windows 10 only)	Only with ASF stream, or with DirectShow using suitable filter
UWP	Yes	Yes (UWP 10 only)	Yes (UWP 10 only)	No
Mac OS X	Yes	Yes	No	No
iOS	Yes	Yes	No	No
tvOS	Yes	Yes	No	No
Android	Yes	Yes, but better on newer versions	Yes, with ExoPlayer API	Yes, with MediaPlayer API
WebGL	Yes*	Browser specific* **	Browser specific* **	No

* Remember for WebGL streaming you need to have proper CORS set up when accessing other servers / ports. See our notes below on streaming with WebGL.

** In WebGL you can use the hls.js and dash.js libraries. See Streaming section for implementation details.

HTTP Progressive Streaming

When encoding MP4 videos for streaming make sure they are encoded with the video header data at the beginning of the file. You normally do this by selecting “Fast Start” in QuickTime encoder, or use the “-movflags faststart” in FFMPEG, Other encoders will have a similar option. To prepare an MP4 for streaming using FFMPEG you can use the following command:

```
ffmpeg -i %1 -acodec copy -vcodec copy -movflags faststart %1-streaming.mp4
```

Vimeo Note:

If you are streaming videos from VIMEO as MP4 then you should note that you can replace the “.mp4” part in the URL with “.m3u8” to instead make it an HLS stream. This may be particularly useful if you are developing apps for the Apple’s App Store as you would need to use HLS streaming to pass certification (as for April 2016).

4.3.1 OS X, iOS and tvOS Streaming

This platform supports streaming of HLS streams which typically end with the m3u or m3u8 extension.

If you have an HTTPS URL it should work fine because Apple trusts the secure connection.

If you can only use HTTP then your app has to have a special flag set to let it use HTTP connections (this is a security issue for Apple).

This setting is exposed in the Unity Player Settings here for iOS and tvOS:



The setting is also exposed in the scripting API here:

<http://docs.unity3d.com/ScriptReference/PlayerSettings.iOS-allowHTTPDownload.html>

If for some reason your version of Unity doesn't expose this then you will have to add it manually. In the Unity editor you need to edit "Unity.app/Contents/Info.plist" and in your built application you would need to edit "your.app/Contents/Info.plist". These files need to have these keys added:

```
<key>NSAppTransportSecurity</key>
<dict>
  <key>NSAllowsArbitraryLoads</key>
  <true/>
</dict>
```

You can find more information about this here:

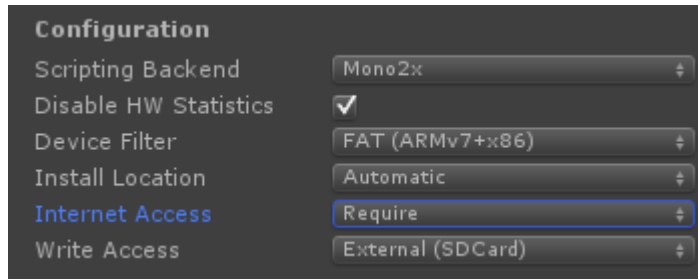
<http://ste.vn/2015/06/10/configuring-app-transport-security-ios-9-osx-10-11/>

We've also included a post process build script called "PostProcessBuild.cs" in the project which edits the plist and adds this attribute. Currently it's only set for iOS but you can edit the #define at the top to allow Mac OS X too.

4.3.2 Android Streaming

Using the ExoPlayer API is recommended for streaming video as it generally has wider

support for streaming protocols. Android streaming requires the Internet Access setting (in Player Settings) to be set to “Require”:



4.3.3 UWP / Windows Phone / Hololens Streaming

Make sure to tick the “InternetClient” capabilities option in Player Settings. If you’re streaming video from a local server / LAN then you need to enable the “PrivateNetworkClientServer” option.

4.3.4 WebGL Streaming

If you are trying to access a URL on another server/port/domain then you need to have CORS (cross-origin resource sharing) configured on that server to allow access. Websites like <https://enable-cors.org/> show you how to configure CORS on different web servers. If you are hosting on a S3 bucket there are also ways to configure this. You can also test whether CORS is the issue by installing a browser plugin to toggle CORS, for example this one for Chrome:

<https://chrome.google.com/webstore/detail/allow-control-allow-origi/nlfbmbojpeacfgkpbjhdidihlkkiljbi>

HLS and MPEG-DASH are not natively supported by all browsers. We have added hooks to include third-party javascript libraries to handle these formats. Under the “Platform Specific > WebGL” section you can select “External Library”. This will force the MediaPlayer to use either [hls.js](#) or [dash.js](#). You can also select “custom” if you wish to add support for your own javascript library.

To add support or dash.js:

1. Download the latest dash.js release (we tested with 2.8.0):
<https://github.com/Dash-Industry-Forum/dash.js/releases>
2. Copy “dash.all.min.js” to the Assets/Plugins/WebGL folder and rename it “dash.all.min.jspre”
3. In the MediaPlayer component set Platform Specific > WebGL > External Library to dash.js
4. Build for WebGL

To add support for hls.js:

1. In the MediaPlayer component set Platform Specific > WebGL > External Library to hls.js

2. Build for WebGL
3. Download the latest hls.js release (we tested with 0.10.1):
<https://github.com/video-dev/hls.js/releases>
4. Once your build is made, copy "hls.min.js" to the Build folder
5. Edit the index.html to add <script src="Build/hls.min.js"></script> before the UnityLoader.js script is loaded. Ideally you would add this to your template.

4.3.5 Test Streams

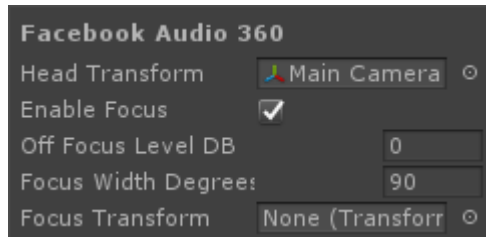
We found these streams handy for testing (no guarantee that they're still working):

- **Streaming MP4**
 - **HTTP**
http://downloads.renderheads.com/2016/BigBuckBunny_360p30_Streaming.mp4
 - **HTTPS**
<https://drive.google.com/uc?export=download&id=0B0JMGMGgxp9WMEdWb1hyQUhIOWs>
- **HLS**
 - <http://qthttp.apple.com.edgesuite.net/1010qwoeiuryfg/sl.m3u8>
 - http://184.72.239.149/vod/mp4:BigBuckBunny_115k.mov/playlist.m3u8
 - Apple Test streams (from <https://developer.apple.com/streaming/examples/>)
 - **Basic complexity**
https://devimages.apple.com.edgekey.net/streaming/examples/bipbop_4x3/bipbop_4x3_variant.m3u8
 - **Medium complexity**
https://devimages.apple.com.edgekey.net/streaming/examples/bipbop_16x9/bipbop_16x9_variant.m3u8
 - **Advanced TS**
https://tungsten.aaplimg.com/VOD/bipbop_adv_example_v2/master.m3u8
 - **Advanced fMP4**
https://tungsten.aaplimg.com/VOD/bipbop_adv_fmp4_example/master.m3u8
- **MPEG-Dash**
 - http://rdmedia.bbc.co.uk/dash/ondemand/bbb/2/client_manifest-high_profile-common_init.mpd
 - http://www.bok.net/dash/tears_of_steel/cleartext/stream.mpd
- **RTSP**
 - <rtsp://rtmp.infomaniak.ch/livecast/latele>
- **RTMP**
 - RTMP is not supported on any platform yet (unless 3rd party support is used)

4.4 Audio Notes

4.4.1 Facebook Audio 360

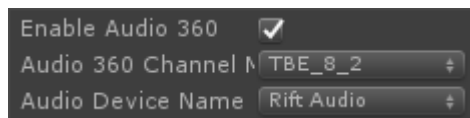
Spatial audio support is currently available using Facebook Audio 360 on Windows desktop and Android. On Windows only Windows 10 and above is supported and the Media Foundation video API must be selected. On Android the ExoPlayer video API must be selected. The video files must be using a MKV file container and audio must be using the Opus codec encoded with Facebook Audio 360.



The settings are located under the Audio section of the MediaPlayer component. The “Head Transform” field must be set to the transform that represents the player's head so that rotation and positional changes affect the audio rendering. Usually this is the main camera.

“Enable Focus” can be enabled when a specific region of audio in the 360 field needs to be given focus. The rest of the audio has its volume reduced.

Next the Facebook Audio 360 support must be enabled for each platform that needs it via the “Platform Specific” panel. Currently it is only available on Windows desktop and Android.



The “Channel Mode” must be set to the channel encoding mode used when creating the video. Currently this can not be determined automatically. The default is “TBE_8_2” which means 8 channels of hybrid ambisonics and 2 channels of head-locked stereo audio.

More information on encoding etc can be found on the Facebook Audio 360 website at:

<https://facebook360.fb.com/spatial-workstation/>

Alternative steps for encoding manually

1. Create a WAV file with the audio format they need (E.g 9 channels ambisonics with 2 channels of head-locked audio will require a 11 channel WAV file with the 2 head-locked channels at the end)
2. Use Opus tools, as described here to convert the WAV file to Opus:
<https://opus-codec.org/downloads/>
https://facebookincubator.github.io/facebook-360-spatial-workstation/Documentation/SDK/Audio360_SDK_GettingStarted.html#encoding-opus-files
3. Use ffmpeg to mux this opus file into the video container (ensure that the video file doesn't have any audio first):

```
ffmpeg -i audio.opus video.mp4 -c:a copy -c:v copy audio_video.mkv
```


4. In AVPro Video specify the required channel map

Converting existing ambisonic videos

It is also possible to convert existing ambisonic videos so they are compatible. For example if you have an existing MP4 file with 4-channel 1st order ambisonic audio, then it is possible to convert this into the above format (MKV container with Opus audio) using a tool like FFMPEG. Simply put the following command in a .BAT file and then drag your MP4 into the batch file:

```
ffmpeg -y -i input.mp4 -c:v copy -acodec libopus -mapping_family 255 output.mkv
```

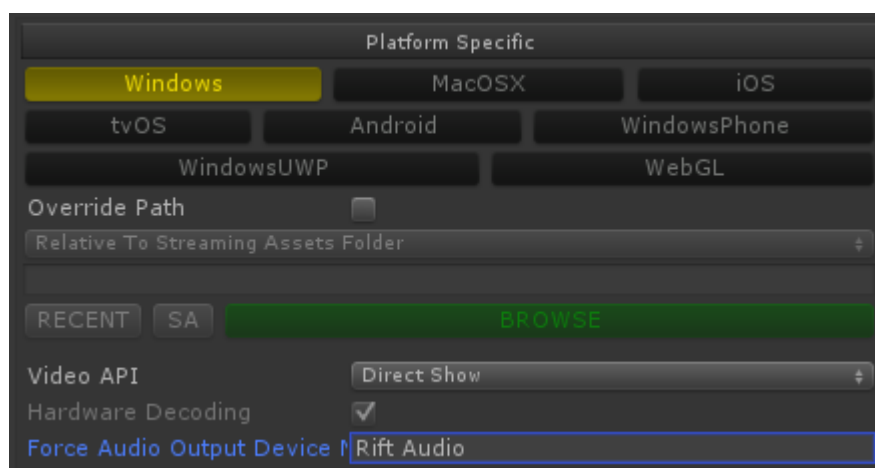
This should then generate an MKV file that you can play with AVPro Video. All that remains is to set the channel mapping in the MediaPlayer to AMBIX_4.

4.4.2 Audio Redirection

Currently only the Windows plugin has support for audio manipulation beyond the standard volume and stereo panning.

Some VR systems such as the Oculus Rift and HTC Vive have their own audio output device and one needs to redirect audio to these devices instead of the system default audio device. Unity does this automatically for its internal audio, but AVPro Video renders to the system default audio device.

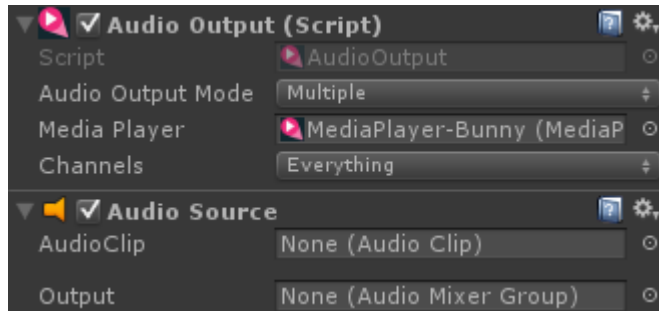
This issue can be solved by either using the AudioOutput component (see below). This component redirects the audio to be rendered by Unity and so it goes to the correct device. AudioOutput requires that the Media Foundation video API be used, so if you need to use the DirectShow API you can specify the name of the output device manually in the field "Force Audio Output Device":



The device name to use can be retrieved from the VR API or hard coded. For Oculus Rift the name is usually "Rift Audio" and for HTC Vive it is "HTC VIVE USB Audio".

4.4.3 Audio Spatialisation

Audio needs to rotate as the user moves their head in the virtual world. This can be achieved by using the AudioOutput component which redirects the audio from the video into Unity (via Unity's AudioListener).



This component should be stacked above its required AudioSource component.

AudioOutput requires that the video API is set to Media Foundation and that the “Use Unity Audio” tickbox is selected.



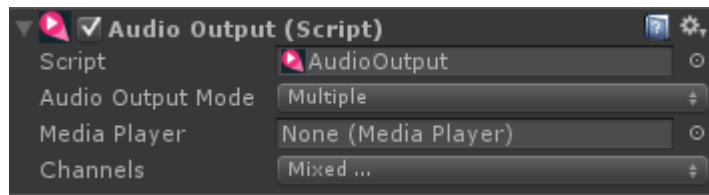
For proper 3D audio placement you will also need to add a spatialiser plugin to the Unity Audio Settings screen (in Unity 5.4 and above) and tick the “spatialize” tickbox on the Audio Source. Multiple instances of AudioOutput component can be created, each one outputting a different audio channel from a different world position.

If Unity Audio is enabled but the Stereo checkbox is not selected, AVProVideo will try to detect how many channels the video has, and send to Unity as many channels as requested. To get all audio channels, make sure that the default speaker mode in the Unity Audio Settings supports enough channels, and ensure that the OS audio sound settings are

in the correct speaker mode (otherwise Unity will just default to the maximum number of supported channels). If the Stereo box is checked, the audio will get resampled to 2 channels.

If you wish to only get specific channels from the video, you can choose to mask the channels using the AudioOutput component.

4.4.4 Channel Remapping



The AudioOutput component has the ability to route different audio channels from the media to different physical channels.

4.5 Augmented / Virtual Reality Notes

So far we have tested AVPro Video with:

- Gear VR
- Google Cardboard
- Google Daydream
- Oculus Rift
- HTC Vive
- Microsoft Hololens

VR is still very new and you should always check for the latest recommended installation steps when creating your project. We found a lot of out of date setup instructions on the net.

AVPro Video supports 4K MP4 playback for creating 360 degree experiences. Stereo 4K videos in both top-bottom and side-by-side formats are also supported. If you're using Windows 10 and have an Nvidia Geforce 1000 series (eg 1070) you can display 8K H.265 videos (requires 64-bit build).

See the FAQ for tips to achieve high resolution video playback for VR.

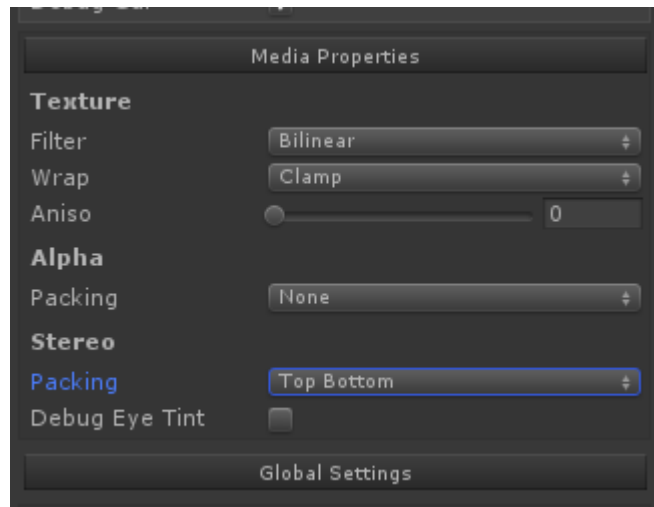
For software decoders reducing the complexity of the encoded video will give the decoding engine a much easier time and could result in higher frames rates and lower CPU/GPU usage. Possible encoding tweaks include:

- Use the lowest profile level possible
- Don't use too many reference frames
- Don't use too many b-frames

- Disable CABAC
- Use the slices option (eg -slices 4)

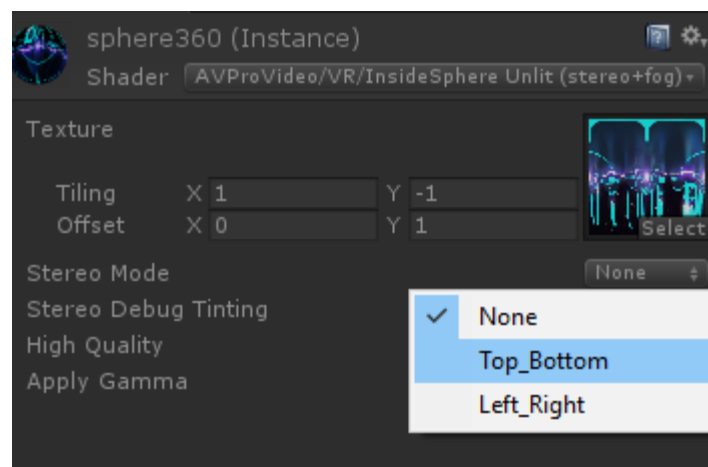
4.5.1 Stereo VR

AVPro Video supports stereoscopic videos in the top-bottom and left-right formats. You can set the stereo packing format of your video in the Media Properties panel:



Now when using the InsideSphere shader on a mesh it will automatically map the right part of the video to each eye. See the “Demo_360SphereVideo” scene for an example of how this works.

Optionally you can manually set the material properties. The included shader “InsideSphere.shader” allows you to easily set what format your video is in via a drop-down in the material:



Select “Stereo Debug Tinting” to colour the left and right eyes different colours so you can be sure the stereo is working.

NOTE: Be sure to add the “UpdateStereoMaterial” component script to your scene when using this material and a stereo video. Often stereo VR requires 2 cameras, each set to a

different layer mask and 2 spheres also set to a different mask. AVPro Video doesn't require this and just uses your normal single camera and single sphere.

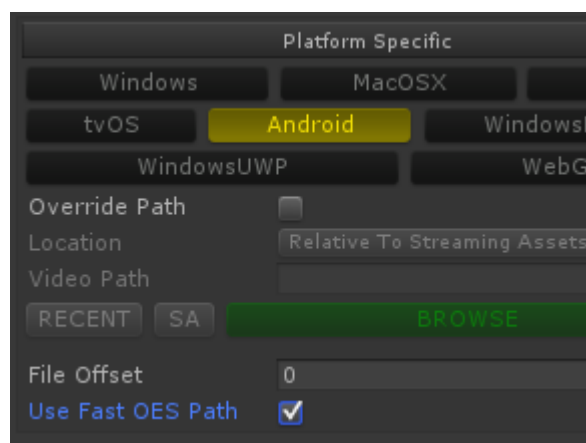
NOTE: If you're playing stereo videos on Windows and the stereo isn't appearing properly, please read our FAQ #8.

An example of how to pack 2 videos together into a left-right stereo packed layout using FFMPEG:

```
ffmpeg -i left.mp4 -vf "[in] pad=2*iw:ih [left]; movie=right.mp4 [right];[left][right] overlay=main_w/2:0 [out]" stereo.mp4
```

4.5.2 Android OES playback path

For Android there is a special playback option called "Use Fast OES Path". This option caters especially for VR where users are trying to get the highest possible frame rate and resolution out of the device (without it overheating at the same time). The option is available in the Platform Specific section of the MediaPlayer component:



The OES path is not enabled by default because it requires some special care to be taken and can be tricky for beginners. When this option is enabled the Android GPU returns special OES textures (see EGL extension OES_EGL_image_external) that are hardware specific. Unfortunately Unity isn't able to use these textures directly, so you can't just map them to a material or UI. To use the texture a GLSL shader must be used. Unfortunately Unity's GLSL support isn't as good as its CG shader support so again this makes things more tricky. The GLSL compiler only happens on the device (not inside Unity) so errors in the shader can be difficult to debug.

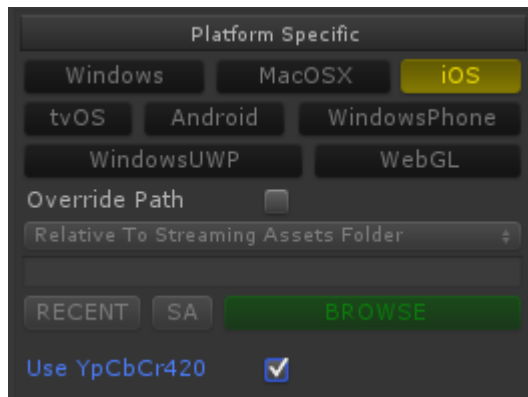
We have included a version of the VR sphere shader that supports stereo videos as an example. Hopefully in the future we can improve the integration of these shaders so they aren't such special cases. This playback path is much faster though, so is definitely worth exploring.

For the sphere demo scene, simply change the shader on the sphere mesh material to be one of the "VR" "OES" ones and tick the "Use Fast OES Path" on the MediaPlayer

component.

4.5.3 iOS YCbCr playback path

For iOS and tvOS we have added support for YCbCr textures which results in memory saving compared to standard RGBA32 textures. This option is enabled by default but can be disabled on the MediaPlayer here:



This option is ideal for memory saving which is especially important when targeting low-end devices (with 1GB RAM) and when playing back very high resolution video, such as 4K for VR content. Improved performance may also be experienced using this option.

4.6 Hap Codec Notes

The Hap video codec is natively supported by AVPro Video on certain platforms and has the following benefits:

- Very low CPU usage
- GPU decompression
- Low memory usage
- Supports very high resolutions
- Supports alpha channel transparency

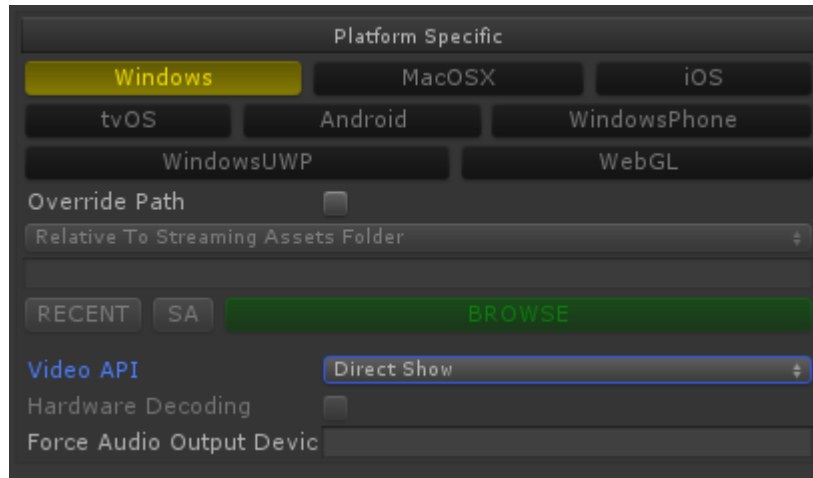
The main down side is:

- Very large files

AVI and MOV containers can both be used however we recommend the MOV container. Hap is only supported on Windows and Mac OS X platforms.

4.6.1 Windows Support

Hap, Hap Alpha, HapQ and HapQ Alpha are supported. Hap currently requires the "DirectShow" video API to be selected:



4.6.2 Mac OS X Support

Hap, Hap Alpha, HapQ and HapQ Alpha are supported.

4.6.3 Encoding

You can download the QuickTime codec for Windows and macOS here:

<https://github.com/Vidvox/hap-qt-codec/releases>

This codec can be used with QuickTime Pro or any other software that supports QuickTime codecs such as Adobe After Effects and Adobe Premiere.

Alternatively you can use a recent build of FFMPEG with the following command-lines:

- `ffmpeg -i input.mov -vcodec hap -format hap output-hap.mov`
- `ffmpeg -i input.mov -vcodec hap -format hap_alpha output-hap.mov`
- `ffmpeg -i input.mov -vcodec hap -format hap_q output-hap.mov`

Notes:

- You can also add the “-chunks 4” option which will encode each frame into 4 chunks so the decoding work can be split across multiple threads, resulting in faster decoding as long as the disk can keep up.
- Width and height must be multiple of a 4.
- Hap Alpha requires straight not pre-multiplied alpha.
- Sadly ffmpeg doesn’t yet support the HapQ Alpha format.
- We don’t support Hap Q Alpha variant in Windows when using the legacy D3D9 graphics API

4.7 Transparency Notes

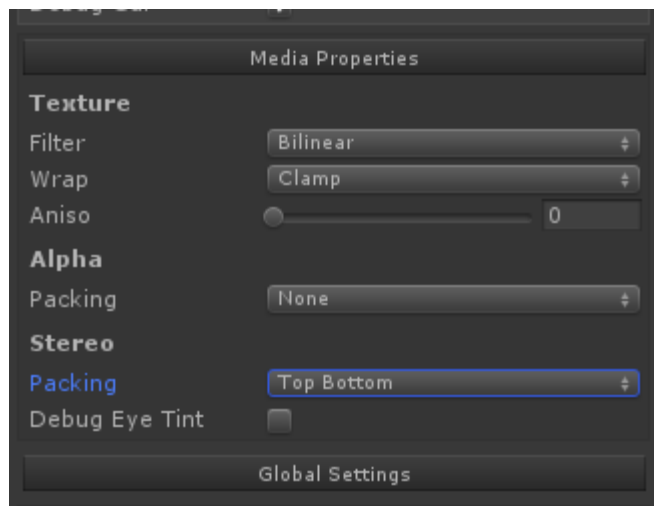
Not many video codecs have native support for transparency / alpha channels. Formats supported by some platforms of AVPro Video are:

- Hap Alpha

- Great support on Windows and Mac OS X. Fast and low overhead format, though file size can get large depending on the content. Currently this is the format we recommend for transparent video.
- Hap Q Alpha
 - Great support on Windows and Mac OS X. Slightly higher quality and file size compared to Hap Alpha.
- Uncompressed RGBA
- Uncompressed YUVA
 - Uncompressed isn't ideal for file size or disk bandwidth but can still be used as a fallback
- ProRes 4444
 - Best support is on Mac OS X. Files are huge.
- VP6
 - Legacy format. We support it only via 3rd party DirectShow plugins for Windows (eg LAV Filters)

4.7.1 Alpha Packing

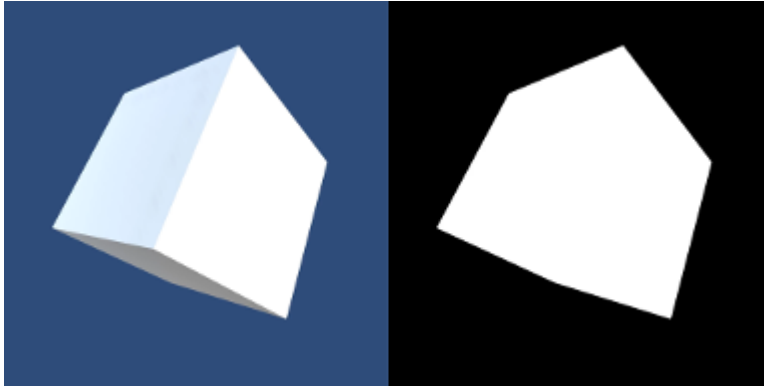
Alternatively you can encode your videos in video formats that don't support an alpha channel by packing the alpha channel into the same frame. You can double the width for a left-right packing layout, or double the height for a top-bottom packing layout. This packing could be created in software such as AfterEffects, or the command-line ffmpeg tool can be used. The packing format is set in the "Media Properties" panel of the AVPro Video MediaPlayer component:



Here we show two examples using ffmpeg to convert a source video containing a transparency/alpha channel into an alpha packed format:

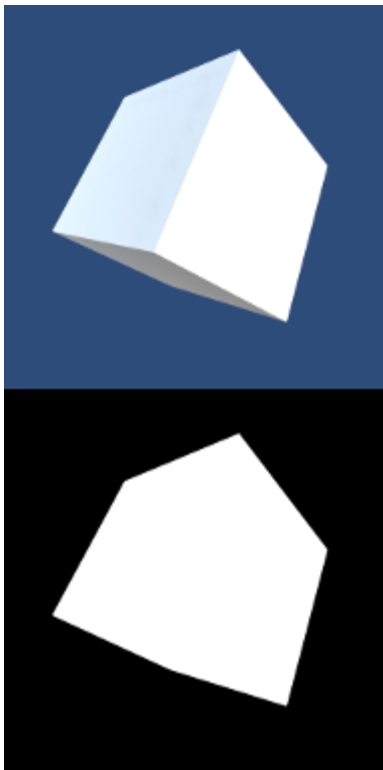
Left-right alpha packing:

```
ffmpeg -i %1 -vf "split [a], pad=iw*2:ih [b], [a] alphaextract, [b] overlay=w" -y %1.mp4
```

Top-bottom alpha packing:

```
ffmpeg -i %1 -vf "split [a], pad=iw:ih*2 [b], [a] alphaextract, [b]  
overlay=0:h" -y %1-tb.mp4
```



4.8 Hardware Decoding

AVPro Video supports hardware decoding on most platforms for optimal performance. WebGL, Windows 8.1, Windows 10, macOS, tvOS, iOS and Android all default to hardware decoding when possible. When playing back multiple videos simultaneously one must be careful not to exceed the number of videos that the hardware can play back smoothly. We have tried to collect information about the limits of specific hardware.

4.8.1 NVidia

NVidia GPU's use a technology called "Purevideo" or "NVDec" to off-load decoding from the CPU. More information can be found here:

https://en.wikipedia.org/wiki/Nvidia_PureVideo#Nvidia_VDPAU_Feature_Sets

Some NVidia Purevideo capabilities:

KEPLER (GK107, GK104)	MAXWELL 1 (GM107, GM204, GM200)	MAXWELL 2 (GM206)	PASCAL (GP100)
MPEG-2, MPEG-4, H.264	MPEG-2, MPEG-4, H.264, HEVC with CUDA acceleration	MPEG-2, MPEG-4, H.264 HEVC/H.265 fully in hardware	MPEG-2, MPEG-4, H.264 HEVC/H.265 fully in hardware
H.264: ~200 fps at 1080p; 1 stream of 4K@30	H.264: ~540 fps at 1080p 4 streams of 4K@30	H.264: ~540 fps at 1080p 4 streams of 4K@30	?
H.265: Not supported	H.265: Not supported	H.265: ~500 fps at 1080p 4 streams of 4K@30	?

(table adapted from presentation "HIGH PERFORMANCE VIDEO ENCODING WITH NVIDIA GPUS")

GPU Architecture	MPEG-2	VC-1	H.264/AVCHD	H.265/HEVC	VP8	VP9
Fermi (GF1xx)	Maximum Resolution: 4080x4080	Maximum Resolution: 2048x1024 1024x2048	Maximum Resolution: 4096x4096 Profile: Baseline, Main, High profile up to Level 4.1	Unsupported	Unsupported	Unsupported
Kepler (GK1xx)	Maximum Resolution: 4080x4080	Maximum Resolution: 2048x1024 1024x2048	Maximum Resolution: 4096x4096 Profile: Main,	Unsupported	Unsupported	Unsupported

			High profile up to Level 4.1			
Maxwell Gen 1 (GM10x)	Maximum Resolution: 4080x4080	Maximum Resolution: 2048x1024 1024x2048	Maximum Resolution: 4096x4096 Profile: Baseline, Main, High profile up to Level 5.1	Unsupported	Unsupported	Unsupported
Maxwell Gen 2 (GM20x)	Maximum Resolution: 4080x4080	Maximum Resolution: 2048x1024 1024x2048 Max bitrate: 60Mbps	Maximum Resolution: 4096x4096 Profile: Baseline, Main, High profile up to Level 5.1	Unsupported	Maximum Resolution: 4096x4096	Unsupported
Maxwell Gen 2 (GM206)	Maximum Resolution: 4080x4080	Maximum Resolution: 2048x1024 1024x2048 Interlaced	Maximum Resolution: 4096x4096 Profile: Baseline, Main, High profile up to Level 5.1	Maximum Resolution: 4096x2304 Profile: Main profile up to Level 5.1	Maximum Resolution: 4096x4096	Maximum Resolution: 4096x2304 Profile: Profile 0
Pascal (GP100)	Maximum Resolution: 4080x4080	Maximum Resolution: 2048x1024 1024x2048	Maximum Resolution: 4096x4096 Profile: Baseline, Main, High profile up to Level 5.1	Maximum Resolution: 4096x4096 Profile: Main profile up to Level 5.1	Maximum Resolution: 4096x4096	Maximum Resolution: 4096x4096 Profile: Profile 0
Pascal (GP10x)	Maximum Resolution: 4080x4080	Maximum Resolution: 2048x1024 1024x2048	Maximum Resolution: 4096x4096 Profile: Baseline, Main, High profile up to Level 5.1	Maximum Resolution: 8192x8192 Profile: Main profile up to Level 5.1	Supported2 Maximum Resolution: 4096x4096	Maximum Resolution: 8192x8192 Profile: Profile 0

(Table adapted from Nvidia Video Decoder Interface documentation:
<https://developer.nvidia.com/nvdec-programming-guide>)

4.8.2 AMD

AMD UVD

https://en.wikipedia.org/wiki/Unified_Video_Decoder

UVD Version	Hardware Code Names
UVD 1.0	RV610, RV630, RV670, RV620, RV635
UVD 2.0	RS780, RS880, RV770

UVD 2.2	RV710, RV730, RV740
UVD 2.3	CEDAR, REDWOOD, JUNIPER, CYPRESS
UVD 3.0	PALM (Wrestler/Ontario), SUMO (Llano), SUMO2 (Llano)
UVD 3.1	BARTS, TURKS, CAICOS, CAYMAN
UVD 3.2	ARUBA (Trinity/Richland), TAHITI
UVD 4.0	CAPE VERDE, PITCAIRN, OLAND
UVD 4.2	KAVERI, KABINI, MULLINS, BONAIRE, HAWAII
UVD 5.0	TONGA
UVD 6.0	CARRIZO, FIJ
UVD 6.2	STONEY
UVD 6.3	POLARIS10, POLARIS11, POLARIS12

(table adapted from X.org RadeonFeature wiki:
<https://www.x.org/wiki/RadeonFeature/#index8h2>)

UVD Version	MPEG 2	MPEG 4	MPEG-4 AVC/VC1	HEVC	Max Size	Notes
UVD 1.0	No	No	Yes	No	2K	
UVD 2.0	No	No	Yes	No	2K	
UVD 2.2	No	No	Yes	No	2K	
UVD 2.3	No	No	Yes	No	2K	
UVD 3.0	Yes	Yes	Yes	No	2K	
UVD 3.1	Yes	Yes	Yes	No	2K	
UVD 3.2	Yes	Yes	Yes	No	2K	
UVD 4.0	Yes	Yes	Yes	No	2K	
UVD 4.2	Yes	Yes	Yes	No	2K	
UVD 5.0	Yes	Yes	Yes	No	4K	
UVD 6.0	Yes	Yes	Yes	Yes	4K	
UVD 6.2	Yes	Yes	Yes	Yes	4K	Supports 10bit
UVD 6.3	Yes	Yes	Yes	Yes	4K	Supports 10bit

(table adapted from X.org RadeonFeature wiki:
<https://www.x.org/wiki/RadeonFeature/#index8h2>)

4.8.3 Intel

Intel's Quick Sync technology is a dedicated video decoder hardware built into the CPU.

Intel Kaby Lake supports H.265 10-bit decoding!

4.9 Multi-GPU SLI / CrossFire Notes

Multiple GPU's are often used to accelerate high-end rendering but it brings with it some subtle challenges for video playback. Here we write some notes about our experience using Nvidia SLI on Windows (specifically Windows 8.1 with dual Nvidia M6000 cards).

Using Alternate Frame Rendering SLI (AFR SLI) can cause stuttering when using the Media Foundation hardware decoding because only one GPU is doing the decoding and then it must pass the frames back to the other GPU which is a slow operation and defeats the purpose of SLI. One option here is to disable GPU decoding in AVPro Video, which is fine for lower resolution videos, but often the CPU just isn't fast enough for very high resolution content. AFR can also suffer from so called "micro stutters" caused by each GPU handling the flip presentation independently which isn't ideal for video playback on large video walls.

Another option is to use the cards in "SLI VR" mode ... To be continued..

4.10 Subtitle Notes

AVPro Video supports external subtitles in the SRT format. Subtitles internal to media files are not yet supported. See the subtitle demo scene to see how to use subtitles.

4.11 DRM / Encryption Notes

DRM support is currently not a key feature of AVPro Video, but we aim to improve support in the future. DRM that we know works with the plugin includes:

- Android
 - HLS with AES-128 clear-key (make sure your TS segments are 188 bytes aligned for maximum Android compatibility)
 - We have a file offset feature which allows you to access files hidden within a file at an offset. Not strictly DRM but it can be used as a quick way to hide video files within other data
 - In Windows you can easily append your video to a dummy video file with the following command:


```
copy /b DummyVideo.mp4 + %1 %~n1-hidden.mp4
```
 - Custom HTTP header fields can be specified which can help with server side validation
- macOS & iOS & tvOS
 - HLS with AES-128 clear-key, direct key and key request using an auth token in the HTTP header ("Authorization" field). More information about HLS encryption can be read in the RFC here:
<https://tools.ietf.org/html/draft-pantos-http-live-streaming-23>
 - Custom HTTP header fields can be specified which can help with server side validation

*DRM schemes Fairplay, Widevine, PlayReady etc are not yet supported.

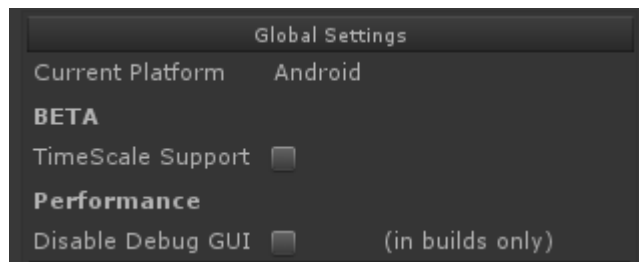
4.11.1 HLS Decryption

On the Apple platforms (macOS, iOS and tvOS) we support HLS streams encoded with AES encryption. Key retrieval from a server URL usually requires an authentication token, which can be specified using the method `SetKeyServerAuthToken(string)`, or this can be ignored if your key retrieval server doesn't require any authentication (clear-key). The auth token is a string that is inserted into the "Authorization" HTTP field when retrieving the decryption key from the server URL specified in the HLS manifest.

We also added some functionality to override the key URL and the to specify the key data directly. `SetDecryptionKey(byte[])` and `SetDecryptionKeyBase64(string)` can be used to specify the key directly. Using this will bypass any server key retrieval. `SetKeyServerURL(string)` can be used to override the key retrieval URL. Both of these are useful for debugging.

These options can also be specified in the MediaPlayer inspector UI (in the Platform Specific section), and in the PlatformOptions properties, eg `mediaPlayer.PlatformOptionsIOS`

4.12 Video Capture Notes



To make a non-realtime video capture of your Unity scenes which include videos, requires the video playback to slow down or speed up to match the video capture rate. AVPro Video supports this through the “TimeScale Support” option which is found in the Global Settings panel of the Media Player component. This means you can create high quality renders running at 1fps to produce a smooth 60fps video, and any videos in your scene will play back at the correct rate for the recording. Audio is not supported though when using this option (as is the case in Unity itself).

4.13 Seeking / Playback Rate Notes

Most videos are optimally encoded for the main use case: normal forward playback with inaccurate seeking.

If you want to start changing the playback rate, play in reverse or have frame accurate seeking then you may run into issues where the playback becomes extremely slow or the seeking is not accurate. There are several reasons for this, but it mostly is related to how the video is encoded and specifically the key-frame distribution. There are also some platform differences to consider.

4.13.1 Video Codecs and Encoding

Codecs such as H.264 and H.265 generally compress video frames so that they depend on data included with previously decoded frames. These are called P and B frames and seeking to one of these is computationally expensive as in order to display them the decoder must first decode the other frames that they depend on. The other type of frame is called a key-frame or I-frame and these frames can be decoded immediately because they don't depend on any other frames. Compressing using P And B frames is known as temporal

compression and isn't ideal for accurate random seeking or playback rate changes.

For the best results you would to encode your video with only key-frames, as then you can seek accurately and quickly anywhere in the video. This is possible, but increases the file size dramatically. Using FFMPEG you can encode a video to use key-frames only using the "-g 1" option. Another option would be to use a codec that only supports key-frames, such as Hap or ProRes - but again these result in large file sizes and limited GPU decoding capabilities.

In most codec with temporal compression the key-frames are spaced every 250 frames. Some platforms can only seek to the key-frames (see table below), while others can do accurate seeking but this can be very slow if the distances between key-frames is too large. Try reducing the key-frame distance for faster seeking. You can also reduce the decoder complexity by encoding with a fastdecode tuning option.

4.13.2 Playback Rate

Generally we recommend these rates:

0.25, 0.5, 1.0, 1.25, 1.5, 1.75, 2.0

Going up to 4.0 might be possible depending on your platform, machine specs and the codec used. Increasing playback rate usually places more demand on the video decoder and also on the disk/network source, and these limit how much you can increase the playback rate by.

Using negative values isn't generally recommended as it isn't as well supported, but if you do have to use a negative rate then also try keeping the numbers small such as:

-0.25, -0.5, -1.0

Audio also may or may not play when changing the playback rate - this depends on the platform (see table below).

One safe alternative to adjusting rate is to pause the video and fast seek to simulate a change in playback rate. This approach would work on all platforms.

Video encoding can also help the performance of a change in playback rate. Videos with more key-frames (or ideally all key-frames) and with less complex encoding (eg no B frames, CABAC disabled etc) will work better. Alternatively a key-frame-only codec could be used, such as Hap.

4.13.3 Platform Differences

Seeking:

Platform and Video API	Fast Inaccurate Keyframe Seeking	Slow Accurate Frame Seeking	Adjust Playback Rate
------------------------	----------------------------------	-----------------------------	----------------------

Android MediaPlayer API	Yes	API 26 and above	API 6 and above
Android ExoPlayer API	Yes	Yes	Yes
Windows Media Foundation	Yes	Yes	Yes
Windows DirectShow	Yes	Depends on the codec	Yes but not negative
UWP Media Foundation	Yes	Yes	Yes
macOS	Yes	Yes	Yes If source supports it
iOS & tvOS	Yes	Yes	Yes If source supports it
webGL	Yes	Varies	Yes but not negative

Playback Rate:

Platform and Video API	Adjust Playback Rate	Audio Plays	Negative Rates
Android MediaPlayer API	API 23 and above	Yes	?
Android ExoPlayer API	Yes	Yes	?
Windows Media Foundation	Yes	Depends on codec	Yes
Windows DirectShow	Yes	No	No
UWP Media Foundation	Yes	Depends on codec	Yes
macOS	Yes	Yes	Depends on media source
iOS & tvOS	Yes	Yes	Depends on media source
webGL	Yes	Depends on browser	No

5. Quick Start Examples

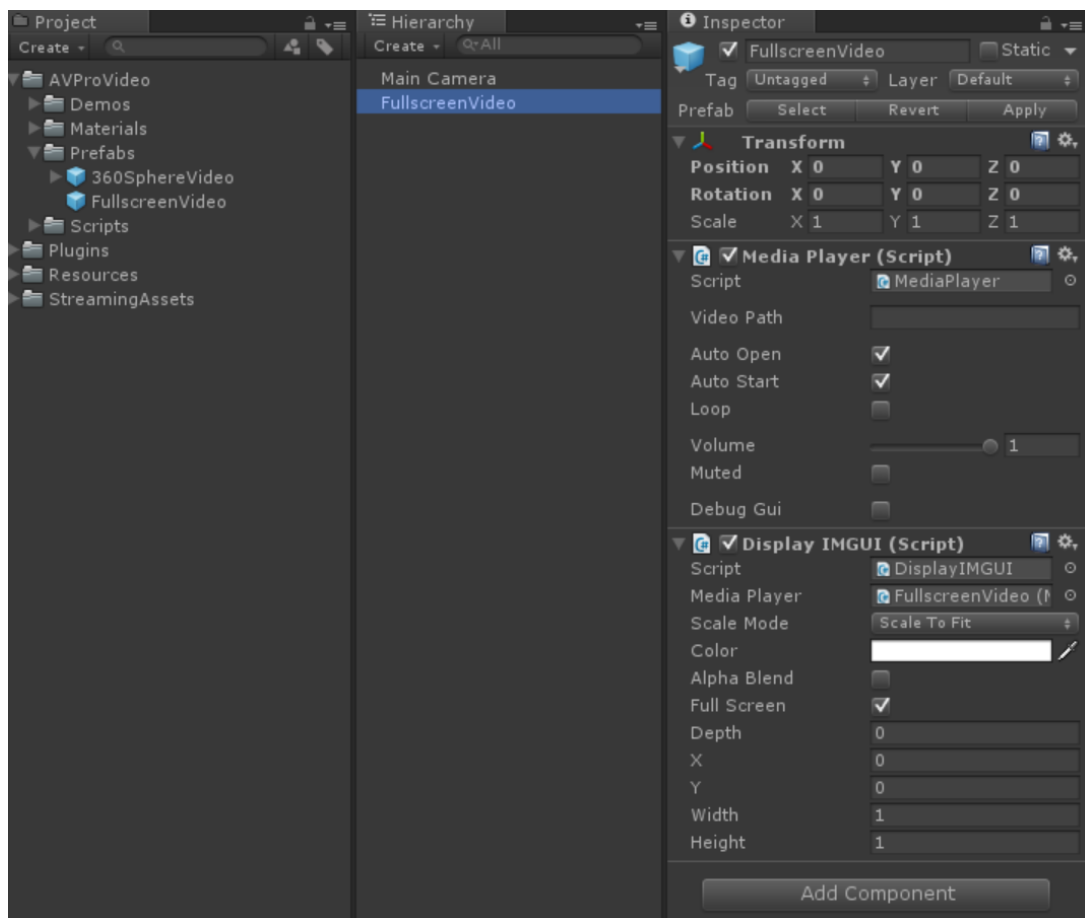
5.1 Quick Start: Fastest Start for Unity Experts

1. Put video files in the StreamingAssets folder
2. Use the MediaPlayer script to play your video (set Video Path to the file name of your video file).
3. Use one of the display scripts to display your video (eg DisplayIMGUI, DisplayUGUI, ApplytoMaterial)

5.2 Quick Start: Fullscreen Video Player using Prefabs

AVPro Video includes a number of example prefabs you can use to easily add video playback to your project. The following steps will create an application that plays back a fullscreen video:

1. Create a new Unity project
2. Import the AVProVideo package
3. From the AVPro/Prefabs folder in the Project window, drag the FullscreenVideo prefab to your Hierarchy window



4. Create a folder called StreamingAssets in your Project window and copy your video

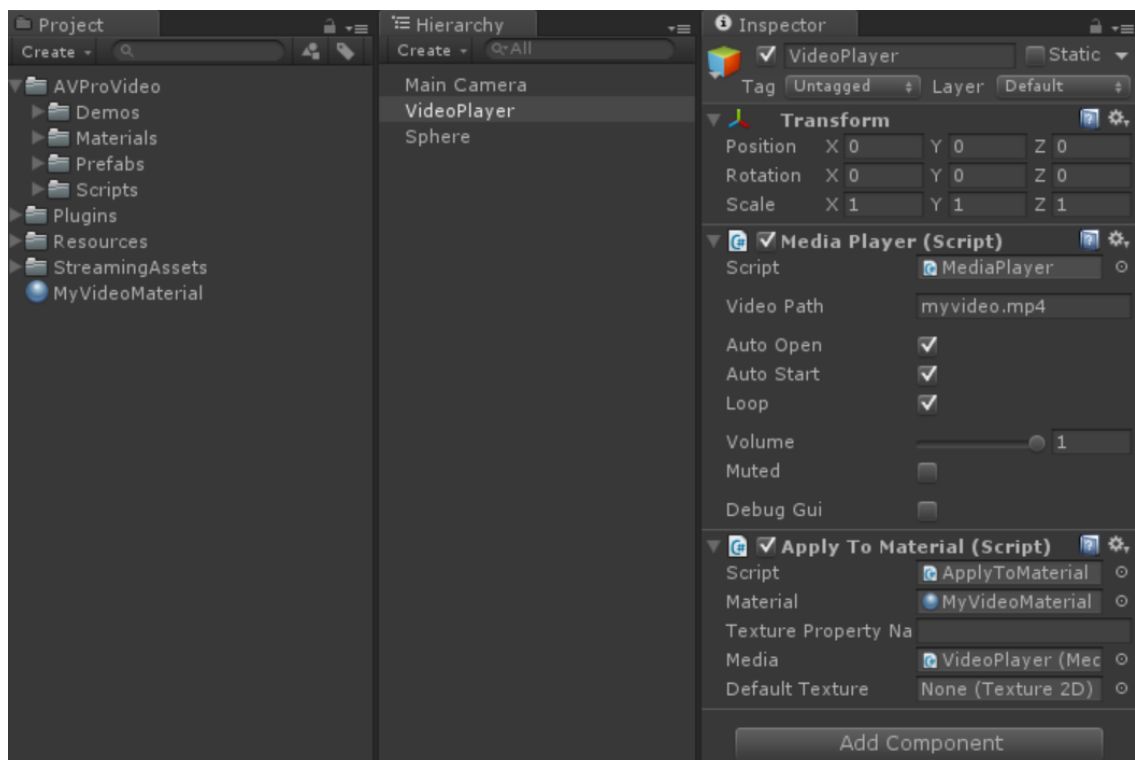
- file (say MP4 file) into that folder
5. Enter the file name (including extension) into the Video Path field in the MediaPlayer component (eg myvideo.mp4)
6. Build and deploy your application, the video will be displayed fullscreen

The DisplayIMGUI component script is just one of the components for displaying video. It uses the legacy Unity IMGUI system which always renders on top of everything else. Try using the DisplayBackground or DisplayUGUI components for more control if you don't want your video to be on top.

5.3 Quick Start: 3D Mesh Video Player using Components

AVPro Video includes a number of easy to use script components you can add to your scene. In this example we show how to use the components to play a video onto a material which is applied to a 3D model in the scene.

1. Create a new Unity project
2. Import the AVProVideo package
3. Create a new GameObject from the "GameObject > AVPro Video > Media Player" menu command
4. Click the "Add Component" button and add "AVPro Video > Apply To Mesh"
5. Drag the Media Player script to the "Media" field in the Apply To Mesh script, this tells the Apply to Mesh script which media player to use
6. Create a sphere via the "GameObject > 3D Object > Sphere" menu command
7. Drag the Mesh Renderer component to the "Mesh" field in the Apply To Mesh script, this tells the Apply to Mesh script which mesh to use



8. Create a folder called StreamingAssets in your Project window and copy your video

file (say MP4 file) into that folder

9. Enter the file name (including extension) into the Video Path field in the MediaPlayer component (eg myvideo.mp4)
10. Build and deploy your application, the video will be displayed on your 3D sphere

6. Usage

6.1 Getting Started

The easiest way to get started is to look at the included demos and see what script components have been used. For video playback you need 3 things in your scene:

1. The video file to play:

Create a “StreamingAssets” folder in your Project window
Copy your video file (usually MP4 file, but consult the list of supported formats for your platform below) to the StreamingAssets folder

2. A MediaPlayer script to load and play the video:

Create a GameObject and add the MediaPlayer script to it
Set the Video Path field to the name of your video file (e.g. myvideo.mp4)

3. A script to display the video:

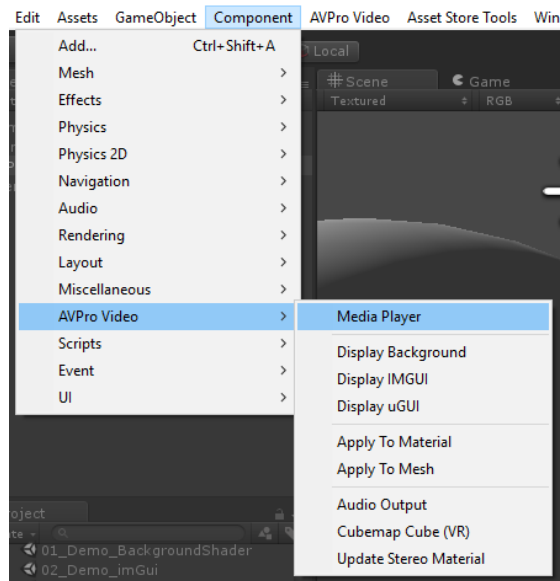
Decide how and where you want your video file to appear. There are a number of different display component scripts included for different usage scenarios. If you want to display the video on top of everything in your scene just add the DisplayIMGUI script to a GameObject in your scene and set the Media Player field your MediaPlayer component. Other display components work similarly.

6.2 Unsupported Platform Fallback

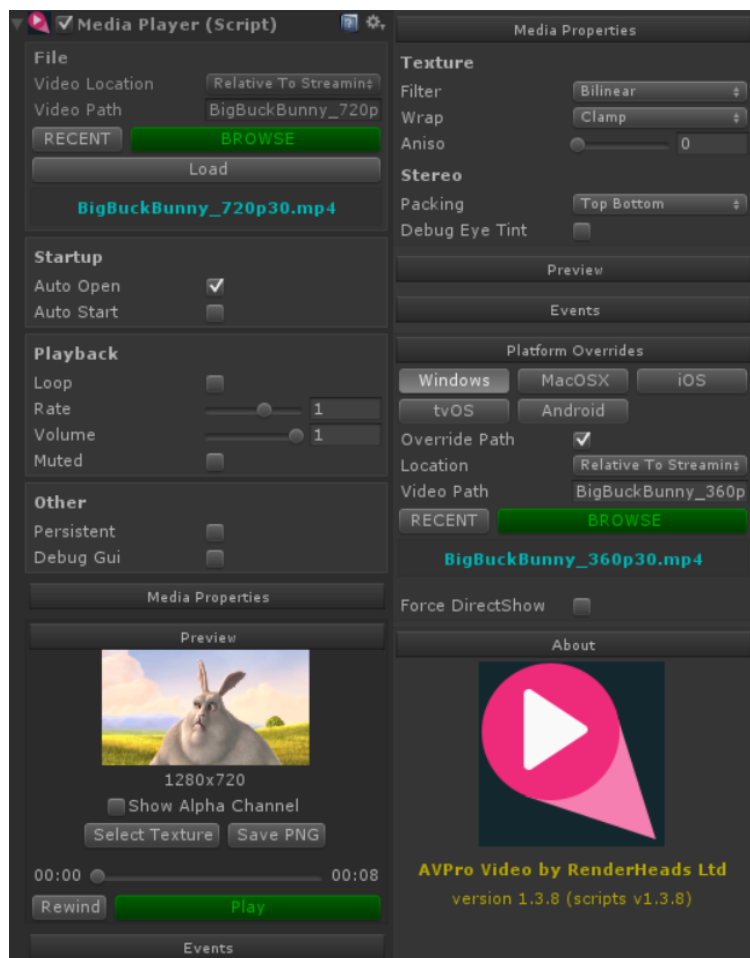
AVPro Video is designed to still function even on platforms that aren’t natively supported. Instead of displaying the actual video though, a dummy 10 second long “AVPro” visual is shown. All of the video controls should still work. For example if you are running your editor in Linux the dummy video player will appear in the editor and the real video will appear when you deploy to supported platforms. If you deploy to an unsupported platform such as Samsung TV you will also see the dummy video player. The code is easily extendable to add custom video players for any unsupported platform.

6.3. Components

Included are a number of components to make this asset easy to use. The components are located in the AVProVideo/Scripts/Components folder or you can add them from the Components menu:



6.3.1 Media Player Component

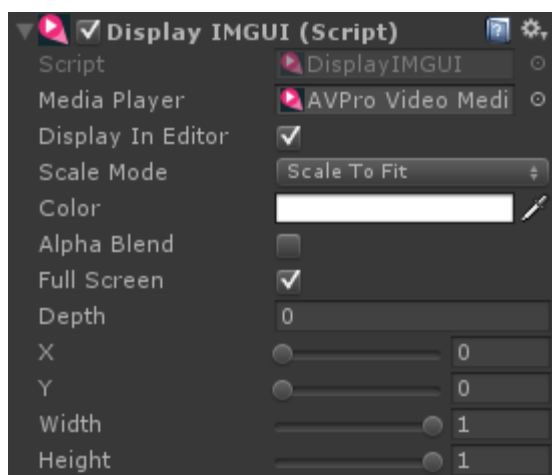


This is the core component for playing media. This component only handles the loading and playback of media and doesn't handle how it is displayed. Use the display script components to control how and where the video is displayed. Fields are:

- Video Location
 - Where to look for the file specified in the Video Path below. This can be an absolute path/URL, or relative to one of the Unity folders. The StreamingAssets folder is the easiest to use. Options are:
 - Absolute or URL
 - This is an absolute path on your device, or an http URL
 - Relative to Project Folder
 - The root folder is the folder above your Assets folder
 - Relative to Streaming Assets Folder
 - The root folder is /Assets/StreamingAssets
 - Relative to Data Folder
 - The root folder is /Assets
 - Unity manual has more information: <http://docs.unity3d.com/ScriptReference/Application-dataPath.html>
 - Relative to Persistent Data Folder
 - Unity manual has more information: <http://docs.unity3d.com/ScriptReference/Application-persistentDataPath.html>
- Video Path
 - The file path to the video in the StreamingAssets folder (e.g. myvideo.mp4 or AndroidVideos/myvideo.mp4 if you want to use a subfolder)
- Auto Open
 - Whether to open the file when this component is enabled/starts
- Auto Start
 - Whether to play the video once a video is opened
- Loop
 - Whether to loop the video
- Playback Rate
 - Sets a multiplier that affects video playback speed
 - Please see section 4.13 notes about this
- Volume
 - 0..1 range for audio volume
- Muted
 - Whether the audio is muted
- Persistent
 - Applies DontDestroyOnLoad to the object so that it survives scene/level loads
- Debug Gui
 - Whether to display an overlay with statistics on the video playback - useful for debugging
- Events
 - This event can be hooked up to scripting functions which will get called when a non-looping video completes playback. See the Events section below for more details and a scripting example
- Visual
 - Texture
 - Set the desired filtering and wrap mode for the final texture that the frames are written to. Useful if you wish to tile your textures in a specific way.

- Transparency
 - Set the pack mode used for transparency, where one half of the video contains the colour data, and the other half contains the monochrome alpha channel data
- Stereo
 - Set the pack mode used for stereo, where one half of the video contains the left eye data, and the other half contains the right eye data
- Resampler
 - The resampler helps smoothen out jitters in video playback caused by unity and decoder vsync drift. The downsides to using it is that it uses more processing power and GPU memory, and that it is out of sync for videos with audio as it displays the video frames a couple of frames later than the decoder.
 - There are two modes in the resampler:
 - POINT picks the closest frame in the buffer and displays it
 - LINEAR picks the two frames directly before and after the current display time, and displays the interpolated version of the two based on how far away the current time is from both of them
 - Resample buffer size determines how many frames are stored in the buffer. A larger buffer size uses more GPU memory as there are more textures, but increases the chance that the desired frames will be found in the buffer, which will allow for smoother playback. A larger buffer size will also mean a larger delay between the video displayed and the actual video on the decoder.
- Platform overrides
 - These allow you to set a different file per platform.

6.3.2 Display IMGUI Component

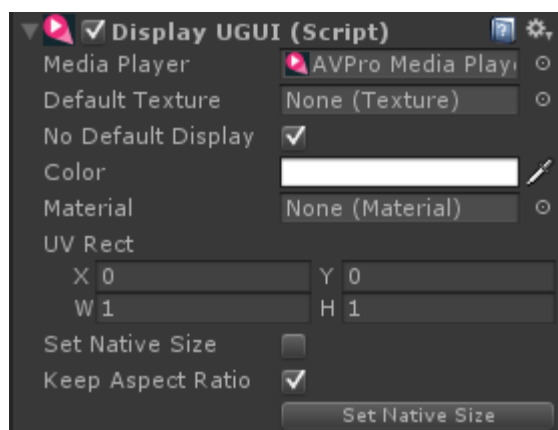


This is the most basic component for displaying the video. It uses the legacy Unity IMGUI system to display the video to the screen. IMGUI is always rendered on top of everything

else in the scene, so if you require your video to be rendered in 3D space or as part of the uGUI system it's better to use the other components. Fields are:

- Media Player
 - The media player to display
- Display in Editor
 - Whether to display the rectangle in the editor - useful for debugging
- Scale Mode
 - How to fit the video to the screen
- Color
 - The color to tint the video, including alpha transparency
- Alpha Blend
 - Whether the video texture controls transparency. Leaving this off for opaque videos is a minor optimisation
- Depth
 - The IMGUI depth to display at. Use this to change the order of rendering with other IMGUI scripts
- Full Screen
 - Whether to ignore the X, Y, Width, Height values and just use the whole screen
- X
 - The normalised (0..1) x position
- Y
 - The normalised (0..1) y position
- Width
 - The normalised (0..1) width
- Height
 - The normalised (0..1) height

6.3.3 Display uGUI Component

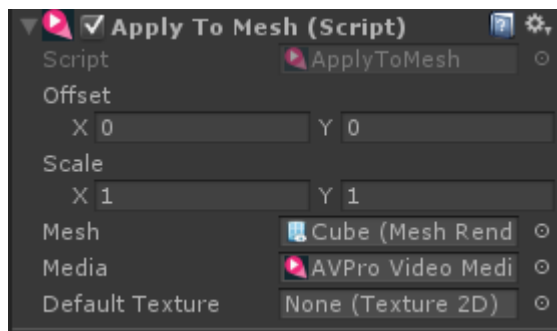


This component is used to display a video using Unity's uGUI system. Field are:

- Media Player
 - The media player to display

- Default Texture (optional)
 - A texture to display while the video isn't playing (while it is buffering for example).
- No Default Display
 - Will not show anything until there are frames available
- Color
 - The color to tint, including alpha transparency
- Material
 - Standard uGUI field, change this to one of the included materials when using packed alpha or stereo videos
- UV Rect
 - Standard uGUI field
- Set Native Size
 - When the video loads will resize the RectTransform to the pixel dimensions of the video
- Keep Aspect Ratio
 - Whether to keep the correct aspect ratio or stretch to fill

6.3.4 Apply To Mesh Component

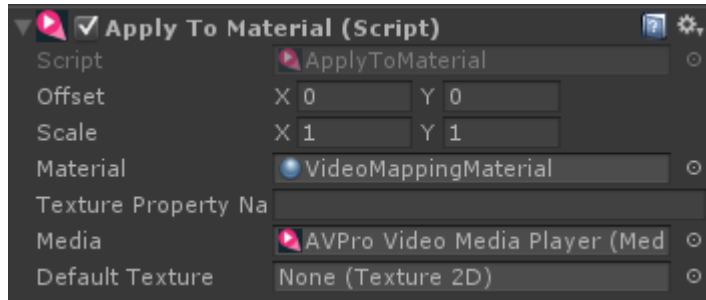


This component takes the texture generated by the Media Player component and assigns it to the texture slot of the material on a 3D Mesh. This is useful for playing videos on 3D meshes. Field are:

- Offset
 - The XY translation to apply to the texture
- Scale
 - The XY scale to apply to the texture
- Mesh
 - The mesh (renderer) to apply the texture to
- Media
 - The media player
- Default Texture (optional)
 - A texture to display while the video isn't playing (while it is buffering for example).
- Texture Property (optional)
 - By default this script assigns to the main texture (`_MainTex`) but if you want to assign to another slot you can put the name in here. If you're using the

Standard Shader and want the texture to drive the emissive property, set the property name to “_EmissionMap”. You may also need to apply a dummy texture to the emissive texture slot in the material to initialise it, and set the emissive colour so it isn’t black.

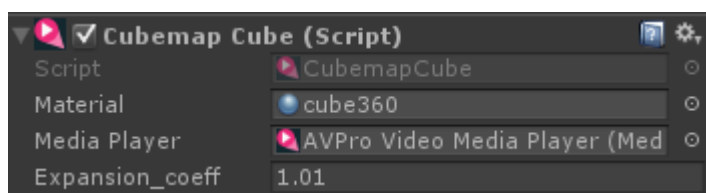
6.3.5 Apply To Material Component



This component takes the texture generated by the Media Player component and assigns it to a texture slot in a Material. This is useful for playing videos on 3D meshes. Fields are:

- Offset
 - The XY translation to apply to the texture
- Scale
 - The XY scale to apply to the texture
- Material
 - The material to apply the video texture to
- Texture Property Name (optional)
 - By default this script assigns to the main texture (_MainTex) but if you want to assign to another slot you can put the name in here. If you’re using the Standard Shader and want the texture to drive the emissive property, set the property name to “_EmissionMap”. You may also need to apply a dummy texture to the emissive texture slot in the material to initialise it, and set the emissive colour so it isn’t black.
- Media
 - The media player
- Default Texture (optional)
 - A texture to display while the video isn’t playing (while it is buffering for example).

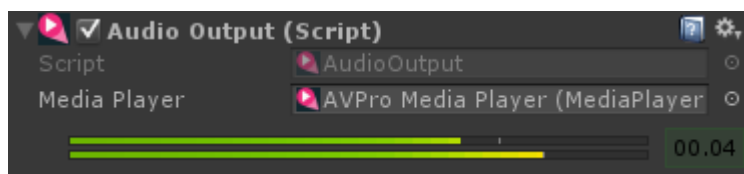
6.3.6 Cubemap Cube Component



This component generates a cube mesh that is suitable for 3:2 cubemap 360 VR videos. Fields are:

- **Material**
 - The material to apply to the cube. This is usually just a standard unlit material.
- **Media Player**
 - The media player that will have its video texture displayed on the cube
- **Expansion_coeff**
 - The value used during enabling to pad the edges to the video to prevent bilinear bleed artifacts. Default is 1.01.

6.3.7 Audio Output Component



This component currently only supports the Windows platforms (UWP, Windows 8 and above) and is used to pass audio from the Media Player to Unity. This allows audio effects, 3D placement and 360 VR spatialisers to be used. Fields are:

- **Media Player**
 - The media player that will have its audio outputted via Unity

6.4 Scripting

6.4.1 Namespace

All scripts in this plugin use the namespace `RenderHeads.Media.AVProVideo` so be sure to add:

```
using RenderHeads.Media.AVProVideo;
```

to the top of your source files.

6.4.2 Media Player Scripting

Most scripting is likely to center around the `MediaPlayer.cs` script. This script handles the

loading, playback and updating of videos. The script exposes a number of interfaces related to different use cases and can be found in Interfaces.cs

MediaPlayer exposes 3 main interfaces:

- Info Interface
 - The IMediaInfo interface is exposed by the Info property
 - This interface is used to access information about the media, eg:

```
MediaPlayer mp;  
mp.Info.GetVideoWidth();
```

- Control Interface
 - The IMediaControl interface is exposed by the Control property
 - This interface is used to control playback, eg:

```
MediaPlayer mp;  
mp.Control.Pause();
```

- TextureProducer interface
 - The IMediaProducer interface is exposed by the TextureProducer property
 - This interface is used to get information about how to display the current texture and is used by the Display components, eg:

```
MediaPlayer mp;  
Texture videoTexture = mp.TextureProducer.GetTexture();
```

The MediaPlayer script also has a number of methods for controlling loading of media:

- OpenVideoFromFile()
 - Loads the video specified. Useful if you need manual control over when the video is loaded
- CloseVideo()
 - Closes the video, freeing memory

6.4.3 Events

MediaPlayer currently has these events:

- MetadataReady - Called when the width, height, duration etc data is available
- ReadyToPlay - Called when the video is loaded and ready to play
- Started - Called when the playback starts
- FirstFrameReady - Called when the first frame has been rendered. *(NB: This event currently doesn't get fired for certain browsers in the WebGL build. This includes all non-mozilla non-webkit browsers)*
- FinishedPlaying - Called when a non-looping video has finished playing
- Closing - Called when the media is closing
- Error - Called when an error occurred, usually during loading
- SubtitleChanged - Called when the subtitles change

- Stalled - Called when media is stalled (eg. when lost connection to media stream)
- Unstalled - Called when media is resumed form a stalled state (eg. when lost connection is re-established)

Scripting example:

```
// Add the event listener (can also do this via the editor GUI)
MediaPlayer mp;
mp.Events.AddListener(OnVideoEvent);

// Callback function to handle events
public void OnVideoEvent(MediaPlayer mp, MediaPlayerEvent.EventType et, ErrorCode
errorCode)
{
    switch (et)
    {
        case MediaPlayerEvent.EventType.ReadyToPlay:
            mp.Control.Play();
            break;
        case MediaPlayerEvent.EventType.FirstFrameReady:
            Debug.Log("First frame ready");
            break;
        case MediaPlayerEvent.EventType.FinishedPlaying:
            mp.Control.Rewind();
            break;
    }

    Debug.Log("Event: " + et.ToString());
}
```

6.5 Platform Specific Scripting

6.5.1 Windows Store / UWP / Hololens

See the Demos/Scriptlets/NativeMediaOpen.cs script for details on how to load directly from the native file system (eg from the Camera Roll)

6.6 Third-Party Integration

6.6.1 PlayMaker Support

AVPro Video includes over 64 components (actions) for PlayMaker, the popular visual scripting system created by Hutong Games. This makes AVPro Video much easier to use for PlayMaker users. The actions can be found in the /Scripts/Support/PlayMaker folder

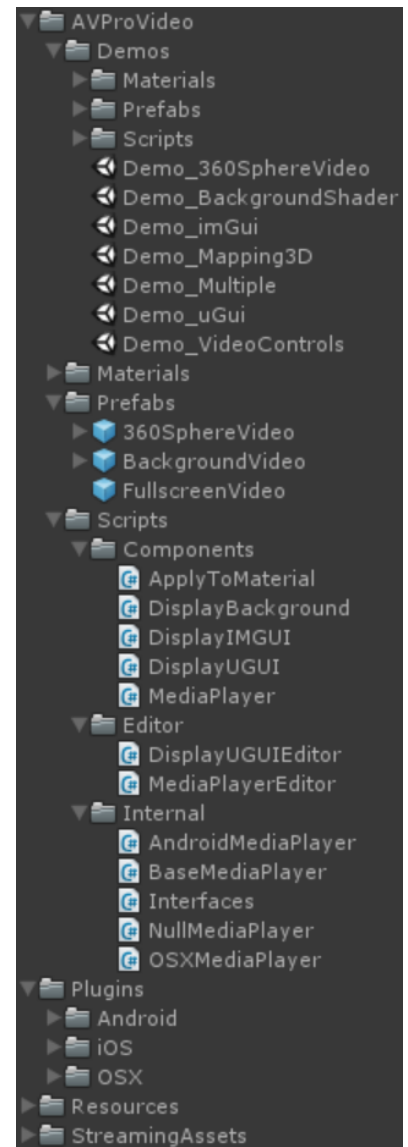
6.6.2 NGUI Support

AVPro Video includes basic support for NGUI, the popular UI system from Tasharen Entertainment. The ApplytoTextureWidgetNGUI component is used to set the AVPro Video texture to an NGUI UITexture widget.

7. Asset Files

7.1 Demos

- Demo_360SphereVideo.unity
 - Demo contains a video player that plays a 360 degree video using equirectangular(lat-long) mapping.
 - The video is applied to a sphere, inside of which is the main camera.
 - If the target device has a gyroscope then moving the device around with rotate the camera to view the video from different angles. For platforms without gyroscope the mouse/touch can be used to look around.
 - A special shader and script are used to allow a single camera to render in stereo on a VR headset. Click on the material to set whether it should display the video as monoscopic, stereo top-bottom or stereo left-right.
- Demo_360CubeVideo.unity
 - Same as the sphere demo above, but using a cubemap 3x2 layout source video.
- Demo_BackgroundShader.unity
 - Basic demo that plays a video using the background material which allows the video to appear behind all content.
- Demo_FrameExtract.unity
 - Shows go to read frames out of the video for saving to disk (jpg/png) or accessing pixel data.
- Demo_imGui.unity
 - Basic demo that plays a video and uses the legacy IMGUI display component to draw the video to the screen.
 - Also has an audio clip to show audio-only media playback.
 - Also has 3 different streaming URLs to demonstrate streaming.
 - IMGUI is drawn on top of all other visual components.
- Demo_Mapping3D.unity
 - Demo containing a video player and a 3D scene
 - Some of the 3D models have the video mapped to them via the ApplyToMaterial script
- Demo_Multiple.unity
 - This demo allows you to programmatically multiple load videos and test multiple videos playing at once. Display is via the AVPro Video uGUI component
- Demo_uGUI.unity
 - This demo shows how to display videos within the uGUI system. It uses the DisplayUGUI component in the canvas hierarchy.
 - It also uses a custom shader to overlay text with a video texture.



- Demo_VideoControl.unity
 - This demo shows how to query the video state and control playback

7.2 Prefabs

- 360SphereVideo.prefab
 - Prefab containing a video player and mapping to a sphere. Useful for playback of equirectangular 360 degree videos
- BackgroundVideo.prefab
 - Prefab containing a video player and a quad model with a special background material applied. This material makes the quad get drawn before everything else so it appears in the background.
- FullscreenVideo.prefab
 - Prefab controls a video player and the IMGUI display component for very easy basic video playback creation

7.3 Scripts

- Components
 - ApplyToMaterial.cs
 - Applies the texture produced by the MediaPlayer component to a unity material texture slot
 - ApplyToMesh.cs
 - Applies the texture produced by the MediaPlayer component to a Unity mesh (via MeshRenderer) by setting the mainTexture field of all its materials
 - CubemapCube.cs
 - Generates a cube mesh that can be used for displaying a 3:2 cubemap packed video
 - DisplayBackground.cs
 - Displays the texture produced by the MediaPlayer component behind all other content (not compatible with SkyBox)
 - DisplayIMGUI.cs
 - Displays the texture produced by the MediaPlayer component using Unity's legacy IMGUI system
 - DisplayUGUI.cs
 - Displays the texture produced by the MediaPlayer component using Unity's new uGUI system
 - MediaPlayer.cs
 - The main script for loading and controlling an instance of video playback
 - UpdateStereoMaterial.cs
 - A helper script for VR stereo rendering to update the camera position variable in a spherical material to help work out which eye to render
 - AudioOutput.cs
 - Used to play audio from the media via Unity's sound system (currently Windows only)
 - ApplyToTextureWidgetNGUI.cs

- Applies the texture produced by the MediaPlayer component to an NGUI Texture widget texture slot
- Editor
 - DisplayUGUIEditor.cs
 - The editor script that controls how the DisplayUGUI component is rendered in the Inspector
 - MediaPlayerEditor.cs
 - The editor script that controls of the MediaPlayer component is rendered in the Inspector
- Internal
 - AndroidMediaPlayer.cs
 - Android specific media player
 - BaseMediaPlayer.cs
 - Common base class for all platform media players
 - Interfaces.cs
 - Interfaces and events
 - NullMediaPlayer.cs
 - The fallback dummy media player for unsupported platforms
 - OSXMediaPlayer.cs
 - iOS and OSX specific media player
 - WebGLMediaPlayer.cs
 - WebGL specific media player
 - WindowsMediaPlayer.cs
 - Windows specific media player

8. Scripting Reference

AVPro Video is designed to be used mainly with the supplied drag and drop component but there are always times when a bit of scripting is needed. The asset includes sample scenes which give some examples of how to use scripting to control video playback, apply video textures to materials etc which are useful to learn from. The full class reference is available online here:

<http://www.renderheads.com/content/docs/AVProVideoClassReference/>

In this document we have included a simplified version of the highlights.

MediaPlayer class

The MediaPlayer class is the main class for video playback and is where video files are specified and controlled. This class is mainly controlled via the Unity Inspector UI and for scripting through the interface properties it exposes.

Properties

- Events
 - returns the MediaPlayerEvent class
- Info
 - returns the IMediaInfo interface
- Control
 - returns the IMediaControl interface
- TextureProducer
 - returns the IMediaProducer interface

Methods

All of these methods use the interfaces exposed above and are just handy shortcuts

- void OpenVideoFromFile(FileLocation location, string path, bool autoPlay)
 - Opens the video specified
- void CloseVideo()
 - Closes the current video and frees up allocated memory
- void Play()
 - Starts playback of the video
- void Pause()
 - Pauses the video
- void Stop()
 - Pauses the video
- void Rewind(bool pause)
 - Rewinds the video with an option to pause it as well
- Texture2D ExtractFrame(Texture2D target, float timeSeconds, int timeoutMs)
 - Extracts a frame from the specified time of the current video as a readable Texture2D. This can then be used to save out the pixel data. The texture

must be destroyed by the user. The texture can be passed in again via the “target” parameter to reuse it.

IMediaInfo interface

This interface is used to query properties of the video

Methods

- float GetDurationMs();
 - Returns the duration of the video in milliseconds
- int GetVideoWidth();
 - Returns the width of the video in pixels
- int GetVideoHeight();
 - Returns the height of the video in pixels
- float GetVideoFrameRate();
 - Returns the frame rate of the video in frames per second
- float GetVideoDisplayRate();
 - Returns the actual frame rate achieved by the video decoder
- bool HasVideo();
 - Returns whether the media has visual tracks
- bool HasAudio();
 - Returns whether the media has audio tracks
- int GetAudioTrackCount();
 - Returns the number of audio tracks
- string GetPlayerDescription();
 - Returns a string describing the internal playback mechanism

IMediaControl interface

This interface is used to control loading and playback of the video

Methods

- bool OpenVideoFromFile(string path);
 - Starts loading the file from the specified path or URL. Returns false if any error was encountered. This function is asynchronous so the video properties will not be available immediately. This function shouldn't be used, instead use the MediaPlayer OpenVideoFromFile function.
- void CloseVideo();
 - Closes the video and any resources allocated
- void SetLooping(bool looping);
 - Sets whether the playback should loop or not. This can be changed while the video is playing.
- bool CanPlay();
 - Returns whether the video is in a playback state. Sometimes videos can take

a few frames before they are ready to play.

- `void Play();`
 - Starts playback of the video
- `void Pause();`
 - Pause the video
- `void Stop();`
 - Stops the video (essentially the same as Pause)
- `bool IsPlaying();`
 - Returns whether the video is currently playing
- `bool IsPaused();`
 - Returns whether the video is currently paused
- `bool IsFinished();`
 - Returns whether the video has completed playback
- `bool IsLooping();`
 - Returns whether the video has been set to loop
- `bool IsBuffering();`
 - Returns whether a streaming video has stopped and is buffering. A buffering video will resume after it has downloaded enough data.
- `void Rewind();`
 - Sets the current time to the beginning of the video
- `void Seek(float timeMs);`
 - Sets the current time to a specified value in milliseconds
- `void SeekFast(float timeMs);`
 - Sets the current time to a specified value in milliseconds but sacrifices accuracy for speed. This is useful if you just want to jump forward/back in a video but you don't care about the accuracy.
- `bool IsSeeking();`
 - Returns whether the video is currently seeking. During seeking no new frames are produced.
- `float GetCurrentTimeMs();`
 - Returns the current time (playback position) in milliseconds
- `void SetPlaybackRate(float rate);`
 - Sets the current playback rate. 1.0f is normal rate. Negative rates aren't supported on all platforms.
- `float GetPlaybackRate();`
 - Returns the current playback rate
- `void MuteAudio(bool mute)`
 - Sets the audio mute or not
- `void SetVolume(float volume)`
 - Sets the volume between 0.0 and 1.0
- `float GetVolume();`
 - Returns the volume level between 0.0 and 1.0
- `int GetCurrentAudioTrack();`
 - Returns the index of the currently enabled audio track
- `void SetAudioTrack(int index)`
 - Sets the index to select the audio track to enable exclusively
- `float GetBufferingProgress();`
 - Returns a value between 0.0 and 1.0 representing network buffering

- `ErrorCode GetLastError()`
 - Returns an error code if an error occurred this frame

IMediaProducer interface

Methods

- `Texture GetTexture();`
 - Returns a Unity Texture object if there is a texture available otherwise null is returned.
- `int GetTextureFrameCount();`
 - Returns the number of times the texture has been updated by the plugin. This can be useful to know when the texture was updated as the value will increment each time.
- `long GetTextureTimeStamp();`
 - Returns the presentation time stamp of the current texture in 100-nanosecond units. This is useful for accurate frame syncing.
- `bool RequiresVerticalFlip();`
 - Some textures are decoded up-side-down and need to be vertically flipped when displayed. This method returns whether the texture needs to be flipped during display.

9. Supported Media Formats

In general the most common format that is supported are MP4 files with H.264 encoding for video and AAC encoding for audio. This format is supported across all platforms though not necessarily all bit-rates and profiles.

Container support:

	Windows Desktop	Mac OS X Desktop	iOS, tvOS	Android
MP4	Yes	Yes	Yes	Yes
MOV	Yes	Yes	Yes	No
AVI	Yes	No	No	No
MKV	Yes in Windows 10	?	?	Yes Android 5.0+
Webm	Yes in Windows 10 - 1607 Anniversary and above	No	No	Yes
ASF/WMV	Yes	No	No	No
MP3	Yes	Yes	Yes	Yes
WAV	Yes	?	?	?

Audio Codec support:

	Windows Desktop	Mac OS X Desktop	iOS, tvOS	Android
AAC	Yes	Yes	Yes	Yes
MP3	Yes	Yes	Maybe*****	Yes
FLAC	Yes in Windows 10	No	No	Yes
AC3	Yes	Yes	?	?
WMA	Yes	No	No	No
MIDI	Yes	?	?	?

Vorbis	No	?	?	Yes
Opus	Yes in Windows 10 - 1607 Anniversary and above	No	No	Yes, Android 5.0+
ALAC (Apple Lossless)	No	Yes	Yes	No
μLAW	Yes	Yes	Yes	No
ADPCM	Yes	Yes	Yes	No
Linear PCM	Yes	Yes	Yes	Yss

Video Codec support:

	Windows Desktop	Mac OS X Desktop	iOS, tvOS	Android
HEVC / H.265	Yes in Windows 10	Yes in High Sierra and above	Yes in iOS 11 and above	Yes
H.264	Yes****	Yes	Yes	Yes
H.263	Yes	?	?	Yes
MJPEG	Yes	No	No	No
WMV	Yes	No	No	No
VP8	Yes*	No	No	Yes
VP9	Yes*	No	No	Yes
Hap	Yes***	Yes	No	No
Hap Alpha	Yes***	Yes	No	No
Hap Q	Yes***	Yes	No	No
Hap Q Alpha	Yes***	Yes	No	No
ProRes 422	No	Yes	No	No
ProRes 4444	No	Yes	No	No
DV	Yes	Yes in Yosemite and above	No	No
Lagarith	Yes, with codec			

Uncompressed RGBA	Yes	?	?	?
Uncompressed YUV	Yes	?	?	?
Uncompressed R10K	No	Yes in Yosemite and above	No	No
Uncompressed V210	?	Yes in Yosemite and above	No	No
Uncompressed 2VUY	?	Yes in Yosemite and above	No	No

For Windows, other codecs can be played if the DirectShow mode is used and 3rd party codecs are installed. We recommend LAV filters for this purpose as this adds support for almost all codecs.

- * Yes, only in Windows 10 and only 4:2:0. Native VP9 support only comes in Yes in Windows 10 1607 Anniversary Update and above, but it may be available before that via Intel GPU drivers. If you use DirectShow and 3rd party filter then 4:4:4 can be supported. Using Media Foundation no audio codecs (Vorbis or Opus) are supported and will cause the video to fail to load if included.
- *** Requires option “Force DirectShow” to be ticked
- **** Older versions of Windows (Vista and XP) do not have support for H.264 decoding
- ***** iOS seems to often have trouble with MP3 audio tracks in a video file, so best to use AAC instead

Cells with “?” are one’s we’re not sure about. We will do more testing and continue to update this table. For more details on which codecs and what type of encoding is best, see the per-platform details below.

9.1 Android

Android supports many media formats. For a complete list check the Android MediaPlayer documentation here: <https://developer.android.com/guide/appendix/media-formats.html> and the ExoPlayer documentation here: <https://google.github.io/ExoPlayer/supported-formats.html>

HEVC (H.265) support was officially added in Android 5.0 (Lollipop) but only as a software decoding implementation on older devices.

We have found that using GearVR on Samsung Galaxy S6 and S7 that H.265 codec works best, with a resolution of 3840x1920 at 30fps, or 2048x2048 at 60fps.

A list of media-player related Android chipsets and which formats they support for hardware decoding: http://kodi.wiki/view/Android_hardware

9.2 iOS, tvOS and OS X

9.2.1 iOS

Many media formats are supported by iOS including H.264. iOS 11 adds support for H.265 (HEVC). The iPhone 7 is the first device with the hardware to support H.265.

The iPhone5C is a low-powered mobile device and has a limitation that the videos must be less than 2 megapixels in resolution.

iOS seems to often have trouble with MP3 audio tracks in a video file, so best to use AAC instead.

iOS also seems to allocate a lot of system memory when loading videos. Unfortunately we're not able to control this which means you have to be very careful when trying to load large or multiple videos, especially with the 1GB iOS devices. To combat this we have added the YCbCr video decoding option (See Platform Specific panel in MediaPlayer component), which uses much less memory.

We recommend only using a single MediaPlayer instance and reusing it for all video loads. The memory issue may be helped by encoding your videos with less reference frames but we haven't tested this for sure.

It has proven difficult getting the true video decoding capabilities of iOS devices. Apple's website has information, but we found it to be slightly inaccurate (for example we can decode 4K video on iPhone5s, which apparently can only do 1080p). It seems that if your device has a 64-bit processor then it will be able to decode 4K H.264, but older devices with 32-bit processors will not.

Device specs according to Apple:

Device	MPEG-4	H.264	MJPEG	AAC-LC	Dolby Audio
iPad 4th generation (Nov 2012)	Maximum Resolution: 640x480 at 30fps, Simple profile. Up to 1.5Mbps In M4V, MP4 and MOV containers	Maximum Resolution: 1920x1080 at 30fps, High profile up to level 4.1 In M4V, MP4 and MOV containers	Maximum Resolution: 1280x720 at 30fps, Up to 35 Mbps In AVI container with PCM audio	160 Kbps 48kHz stereo In M4V, MP4 and MOV containers	Unsupported
iPhone 6 (Sept 2014)	Maximum Resolution: 640x480 at 30fps, Simple profile. Up to 1.5Mbps In M4V, MP4 and MOV containers	Maximum Resolution: 1920x1080 at 60fps, High profile up to level 4.2 In M4V, MP4 and MOV containers	Maximum Resolution: 1280x720 at 30fps, Up to 35 Mbps In AVI container with PCM audio	160 Kbps 48kHz stereo In M4V, MP4 and MOV containers	Unsupported

iPad 5th generation (March 2017) iPad 9.7inch iPad Pro iPhone 6S (Sept 2016) iPhone SE (March 2016) iPhone 7 (Sept 2016)	Maximum Resolution: 640x480 at 30fps, Simple profile. Up to 1.5Mbps In M4V, MP4 and MOV containers	Maximum Resolution: 3840x2160 at 30fps, High profile up to level 4.2 In M4V, MP4 and MOV containers	Maximum Resolution: 1280x720 at 30fps, Up to 35 Mbps In AVI container with PCM or ulaw stereo audio	160 Kbps 48kHz stereo In M4V, MP4 and MOV containers	Up to 1008Kbps, 48kHz, stereo or multi-channel In M4V, MP4 and MOV containers
iPod 6	Unsupported	Maximum Resolution: 1920x1080 at 30fps ,Main Profile level 4.1 In M4V, MP4 and MOV containers	Unsupported	160 Kbps 48kHz stereo In M4V, MP4 and MOV containers	Unsupported

iPad 4 supported formats according to Apple are from here:

https://support.apple.com/kb/sp662?locale=en_US

iPad 5 supported formats according to Apple are from here:

https://support.apple.com/kb/SP751?locale=en_US

iPad 9.7inch supported formats according to Apple are from here:

<https://www.apple.com/ipad-9.7/specs/>

iPad Pro supported formats according to Apple are from here:

<https://www.apple.com/ipad-pro/specs/>

iPod 6 supported formats according to Apple are here:

https://support.apple.com/kb/SP720?locale=en_US&viewlocale=en_US

9.2.2 macOS

Many media formats are supported by macOS including H.264, H.265, ProRes 422 and ProRes 4444.

macOS Yosemite adds support for

- DV
- Uncompressed R10k
- Uncompressed v210
- Uncompressed 2vuy

macOS High Sierra adds support for

- H.265 / HEVC

9.3 Windows

A full list of supported formats can be found here:

[https://msdn.microsoft.com/en-us/library/windows/desktop/dd757927\(v=vs.85\).aspx](https://msdn.microsoft.com/en-us/library/windows/desktop/dd757927(v=vs.85).aspx)
<https://msdn.microsoft.com/en-us/windows/uwp/audio-video-camera/supported-codecs>

H.264 decoder supports up to profile L5.1, but Windows 10 supports above L5.1 profile:

[https://msdn.microsoft.com/en-us/library/windows/desktop/dd797815\(v=vs.85\).aspx](https://msdn.microsoft.com/en-us/library/windows/desktop/dd797815(v=vs.85).aspx)

H.265 decoder specs are here:

[https://msdn.microsoft.com/en-us/library/windows/desktop/mt218785\(v=vs.85\).aspx](https://msdn.microsoft.com/en-us/library/windows/desktop/mt218785(v=vs.85).aspx)

Windows 10 adds native support for the following formats:

- H.265 / HEVC
- MKV
- FLAC
- HLS Adaptive Streaming
- MPEG-DASH

Windows 10 Fall Update seems to remove native H.265 / HEVC support for some users and requires them to download the (free) [HEVC Video Extension](#). Before update KB4056892 (4 Jan 2018), users also had to open a H.265 video in the Films & TV app after a restart before AVProVideo could play H.265 videos. This update seems to fix that however.

9.4 Windows Phone / UWP

Details on media supported by this platform can be found is platform are here:

[https://msdn.microsoft.com/library/windows/apps/ff462087\(v=vs.105\).aspx](https://msdn.microsoft.com/library/windows/apps/ff462087(v=vs.105).aspx)
<https://msdn.microsoft.com/en-us/windows/uwp/audio-video-camera/supported-codecs>

9.5 WebGL

Support for WebGL platform is still varied and depends on the platform and browser support. Some formats such as AVI file container are not supported at all. As with all other platforms, H.264 video in an MP4 container is the most widely supported format.

Adaptive streaming (such as HLS) is still not supported natively by most browsers, but we have seen it working in the Microsoft Edge and Safari browsers.

For best compatibility make sure to force WebGL 1.0 by going to Player Settings > Other Settings > Auto Graphics API and removing WebGL 2.0. Failure to do so can make videos on Chrome not render.

HLS and MPEG-DASH are not natively supported on all browsers. We have added the ability to include 3rd party javascript libraries to handle these (dash.js and hls.js). See the streaming section for how to implement these.

On newer versions of Safari videos are not allowed to auto-play unless given permission by the user (in the preferences menu). This doesn't affect videos that have no audio track so this may be a workaround. More details can be found here:

<https://webkit.org/blog/7734/auto-play-policy-changes-for-macos/>

Some resources about the supported formats:

https://developer.mozilla.org/en-US/docs/Web/HTML/Supported_media_formats

https://en.wikipedia.org/wiki/HTML5_video#Browser_support

<http://www.encoding.com/html5/>

10. Support

If you are in need of support or have any comments/suggestions regarding this product please contact us.

Email: unitysupport@renderheads.com

Website: <http://renderheads.com/product/avpro-video/>

Unity Forum:

<http://forum.unity3d.com/threads/released-avpro-video-complete-video-playback-solution.385611/>

10.1 Bug Reporting

If you are reporting a bug, please include any relevant files and details so that we may remedy the problem as fast as possible.

Essential details:

- Error message
 - The exact error message
 - The console/output log if possible
 - If it's an Android build then an "adb logcat" capture
- Hardware
 - Phone / tablet / device type and OS version
- Development environment
 - Unity version
 - Development OS version
 - AVPro Video plugin version
- Video details:
 - Resolution
 - Codec
 - Frame rate
 - Better still, include a link to the video file

Better still, send us a full or reduced copy of your Unity project

11. About RenderHeads Ltd



RenderHeads Ltd is an award-winning creative and technical company that has been designing and building cutting edge technology solutions since its formation in 2006. We specialise in creating interactive audio-visual software for installations at auto shows, museums, shows and expos.

11.1 Services

- Unity plugin development and consulting
- Bespoke software development:
 - High-end technology for events and product launches
 - Interactive installations and educational museums
 - Video walls
 - Virtual reality experiences
 - Augmented reality apps

11.2 Careers at RenderHeads

We're always looking for creative technical people to join our team. RenderHeads is an innovative software company that develops interactive experiences lead by high-end technology and beautiful graphics. We have created installations for Nike, Ford, Nissan, Dell, Intel, PwC, Shell, Cisco, and others. Our work also appears in the National Maritime Museum Greenwich, Museum of Science and Industry Manchester, Sheikh Abdullah Al Salem Cultural Centre Science Museum Kuwait and Guinness Storehouse Ireland.

We create games for museums and brands, bespoke AR, VR and huge video wall experiences for shows, real-time visualisations for events and audio-visual products for developers and the broadcast industry. All of the software we develop is unique, and our clients have high expectations. We work with some of the latest hardware and software technologies, and each project gives us a new opportunity to explore the edge of possibility.

RenderHeads offer a flexible working opportunity with remote or in-office working. We have offices in Cape Town, South Africa and Glasgow, Scotland, and team members working remotely from around the world.

If you're looking for a new opportunity to push the limits and create awesomeness, please read through the requirements below and email us at jobs@renderheads.com. Send us your CV and links to showreel, past projects or code examples.

General Requirements

- You must be able to show a history of making software, either by professional experience or personal projects
- Pragmatic software development approach - we ship software frequently
- Either very strong technical skills, or a mix of creative and technical skills
- Good communication skills - most of our communication is online, via Slack/Skype/Hangouts and email/Google Docs

Positions we have available:

Video Software Developer

- You would be developing in-house camera and video related software, including our AVPro series of Unity plugins, related to cross-platform video playback, streaming, capture and encoding
- Required experience:
 - Strong C++
 - Multi-threaded programming
- Ideal experience:
 - C# and Unity
 - AVFoundation / Media Foundation / DirectShow / libAV / ffmpeg / gstreamer
 - DeckLink / NDI SDK
 - Low-level MP4 / H.264 / H.265 / HEVC / HLS / DASH / RTSP / RTP
 - Shader development
 - Camera / broadcast experience
 - 360 video workflows
 - 360 audio technologies

Interactive Software Developer

- You would be creating software for a wide variety of technically challenging and creative projects, and implementing cool interactive experiences using the latest technologies
- Features of our typical projects:
 - Most development is in Unity
 - Visualisation and effects
 - Educational games
 - VR experience development
 - Integration with cameras, sensors and hardware
 - UI and animation development
- Required experience:
 - C# and Unity
 - SVN / Git
- Ideal experience:

- iOS / Android development
- An interest in UI and UX
- An interest in improving workflow / tools
- Shadertoy and other graphics rendering tech
- Ability to travel (for on-site installations)

Senior Software Developer

- You would oversee the progress of the other developers in your team: making sure everyone is on track, helping to instill good development practices, helping to grow everyone's experience and skills
- You would tackle some of the more difficult programming problems and make sure that the final software is of high quality
- You would also help to scope and plan the approaches for new projects, working closely with the other senior members
- Required experience:
 - Many years of software development
 - Many projects/products released
 - Optimisation
 - Unity and C#
- Ideal experience:
 - Graphics programming
 - An interest in improving workflow / tools (Jenkins, CI, Dev ops)

11.3 Our Unity Plugins

Many of the apps and projects we develop require features that Unity doesn't yet provide, so we have created several tools and plugins to extend Unity which are now available on the Unity Asset Store. They all include a **free trial or demo version** that you can download directly from the website here:

<http://renderheads.com/product-category/for-developers/>

11.3.1 [AVPro Video](#)



Powerful cross-platform video playback solution for Unity, featuring support for Windows, OS X, iOS, Android and tvOS.

11.3.2 [AVPro Movie Capture](#)

Video capture to AVI files direct from the GPU and encoded to files using DirectShow codecs. Features include 8K captures, lat-long (equirectangular) 360 degree captures, off-line rendering and more. Windows only.

11.3.3 [AVPro Live Camera](#)

Exposes high-end webcams, tv cards and video capture boards to Unity via DirectShow. Windows only.

11.3.4 [AVPro DeckLink](#)



Integrates DeckLink capture card functionality into Unity, allowing users to send and receive high-definition uncompressed video data to and from these capture cards.

Appendix A - Frequently Asked Questions (FAQ)

1. Why won't my high-resolution video file play on Windows?

The ability to play high resolution videos depends on the version of Windows operating system and which video codecs you have installed.

By default AVPro Video will try to use the standard Microsoft codecs that come with Windows. These have limitations, for example:

Decoder	Windows 7 and below	Windows 8+
h.264	1080p	2160p (4K)
h.265 (HEVC)	unsupported	2160p (4K) or 4320p (8K) if your video driver supports

If you want to use 3rd party codecs you can install them to improve the range of resolution and format options available. These come in the form of Media Foundation or DirectShow codecs. The LAV Filters are a great example of DirectShow codecs that will allow for higher resolution video decoding.

2. Does Time.timeScale affect video playback speed?

Yes we have BETA support for time.timeScale and time.captureFramerate. Simply enable the option on the Media Player component in the panel labelled "Global Settings".

3. Does AVPro Video support playing YouTube videos and live streams?

Yes and no. If you enter a YouTube URL into AVPro Video it will not be able to play it because this is the URL to the website and not the video. It is possible to gain access to the underlying MP4 file or HLS stream URL which will work with AVPro Video. This may be against the terms and conditions of YouTube though. We have heard that some users have experimented with using the youtube-dl <https://rg3.github.io/youtube-dl/> command-line tool to extract the video URL and then use that for playback within AVPro Video.

4. How can I get smoother video playback for my Windows VR app?

This is usually caused by the video decoding taking too much CPU time. Some videos (especially highly compressed ones) require a lot of CPU time to decode each frame.

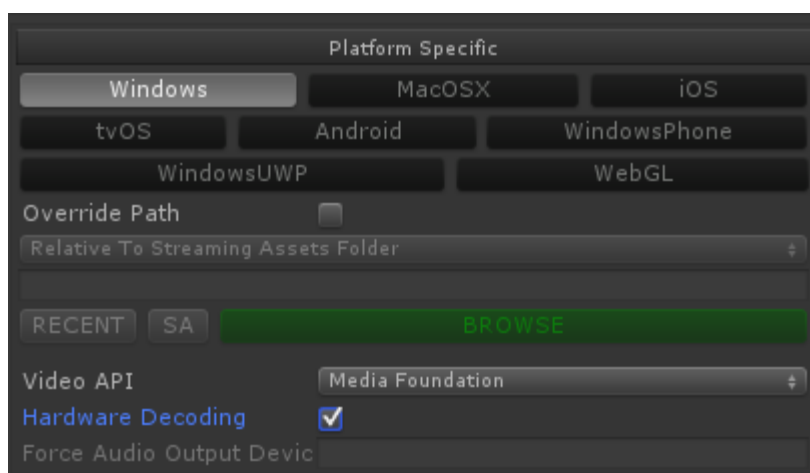
Try enabling the hardware decoding option in “Platform Specific” panel. This will enable your application to use GPU decoding which is much faster. This option is only supported on Windows 8.1 and above and when D3D11 graphics API is used.

You could also try re-encoding your video using settings that are less demanding for the decoder. Most H.264 encoders have a ‘fast decode’ preset, or you can manually change settings such as disabling CABAC, reducing the number of reference frames, reducing bitrate, disabling B-frames, disabling the loop (deblocking) filter etc.

You could also try switching to another video codec that allows for less CPU intensive decoding. Codecs such as H.264 / H.265 are generally very heavy on the CPU. Hap is an extremely fast codec but will result in large files.

5. Is GPU hardware decoding available?

Yes it is on most platforms. Android, iOS, tvOS and macOS mostly use GPU decoding - but it depends on the codec. For Windows GPU decoding is enabled by default but is only available for Windows 8.1 and above and when using D3D11 graphics API. You can toggle GPU decoding is enabled via the Platform Specific panel:



6. Is multi-channel audio supported?

Audio with more than 2 channels should be supported on desktop platforms. On Windows you will need to set your sound settings in the Control Panel for the number of channels you want to output. If you leave your Windows sound settings as stereo then the audio will get mixed to stereo.

7. Why isn't seeking accurate / responsive?

The way seeking works depends on the platform. Some platforms support frame accurate seeking but most will only seek to the nearest key-frame in the video. In general to improve seek accuracy and responsiveness you can re-encode your videos with more frequent key-frames (smaller GOP). The downside of this is that

the size of the video file will increase (more key-frames = larger file).

We have two seek functions: Seek() and SeekFast(). SeekFast can be used when accuracy isn't important but whether it's faster or not depends on support from the platform and can vary based on the video codec used.

Platform / API	Accurate Seeking Supported
Windows Desktop / DirectShow	Yes (but depends on codec used, native Microsoft H.264 decoder doesn't support)
Windows Desktop / Media Foundation	Yes
Windows Store / Phone / UWP	Yes
Android / MediaPlayer	No (but coming in Android "O")
Android / ExoPlayer	Yes
macOS	Yes
iOS / tvOS	Yes
WebGL	Depends on browser

8. Windows - Why isn't my stereo top-bottom or left-right video displaying correctly?

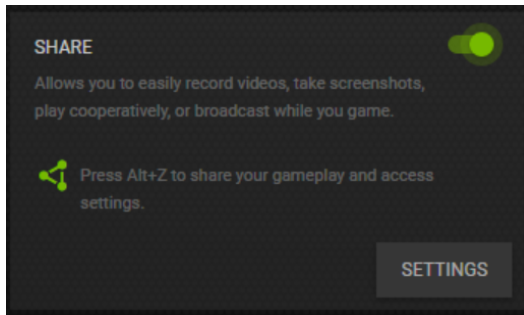
If your stereo video is only decoding one of the views then this is because there is stereo metadata encoded within the video which causes our Media Foundation decoder to interpret incorrectly. The only way to currently solve this is to remove the metadata from the video. One way to do this is using FFMPEG:

```
ffmpeg -i %1 %1-video.nut  
ffmpeg -i %1-video.nut -crf 10 %1-stripped.mp4
```

We have also had reports that this works:

```
ffmpeg -i in.mp4 -map_metadata -1 -c:v copy -c:a copy out.mp4
```

9. Windows - Why do videos take a long time (1-2 seconds) to open when using DirectShow?



We have seen this happen when the Nvidia GeForce Experience is installed and the Share option is enabled (ShadowPlay). Disabling the share option or uninstalling this software resolves this issue.

10. Windows - Why doesn't my H.265 8K video play when I make a build?

This is probably because your build is 32-bit. Try making a 64-bit build. See our other notes above for other 8K requirements.

11. Laptop - Why can't my powerful laptop decode a 8K video?

Laptops can have multiple GPUs and will often default to the built-in GPU (eg Intel) instead of the more powerful discrete GPU (eg NVidia / AMD). Try going to the NVidia Control Panel to make the discrete GPU the default and then reload Unity or your application.

12. Hap Codec - Why don't my Hap encoded videos play?

If your platform is Windows desktop then this is usually because the DirectShow video API has not been selected. See the notes above about how to use the Hap codec.

13. Scrubbing - Why is seeking/scrubbing unresponsive when using a Slider GUI component?

This is a common mistake where the OnValueChanged event in the Slider component is set to trigger a method that calls Seek() on the video. The problem is that OnValueChanged doesn't only trigger when the user is interacting with the slider, but also when the video is playing normally and is updating the slider position. So the Update method might be changing the slider position based on the video position, which then causes OnValueChanged to trigger, which causes a seek. You need to guard against this by checking that the user is interacting with the slider, perhaps by adding OnPointerDown and OnPointerUp events. OnPointerDown you would seek to that position and also set a flag. Then in OnValueChanged you would only seek if that flag was set. In OnPointerUp you would unset the flag.

14. macOS - Errors when using Unity Cloud Build

Make sure that you set the correct XCode version in the Cloud Build settings. Try XCode 8.3.3 as this is the version we currently use for building the plugin.

15. macOS - Publishing for Mac App Store and get error “Invalid Signature”?

We're not sure why this happens but we've had reports that simply deleting all of the .meta files inside the AVProVideo.bundle will resolve this issue.

16. macOS - Why is the video playback very jumpy when I make a build, but fine in the editor?

We have seen this happen when using the Metal graphics API. Try going to Player Settings, unticking the option “Auto Graphics API for Mac” and make “OpenGLCore” at the top of the list.

17. iOS / tvOS - Why doesn't my video file play properly?

Make sure that your video file doesn't contain an MP3 audio track. In our experience iOS doesn't handle MP3 audio correctly and can often lead to the whole file not loading/playing correctly. Use AAC for audio instead.

18. iOS - Can I playback a video from the Videos library?

Yes if the video is not content protected and you have it's URL. URL's for items in the video library take the following form:

```
ipod-library://item/item.m4v?id=1234567890123456789
```

You can get the URL of an item by using the MPMediaQuery class from the MediaPlayer framework.

19. iOS - Can I playback a video from the Photo Library?

Yes. You need to use the UIImagePickerController to select the video. This will result in the video being processed into your app's temp folder where you can access it via the URL returned from the controller.

20. iOS / tvOS - Why doesn't my HLS m3u8 stream play?

First you should check the XCode console for error messages. This can give you a clue about the problem.

Next you should run your HLS manifest through the Media Stream Validator Tool (https://developer.apple.com/library/archive/technotes/tn2235/_index.html) provided by Apple. iOS and tvOS are VERY strict when it comes to streaming video, so it is possible that a stream will play on macOS, but be refused on iOS or tvOS.

21. iOS - How can I fix the error message: *"Missing Push Notification Entitlement - Your app includes an API for Apple's Push Notification service, but the aps-environment entitlement is missing from the app's signature"*?

If you are not using Push notifications in your app, this Unity Asset does the job of fixing this error: <https://www.assetstore.unity3d.com/en/#!/content/59160>. Just import it, and build the xcode files again.

- 22. iOS - How can I fix the error message: *"This app attempts to access privacy-sensitive data without a usage description. The app's Info.plist must contain an NSCameraUsageDescription key with a string value explaining to the user how the app uses this data."***

Open the Info.plist file in xcode, and manually add "NSCameraUsageDescription" (Privacy - Camera Usage Description), with a value explaining the reason why you are using the webcam. In our case, this was caused by using the Google Cardboard code and that needs the webcam to read the Cardboard device QR code, so we added the following value "Requires camera for reading Cardboard QR code".

- 23. Android - Why doesn't my huge video file play from StreamingAssets folder?**

Files in the StreamingAssets folder for Android are packed into a JAR file and so before we can play them we must extract them to the apps persistent data folder. Huge files can take a long time to extract and copy and sometimes they could even cause the device to run out of storage space or memory. For really large files we recommend placing them the videos in other folders on the device and then referencing the absolute path to that file. This also has the added benefit of not having a copy huge files and wait ages when deploying builds to the Android device.

- 24. Android - Why does the adb logcat receive so many logs "getCurrentPosition" from MediaPlayer-JNI?**

Android's MediaPlayer logs this to verbose channel, simply change your logging filter to ignore verbose logs.

- 25. Android - Why doesn't the video display when using Vuforia?**

In our test Vuforia doesn't play well with AVPro Video when multi-threaded rendering is enabled. Simple disable this option in the Player Settings screen.

- 26. Android - Why does my build fail with a message about DEX and zip classes?**

This can happen when there is a conflict in the Java code. We include a JAR called zip_file.jar which contain classes for handling zip files. If you have another plugin in your project that also contains these classes then Unity will fail the build. Read the exact Unity error message and if it is related to zip classes then you can try deleting zip_file.jar file.

Or you may need to upgrade from JDK 1.7.0 to 1.8.0

- 27. Cardboard/Google VR - Why is the image shaking?**

We've had reports that this is caused by enabling the option "track position" in the Gvr head.

28. Windows 10 - Why doesn't my H.265 / HEVC video play?

Microsoft removed the HEVC codec that was previously included in Windows during the Fall Creators Update in April 2018, Windows 10 version 1709.

Currently in Windows 10 if you want to play HEVC content you either need to open a HEVC video in the default Film & Movie app, or you need to install this extension:

"HEVC Video Extensions from Device Manufacturer"

<https://www.microsoft.com/en-us/p/hevc-video-extensions-from-device-manufacturer/9n4wgh0z6vhq>

29. macOS / iOS / tvOS - Why doesn't my H.265 / HEVC video play?

Apple is very strict with the 4 character (FOURCC) 'tag' that is used to identify the codec of the video, and only accept videos with the HVC1 tag, whereas many video encoders embed the tag HEV1, which would cause the video not to play on Apple platforms.

To fix this you either need to be using encoding software that lets you specify the HVC1 tag, or use a tool such as FFMPEG to change the tag for you using this command-line:

```
ffmpeg -i video.mp4 -c:v copy -tag:v hvcl -c:a copy video-hvcl.mp4
```

30. Why is my video displaying with the wrong rotation?

Videos recorded from mobile devices contain orientation metadata. Some platforms parse this metadata during decoding and produce the texture in the correct final orientation, while others don't and we have to correct it in C# or in the shader. We do handle this for most cases, however if you are using the ApplyToMesh or ApplyToMaterial on macOS, iOS and tvOS then this rotation will not be applied. There are a few ways to fix this:

1) Re-encode the video with the rotation metadata removed and with the video encoded in its final orientation. Using FFMPEG you can do this via:

```
ffmpeg -y -i %1 -metadata:s:v:0 rotate=0 %1-norotation.mp4
```

2) Detect the orientation of the video and apply a rotation of the texture coordinates in the shader:

```
Orientation ori = Helper.GetOrientation(_media.Info.GetTextureTransform());  
Matrix4x4 oriMatrix = Helper.GetMatrixForOrientation(ori);  
_material.SetMatrix("_texRotation", oriMatrix);
```

and then the shader define the matrix variable:

```
uniform float4x4 _texRotation;
```

and apply the matrix rotation in the shader via something like:

```
o.uv.xy = mul(_texRotation, v.texcoord.xy).xy;
```

You may also have to change the texture wrapping mode in MediaPlayer > Visual > Wrap to Repeat

If you are using WebGL, then we have found that most browsers (Edge and Chrome) pre-transform the video so that it is in the correct orientation, as there is no mechanism in HTML 5 to retrieve the video orientation/transform. We have found that Firefox doesn't support this though.

31. iOS - Why do I get this message about privacy permission using camera?

Some users have reported getting this message:

"This app attempts to access privacy-sensitive data without a usage description. The app's Info.plist must contain an NSCameraUsageDescription key with a string value explaining to the user how the app uses this data."

This seems to be a bug in Unity 5.4.1 and has been resolved in Unity 5.4.2.

32. Will you support MPEG-DASH or another adaptive streaming system?

MPEG-DASH is currently supported on Windows 10, Windows UWP 10 and Android (when using ExoPlayer API) only. We hope to improve support for these sorts of streaming systems eventually. The plugin already supports some basic streaming protocols and for now we're focusing on basic features before we look at advanced features such as these. HLS adaptive streaming is supported on most platforms.

33. Android - Why is my video playback freezing?

We have found that H.264 videos with GOP = 1 (all I-Frames / Key-frames) freeze on Android. GOP interval of 2 seems to be fine.

34. Windows - Why can't I stream HLS at 4K in Windows 10?

Windows 10 (before Anniversary update) seems to limit the stream resolution based on your screen resolution and the monitor DPI scaling setting. To get 4K using HLS you need a 4K monitor and your DPI scaling set to 100%. This issue now seems to be resolved in the latest version of Windows 10.

35. Windows - Why does the video control react correctly in Windows 7, but not in Windows 8 or above?

If you try to call video control function (eg Seek, Mute, SetVolume etc) just after you open the video file, this can cause problems. Video loading can be synchronous or asynchronous, so you need to wait until the video has completed loading before issuing any control commands. In Windows 7 and below the DirectShow API is used by default. Currently the open function works synchronously, so control functions will work immediately after loading. In Windows 8 and above the Media Foundation API is used by default, and this is asynchronous. The best approach is to use the event system to wait for the video to be ready (contain meta data), or to poll the MediaPlayer (Control.HasMetaData()) before issuing control functions.

36. Why does my HLS / RTSP stream created with FFMPEG work so badly in AVPro Video?

Some users have reported issues with creating a stream with FFMPEG where the stream will take a long time to connect and will only send through frames occasionally. We have found that you need to manually add the GOP size parameters to be a multiple of your frame-rate. So for example if your frame-rate is 25 then you should add "-g 25" in your FFMPEG command-line.

37. Android - How do I authenticate my RTSP stream?

RTSP on Android is currently only supported when using the MediaPlayer API. You should be able to pass in your username and password in the URL using the following format:

```
rtsp://<user>:<password>@<host>:<port>/<url-path>
```

Another way is to pass it via HTTP header fields. We also support this. In the MediaPlayer component, go to Platform Specific > Android section and use the JSON HTTP HEADER field to put something like this JSON:

```
{
  "SERVER_KEY_TO_PARSE_USER_NAME": "username",
  "SERVER_KEY_TO_PARSE_PASSWORD": "password"
}
```

38. Windows - Why is there a slight colour shift between software and hardware decoding?

We're not completely sure why this is. It appears that sometimes that hardware decoder decodes the video slightly darker in places. On the whole the effect is very small, so it only affects videos that contain data that must be reproduced exactly. We have found that the following FFMPEG command does improve the colour matching.

```
ffmpeg -i video.mp4 -y -vf
"scale=in_range=tv:out_range=tv:in_color_matrix=bt601:out_color_matri
x=bt709" out.mp4
```

39. Windows Audio - Why does my HLS/DASH stream audio have gaps or play at the wrong rate when using the AudioOutput component?

This currently can happen when using adaptive streams as we can't determine the sample rate, and thus cannot set up a resampler to convert to the sample rate Unity is using internally. To solve this you need to set Unity's sample rate in the Audio Settings to match that of the stream (eg 44100).

40. Audio - Why does my multi-track audio file play all tracks at once?

This can happen when all of the audio tracks are set to default. You need to encode the video with only one of the tracks set to default. Using FFMPEG you can do this:

```
ffmpeg -i video_noaudio.mp4 -i audio_esp.m4a -i audio_jap.m4a -i audio_eng.m4a -map 0 -map 1 -map 2 -map 3 -disposition:a:1 none -disposition:a:2 none -codec copy output.mp4
```

41. Which DRM content protection schemes does the plugin support?

See the DRM section in this documentation.

42. How do I flip my video horizontally?

- a. In the MediaPlayer component, in the Media Properties section, set the wrap mode to "Repeat".
- b. If you're using the ApplyToMesh component, then you just need to set the Scale X value to -1
- c. If you're using the ApplyToMaterial component, then you just need to set the Scale X value to -1
- d. If you're using the DisplayIMGUI component, then this doesn't have any way to flip video without editing the script.
- e. If you're using the DisplayUGUI component, then just set the UVRect W value to -1.

43. Windows - Why doesn't the plugin support Windows XP SP2 and below?

Modern Visual Studio compilers require XP SP3 as a minimum. One of the reasons for this is builds reference the function GetLogicalProcessorInformation() in Kernel32.dll which isn't present in XP SP 2. The lack of this function causes our DLL to fail to load. More information here:

<https://connect.microsoft.com/VisualStudio/feedback/details/811379/>

44. How do I use a video in a reflection probe?

If you want a video to appear as part of a reflection in your scene, then you can add a reflection probe, set to update in real-time and refresh every frame.

Then add geometry to your scene and use the ApplyToMesh component to apply the video to that geometry. If you are using a equirectangular video then you can apply

the video to our OctahedronSphere mesh and use a material on it with the InsideSphere Unlit shader. Then as long as your reflection probe is inside this sphere, it should collect the video.

If you don't want this geometry to appear in your scene, then you can either move the geometry and reflection probe to another area of your scene (you will then have to set the Anchor Override on your MeshRenderer or make it use that reflection probe), or create a new Layer name and assign it to the geometry and reflection probe, also setting the Culling Mask of the reflection probe so it only renders that geometry. Then in your other cameras you will need to exclude that layer from the camera culling mask list.

45. How do I use a video as a skybox?

If you want the video to appear as the Skybox, create a new material that uses Skybox/Panoramic shader, then go to Lighting Settings and assign this material to the Skybox field. Then add a ApplyToMaterial component and assign it to this material and to the mediaplayer. The video should now render to the default skybox in your scene. You can also leave the Lighting Settings default Skybox field as default, and just add a Skybox component to your camera to override which skybox material it uses.

46. What's the difference between your different Unity video playback plugins?

We previously had 3 video playback plugins for Unity:

- AVPro Video
- AVPro Windows Media (deprecated August 2016)
- AVPro QuickTime (deprecated May 2016)

Here is a table giving a rough comparison of the plugin features:

	AVPro Video	AVPro Windows Media	AVPro QuickTime
First Released	2016	2011	2011
Windows XP-7	Yes**	Yes	Yes (with QT installed)
Windows 8-10	Yes	Yes	Yes (with QT installed)
Windows UWP	Yes	No	
Windows Phone	Yes	No	
OS X	Yes	No	Yes
Android	Yes	No	No
iOS	Yes	No	No
tvOS	Yes	No	No

WebGL	Yes	No	
64-bit	Yes	Yes	No
2K H.264	Yes	Only with 3rd party codec	Yes
4K H.264	Yes	Only with 3rd party codec	Yes but very slow
8K H.265	Yes	Only with 3rd party codec	No
Streaming URL	Yes	Not really	Yes a bit
Hap Codec	Yes	Yes	Yes
MP4 Container	Yes	Only with 3rd party codec	Yes
Works with VR	Yes	Yes best with 3rd party codecs	Not great
ASync Loads	Yes	No	Yes
Transparency	Yes	Yes	Yes
Speed	Fast	Medium, fast with 3rd party codecs	Medium

** Currently only using DirectShow path, adding Media Foundation path soon.

Appendix B - Release History

- **Version 1.9.6 - 16 November 2018**
 - macOS
 - Fixed a Metal rendering issue where the watermark didn't display in the editor
 - Fixed issue with Hap and Metal rendering in the editor
 - Upgraded to latest Hap version (1.6.9)
 - iOS / tvOS
 - Fixed a crash in iOS 9 and lower that could happen when closing a player
 - Fixed packed transparent shaders to expand range correctly when using YpCbCr mode
 - Android
 - Fixed bug where using the OES shader would cause video to display pink/black, this was a regression introduced in 1.9.5
 - General
 - Shaders refactored
- **Version 1.9.5 - 7 November 2018**
 - Known Issues
 - A regression in our Android OES shader causes videos to appear black/pink when using OES mode - Fixed in 1.9.6
 - Custom shaders may not compile due to removal of Convert420YpCbCr8ToRGB - Fixed in 1.9.6
 - macOS / iOS / tvOS
 - Fixed issue where videos would appear too bright when using Linear colorspace and YpCbCr mode
 - Improved support for different video colour transforms(Rec601, Rec709)
 - Convert420YpCbCr8ToRGB shader function removed and replaced with ConvertYpCbCrToRGB
 - Android
 - Fixed a crash and memory leak bug regression introduced in 1.9.3, caused videos not to release resources when a player is destroyed
 - Windows
 - Fixed issue where using Low Latency option and Unity Audio would cause the application to lock up
- **Version 1.9.4 - 25 October 2018**
 - Known Issues
 - A regression in our Android implementation causes videos not to release resources when a player is destroyed - Fixed in 1.9.5
 - iOS / tvOS

- Fixed issue where subsequent video loads would sometimes fail to display frames
- **Version 1.9.3 - 22 October 2018**
 - Known Issues
 - A regression in our Android implementation causes videos not to release resources when a player is destroyed - Fixed in 1.9.5
 - Android
 - Fixed Oculus Go texture wrap mode being set to repeat instead of the default clamp. This was due to a new firmware update that allowed different texture wrap modes on OES textures
 - Added support for SeekFast() to ExoPlayer which seeks to the closest keyframe
 - Various robustness improvements related to resource freeing and plugin shutdown for Android apps that contain a Unity player instance
 - Built with new version of Android Studio (3.2)
 - macOS / iOS / tvOS
 - Added support for handling key requests for encrypted HLS streams (eg using AES). Supports direct key setting and key retrieval using authentication token via HTTP header. See DRM section for details.
 - Added new SetPlayWithoutBuffering(bool) method to allow playback to start immediately, bypassing the API buffering duration logic
 - WebGL
 - Added support for mip-map texture generation
 - General
 - Fixed regression in 1.9.2 causing some events not to fire, in particular the subtitle change event
 - Fixed issue where videos would open twice when calling OpenVideoFromFile() while AutoLoad was enabled and Start() hadn't run yet
 - Many improvements to PlaylistMediaPlayer, including StartMode and ProgressMode options, improved UI and per-item transitions
- **Version 1.9.2 - 2 October 2018**
 - Known Issues
 - A regression in the the general event handler can cause some events not to fire. Fixed in 1.9.3
 - Android
 - Fixed rare crash bug when using ExoPlayer due to commands being called in the render thread
 - Added file offset support when using ExoPlayer and loading from StreamingAssets folder

- iOS
 - Fixed issue where some HLS streams wouldn't play on older iOS devices
 - Fixed XCode 8/9 compatibility issue
- WebGL
 - Fixed support for WebGL 2.0
- General
 - Exposed options for automatically pausing / playing the media when application pauses
 - Exposed a mask to control which events the MediaPlayer should trigger. This is a minor optimisation to allow event logic to be skipped.
 - Fixed a minor issue with OnApplicationPaused and m_WasPlayingOnPause
 - Fixed a logic bug where a non-auto-play video loaded from a prefab wouldn't play after calling Play()
 - Fixed a minor issue with PlaylistMediaPlayer where stereo/alpha/loop/path state wasn't set correctly
- **Version 1.9.1 - 7 September 2018**
 - macOS and iOS
 - Fixed bug where video would always auto-play (only iOS < 10.0 and macOS < 10.12)
 - Fixed bug where texture properties (wrap, filter etc) weren't being set
 - WebGL
 - Fixed regression introduced in 1.9.0 which prevents videos from loading
 - Fixed support for 3rd party decoder libraries
 - Added support for "blob:" URL scheme
 - General
 - Resampler now honours texture properties set in MediaPlayer
 - Added position bar to PlaylistMediaPlayer editor
 - Windows Desktop
 - Fixed focus, volume and mute on videos using FB 360 Audio
 - Fixed some issues with switching between instances of videos using system audio and FB 360 Audio
 - Fixed a bug where audio sample rate and channel count were swapped around
- **Version 1.9.0 - 23 August 2018**
 - Known Issues
 - A regression in the WebGL player causes videos to not load, fixed in version 1.9.1
 - Android
 - Upgraded Facebook Audio 360 to version 1.6.0 from 1.5.0
 - Upgraded ExoPlayer to 2.8.4 from 2.8.2
 - ExoPlayer is now the default video API instead of MediaPlayer

- Changed Android API level requirement to 15 from 16 when using MediaPlayer API (ExoPlayer still requires 16)
 - Windows Desktop
 - Upgraded Facebook Audio 360 to version 1.6.0 from 1.5.0
 - WebGL
 - Added support for 3rd party decoder libraries such as dash.js and hls.js, see documentation for details
 - Added warning for unsupported WebGL 2.0
 - General
 - Added new (beta) PlaylistMediaPlayer component which allows seamless playlist progression and has a number of optional transitions, and a new demo scene using it
 - Added a new demo scene and video showing stereo 360 playback with spatial audio (on Windows and Android only)
 - Minor
 - Resampler now has some support for videos with unknown frame rate
 - Sphere demo no longer has camera affected by VR positional head tracking
 - Added demo scriptlet to show how to toggle stereo mode via script
- **Version 1.8.9 - 9 July 2018**
 - Android
 - Upgraded ExoPlayer to version 2.8.2 from 2.8.1
 - Fixed audio glitches on Oculus Go when using Facebook Audio 360 by increasing the default spatial buffer size
 - Reduced garbage generation by caching frequently used methods
 - Windows UWP / Hololens
 - Fixed an issue where non-debug builds would crash on some versions of Unity
 - WebGL
 - Added notes to AVProVideo.jslib on how to integrate dash.js
 - General
 - Reduced some garbage generation in various components
 - Improved shader support for multi-view stereo rendering
- **Version 1.8.8 - 26 June 2018**
 - Android
 - Upgraded ExoPlayer to version 2.8.1 from 2.6.0
 - Upgraded Facebook Audio 360 to version 1.5.0 from 1.4.0
 - Fixed audio track 1 not being set initially on ExoPlayer
 - Removed unneeded debugging and logging code on ExoPlayer
 - Windows Desktop
 - Upgraded Facebook Audio 360 to version 1.5.0 from 1.4.0
 - Fixed bug where videos using FB Audio 360 wouldn't stop at

- the end of the video
 - Fixed a bug where using D3D9 and DirectShow and resizing the window or switching fullscreen mode would cause a crash
 - macOS / iOS / tvOS
 - Fixed an issue in Unity 2018.1 and above that caused the projects not to compile
 - WebGL
 - Fixed issue where Buffering and Stall events weren't triggered correctly
 - General
 - Fixed garbage generation in DisplayUGUI component
 - Added support for Stall event on platforms that don't natively support it
 - Added documentation notes on seeking and playback rate
- **Version 1.8.7 - 16 May 2018**
 - macOS
 - Fixed a bug in the HapQ colour conversion
 - WebGL
 - Fixed compile issue in Unity 2017.4.1 by removing unused method and variable
 - Windows
 - Fixed a bug where FinishedPlaying event wouldn't get retriggered after the first time when playing a WAV or MP3 audio file
 - Now when emulating mobile builds in the editor, texture size limitations are ignored to allow videos to play locally
 - General
 - Fixed a bug with the 180 video shader where left-right stereo packed videos appear behind the viewer
 - Fixed the SSL certificate validation code in HLSSStream so it doesn't ignore bad certificates
- **Version 1.8.6 - 13 May 2018**
 - macOS, iOS, tvOS
 - Fixed issue where playback wouldn't resume after setting playback rate to zero
 - Fixed crash issue when playing back HLS streams on iOS/tvOS versions older than 10.0
 - Fixed issue playing some unescaped URLs
 - Android
 - Added option to force a streaming format using Exoplayer regardless of the file extension
 - Added option to prefer software decoders using ExoPlayer
 - Fixed bug where video wasn't pausing correctly when seeking and the app is suspended
 - Windows
 - Fixed rare runtime error when audio is disabled in Unity

- General
 - Fixed stretching issue in 180 degree video display and added a new mapping layout field in the Visual section for specifying that the video is using equirectangular 180 degree layout
 - Fixed null reference exception in ApplyToMaterial script when no material is assigned
 - Added buffered progress rendering to the 03_Demo_VideoControls sample scene timeline
 - Moved the MediaPlayer debug display option into a separate component called DebugOverlay
 - Added new option to UpdateStereoMaterial component so allow stereo rendering to force just the left or right eye
 - PlayMaker actions now have a logo in the header
 - Shaders updated to use a common function for vertex transform
- **Version 1.8.5 - 5 April 2018**
 - macOS, iOS, tvOS
 - Fixed issue since iOS 11 where live HLS streams refused to go higher than the device native resolution
 - Fixed a potential crash bug on old iOS versions (before 10.0) when querying audio or video bitrate
 - General
 - Fixed minor bug where newly loaded subtitles wouldn't immediately update
- **Version 1.8.4 - 23 March 2018**
 - macOS, iOS, tvOS
 - Fixed crash bug introduced in 1.8.0 related to seekableTimeRanges in HLS streams
 - Android
 - Added OES shader support for the GUI component
- **Version 1.8.2 - 19 March 2018**
 - Known Issues
 - There is a crash bug on macOS, iOS and tvOS when closing down a HLS stream. This is fixed in 1.8.4
 - Windows
 - Improved accuracy of the Stalled state/event which triggers when the player is unable to decode the next frame, usually due to network connection issues
 - Improved accuracy of IsBuffering state/event which occurs when data is being downloaded over the network
 - Fixed a bug with HLS live streams where pausing the stream or a dropped connection would stop streaming indefinitely. The stream now resumes correctly, or throws an error if the stream cannot be resumed
- **Version 1.8.0 - 14 March 2018**

- Known Issues
 - There is a crash bug on macOS, iOS and tvOS when closing down a HLS stream. This is fixed in 1.8.4
- Android
 - Performance improvement by minimising texture copy operations
 - Upgraded ExoPlayer from 2.5.4 to 2.6.0
 - Upgraded Facebook Audio 360 from 1.3.0 to 1.4.0
 - New method `GetCurrentDateTimeSecondsSince1970()` for getting the absolute date-time of a video stream
 - New method `GetSeekableTimeRanges()` returns an array of seekable time ranges
 - Fixed bug where only up to 255 video player instances could be created
 - Fixed issue where camera set to skybox clear mode would make OES videos not appear, by changing shader to write to the depth buffer, just like the other VR shaders do
 - OES mode now uses less memory and starts faster
 - Fixed bug when using Facebook Audio 360 where sometimes the audio or video wouldn't play
- macOS, iOS and tvOS
 - New method `SeekWithTolerance()` offers fine seek control
 - New method `GetCurrentDateTimeSecondsSince1970()` for getting the absolute date-time of a video stream
 - New method `GetSeekableTimeRanges()` returns an array of seekable time ranges
 - Fixed YCbCr support in shader used by 180 video demo
- Windows
 - Improved adaptive stream resolution switch seamlessness by eliminating the black frame flash
 - Added DirectShow chunk-based file loading method to allow for loading large files into memory without making large managed buffer allocations. See `LoadFromBufferInChunks.cs`
 - Fixed a bug when loading from buffer using DirectShow where memory was deleted twice
 - Fixed a D3D9 rendering bug that caused only the skybox to render on some newer versions of Unity due to renderstate restore issues
 - Upgraded Facebook Audio 360 from 1.3.0 to 1.4.0
 - Various improvements when using the `AudioOutput` component, including better AV sync and fixed glitching. Also added manual sample rate setting for streaming videos.
 - Improved UWP file loading demo script `NativeMediaOpen.cs`
- WebGL
 - Changed the way textures are updated to hopefully be more compatible
- General
 - `DisplayUGUI` component now exposes `Raycast Target` field so

- videos can allow touch/mouse input to pass through
 - Added new events for video resolution change, stream stalling, buffering and seeking
 - Added SSL/HTTPS support to StreamParser
 - Various code refactoring and cleanup
- **Version 1.7.5 - 22 January 2018**
 - macOS
 - Fixed build issue with Unity 2017.3 related to the post build script
 - Fixed build issue with Unity 2017.3 related to universal/64-bit plugin metadata
 - macOS, iOS and tvOS
 - Fixed a build issue with Unity 5.6.x related to a missing zlib dependency
 - Android
 - Fixed stereo support in OES shader
 - Fixed support for IsBuffering state in ExoPlayer
 - Windows desktop
 - Fixed a rare bug when using DirectShow and Unity 2017.3 that would cause the video texture to display as a single channel or black
 - Fixed a performance bug in the DirectShow player that meant a paused video would continue to upload frames to the GPU
- **Version 1.7.4 - 28 December 2017**
 - WebGL
 - Added support for URL's that start with "chrome-extension://"
 - Fixed recent regression causing video to not render when not rendering anything else
 - iOS
 - Plugin rebuilt with XCode 8.3.3 to work around linker missing framework issue when building Unity apps using XCode 8 and previous versions of the plugin that were compiled with XCode 9
 - Fix to the ApplyToMaterial component when using YCbCr mode so the default texture gets displayed correctly when the MediaPlayer is closed
 - General
 - Added support for Facebook's "360-capture-sdk" cubemap layout to the CubemapCube component
- **Version 1.7.3 - 9 December 2017**
 - Windows
 - Fixed a bug when using D3D9 that would cause the DirectShow video to either render black or cropped. This was a regression since version 1.7.0
 - Fixed DirectShow loading from buffer support for 32-bit builds
 - WebGL

- Added support for error events
 - Fixed issue where resampler could be enabled when it is not supported for WebGL
- General
 - Optimised SRT subtitle file parse to be much faster
- **Version 1.7.2 - 30 November 2017**
 - Known Issues
 - There is a bug that causes video to appear black or cropped, only when using Windows desktop with D3D9. This is fixed in 1.7.3
 - Android
 - Fixed two major GLES bugs which sometimes prevented the video appearing. This mostly affected Galaxy S8 devices, Lenovo tablets and anyone using the Vuforia plugin
 - Added support for accurate seeking when using MediaPlayer API - requires Android 8.0 Oreo
 - Added support for HTTP/HTTPS redirects when using ExoPlayer API
 - macOS, iOS and tvOS
 - Added support for switching between multiple audio and video tracks
 - Added support for querying audio and video track bitrate
 - Windows Desktop
 - Added the ability to set a list of preferred decoders for DirectShow. This makes it easier to predict which decoder installed on the user's system will be used. For example they could have many codec packs installed, but you prefer to use the Microsoft decoders for stability
 - When using the Use Unity Audio option, the video will no longer fail to load if the audio is not able to pass through to Unity
 - Fixed a bug where Facebook Audio 360 channel mode wouldn't be passed through to the plugin
 - Fixed a shader bug causing Main10 videos in DirectShow to display too dark
 - General
 - Added new HLSParser class to help parse HLS m3u8 manifests. This allows for the discovery of all of the streams available, their resolutions and bitrates
 - Improved Facebook Audio channel mode enumeration UI
- **Version 1.7.0 - 15 November 2017**
 - Known Issues
 - There is a bug that causes video to appear black or cropped, only when using Windows desktop with D3D9. This is fixed in 1.7.3
 - Facebook Audio 360

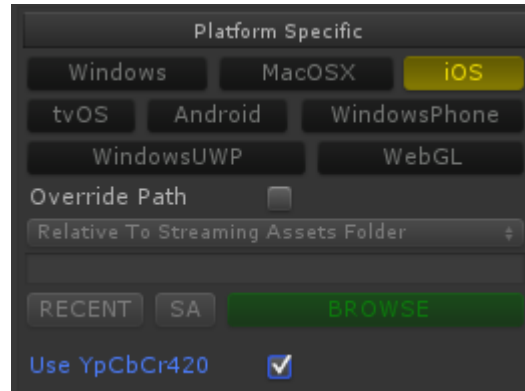
- Added Facebook Audio 360 support for spatial audio in VR. Currently we have support for Windows desktop (Rift, Vive etc) and Android (Cardboard, GearVR, Daydream etc). Uses MKV videos with Opus audio tracks encoded using Facebook Audio 360
- Windows Desktop
 - Added Facebook Audio 360 support
 - Added “Alpha Channel Hint” option to DirectShow for cases where alpha channel is needed - currently required by Lagarith codec
 - Added native NV12 support for legacy D3D9 with DirectShow - this a performance optimisation, but also fixes some issues when using subtitle rendering DirectShow filters (such as DirectVobSub) which would cause the image to become flipped
 - Added Hap Q support for legacy D3D9 with DirectShow
 - Fixed a memory leak when an invalid Hap video (non multiple of 4 resolution) was loaded
 - Fixed an issue where AudioOutput wouldn’t redirect audio to another device (eg Rift Audio) for streaming media
 - Fixed “Low Latency” option so it is actually used
- Windows UWP
 - Fixed “Low Latency” option so it is actually used
- Android
 - Added Facebook Audio 360 support (requires ExoPlayer API)
 - Added ExoPlayer video API option which can offer improved format support, including MPEG-DASH and in the future will include more control over streaming video
- iOS / tvOS
 - The YCbCr optimisation is now enabled by default
- WebGL
 - Fixed issue with Safari on macOS calling Play() with default auto-play permission disabled as outlined here: <https://webkit.org/blog/7734/auto-play-policy-changes-for-macos/>
- General
 - Added new frame resampler option which can be used to get smoother playback by buffering frames and presenting them at the right interval. This feature does use more memory and is still in beta
 - Fixed a bug where the FinishedPlaying event didn’t fire when a second stream was played on the same MediaPlayer
 - Fixed a bug where Instantiating ApplyToMaterial would cause a null exception
 - Fixed compile error in Unity 2017.2 related to mobile multi-threading
 - Fixed warnings in Unity 2017.2 related to API changes to playModeStateChanged
 - Changed shader line endings to Unix to prevent mixed line

- ending warnings
 - Inspector UI improvements
 - Documentation updates
- **Version 1.6.15 - 5 October 2017**
 - Windows
 - Fixed an issue mainly affecting Windows mixed reality and VR headsets using “hybrid-gpu” mode where more than one GPU is available to the system
 - Fixed the WSA 8.1 x86 DLL that didn’t get recompiled since 1.6.12
- **Version 1.6.14 - 23 August 2017**
 - macOS / iOS / tvOS
 - Fixed issue where audio-only media would not update current time
 - Improved error reporting
 - iOS
 - Fixed texture error when using Unity 4.x
 - Android
 - Fixed file offset not working for videos in StreamingAssets folder. Until now file offset only worked for files at other locations in the file system
 - Windows
 - Fixed regression introduced in 1.6.12 that would cause DirectShow videos to not play when using Direct3D9 or OpenGL
 - AudioOutput component now handles different sample rates and channel counts set in Unity’s audio settings and automatically detects number of audio channels in source media
- **Version 1.6.12 - 6 July 2017**
 - Known Issues
 - On Windows when using DirectShow and Direct3D9 or OpenGL, videos do not display and VRAM runs out. This is a regression introduced in this version and is fixed in 1.6.14
 - Android
 - Fixed a rare crash bug that could happen during seeking
 - Windows Desktop / UWP
 - Added new low latency option for Media Foundation which provides a hint to the decoder to do less buffering
 - Windows Desktop
 - Added support for 10-bit HDR video decoding (Main10) when using DirectShow any suitable decoder such as LAV Filters. The decoding still resolves to an 8-bit texture but we plan to add 10-bit or floating point texture resolve soon
 - Fixed a crash bug when using DirectShow and LoadFromBuffer to load a video from memory

- General
 - ExtractFrame() method now faster and more accurate
 - Time Scale support (where a non-realtime video capture solution changes Time.timeScale or time.captureFrameRate) has been improved, making it faster and more accurate
 - Added new 180 degree sample video
 - Fixed a bug in AudioOutputManager when channel count <= 0
- **Version 1.6.10 - 14 June 2017**
 - iOS
 - Improved support for iOS 8.0 by fixing an issue with CoreVideo
 - Android
 - Fixed issue where loading over 255 videos would cause videos to no longer load correctly
 - Windows Desktop / UWP
 - The AudioOutput component now supports routing audio to a specific channel, or to multiple channels. It also now supports multiple instances so you can more easily have audio coming from different world positions.
 - Fixed a memory leak when using AudioOutput component
 - Windows Desktop
 - Added new function to load media from memory for DirectShow API. This is demonstrated in the scriptlet LoadFromBuffer.cs
 - General
 - Started adding a new 180 degree video playback demo, it just lacks a media file which will come in the next release.
 - Videos with auto-start enabled no longer fire the ReadyToPlay event.
 - Added new method ForceUpdate() to ApplyToMesh component which refreshes the material when changing media properties such as stereo packing.
- **Version 1.6.8 - 31 May 2017**
 - iOS / tvOS
 - No longer requires a separate plugin file for Unity 5.3 and below. New bootstrap C code handles the change in Unity's plugin API.
 - Improved Metal compatibility with older versions of Unity
 - General
 - The AudioOutput component has some new experimental changes, including the ability to have multiple AudioOutput instances and to remap which channels the audio outputs to
- **Version 1.6.6 - 25 May 2017**
 - General
 - PlayMaker (the popular visual scripting system for Unity) is now supported by AVPro Video. We have added over 64 new PlayMaker actions for seamlessly integration into your

- PlayMaker workflow
 - Added audio stereo balance support
 - Added new stereo packing mode that uses a pair of UV sets for custom left and right mapping.
 - Added new Support & Help window to make reporting issues easier and to include helpful diagnostic information
 - Added documentation about 3rd-party library usage
 - Added documentation about iOS video decoders
- Windows Desktop
 - Added multi-threaded decoding for chunked Hap videos
- Windows Store / UWP / Hololens
 - Added new function to load media from native file locations using `IRandomAccessStreamWithContentType`. This means you can now play media from the camera roll. See the example script in `Demos/Scripts/Scriptlets/NativeMediaOpen.cs` for details of usage.
- Android
 - Fixed lost GLES context issue that can happens at least when switching Google Cardboard on/off
 - Fixed one of the OES shaders that was failing to compile on Android due to undefined `TRANSFORM_TEX` macro
 - Refactored some of the low-level code
- iOS
 - Added support for headphone connection changes. Unplugging / connecting headphones will now correctly set state of the video so that `IsPaused()` and `IsPlaying()` return the correct value
 - Fixed a rare bug in the VCR demo script which caused the `FinishedPlaying` event not to fire due to triggering a `Seek()` at the end of an HLS stream
- iOS / tvOS / macOS
 - Fixed frame flash issue due to `FirstFrameReady` event firing too early due to frame count increment bug
- **Version 1.6.4 - 5 May 2017**
 - Windows Desktop
 - Fixed an intermittent bug introduced in version 1.6.2 which caused videos to sometimes not appear or appear black
- **Version 1.6.3 - 3 May 2017**
 - Windows Desktop
 - Fixed mistake from 1.6.2 which included a Visual Studio 2015 dependency (the `OpenMP vcomp140.dll`)
 - Chunked Hap decoding is now no longer multi-threaded. We will add this optimisation back in 1.6.6
 - Added some notes to documentation about Windows N / KN editions

- Known Issues
 - There is an intermittent bug in Windows desktop which causes videos to not appear or to appear black sometimes - fixed in 1.6.4
- **Version 1.6.2 - 25 April 2017**
 - iOS / tvOS
 - Added support for Y'CbCr Biplanar textures which results in less memory usage. This feature means older devices with only 1GB of RAM (iPhone 5+, iPhone6+) will no longer struggle with memory when playing back 4K video content.



- Tweaks which hopefully fix a rare flickering issue for Metal when using multi-threaded rendering
 - Fixed shader compile issue for legacy Unity 4.x
 - macOS
 - Fixed bug for high resolution Hap decoding due to apparent bug in Apple OpenGL extension
 - Fixed an issue with transparent ProRes video
 - Android
 - Fixed bug that would cause video to not display when using the Mask uGUI component
 - Fixed OES GLSL shader support for Unity 5.5.2
 - Fixed shader compile issue for legacy Unity 4.x
 - Reported bug in Unity 5.6.0f3 support for GLSL (OES) shaders
 - Windows
 - Performance improvement for Hap codec when using “chunks” encoding option. Now decoding happens over multiple threads.
 - Added support for the “-force-d3d11-no-singlethreaded” command-line parameter which doesn’t require the use of a new D3D context with a shared texture in the MF-Hardware path
 - Media Foundation code refactored
 - General
 - Fixed bugs in NGUI script, previously it could crash when changing videos

- Fixed very specific bug related changing texture quality settings while the MediaPlayer is disabled which would cause texture to become black. Removed the global setting that disabled the above texture quality fix as it no longer has a performance benefit
 - Improved UI of ApplyToMesh component with custom editor
 - Some shaders now default to black textures instead of white
 - Added basic playback controls to the debug UI
 - Added documentation about AMD hardware decoding (UVD) capabilities
 - Added support for Unity 2017 beta
 - Known Issues
 - Windows desktop - this release includes a Visual Studio 2015 OpenMP dependency by mistake (vcomp140.dll) which means that the Visual Studio 2015 runtime must be installed. Fixed in 1.6.3
 - There is an intermittent bug in Windows desktop which causes videos to not appear or to appear black sometimes. Fixed in 1.6.4
- **Version 1.6.0 - 29 March 2017**
 - iOS / tvOS
 - Added support for linear color-space (available in Unity 5.5 and above)
 - Performance improvements, especially when reusing MediaPlayer component to load videos
 - iOS simulator support added
 - macOS
 - Added support for Hap Q Alpha format (HapM)
 - Performance improvements, especially when reusing MediaPlayer component to load videos
 - Android
 - Fixed OES rendering path support in Unity 5.6
 - Improved linear colour-space support (available in Unity 5.5 and above)
 - Performance improvement due to alternative way to get around checking GetNativeTexturePtr() and instead checking for when texture quality level changes
 - Removed unused AndroidManifest.xml file
 - Windows
 - Performance improvement due to alternative way to get around checking GetNativeTexturePtr() and instead checking for when texture quality level changes
 - General
 - Fixed DisplayIMGUI component depth value not working
 - Improved IMGUI linear color-space conversion function
- **Version 1.5.28 - 24 March 2017**

- Windows
 - Added support for HapQ+Alpha format
 - Fixed Unstalled event not firing
- macOS / iOS / tvOS
 - Added support to ExtractFrames demo to handle videos containing rotation
 - Minor C# performance improvements
- WebGL
 - Fixed support for Safari browser
 - Added documentation about supported browsers
- General
 - Added some DRM notes to the documentation
 - Fixed PlayMaker example script
- **Version 1.5.26 - 14 March 2017**
 - Android
 - Added support for passing custom HTTP header fields
 - Fixed minor bug when calling SetPlaybackRate too soon
 - Android API 15 (4.0.4 Ice Cream Sandwich) is now supported, previously API 16 (4.1 Jelly Bean) was required
 - Added plugin files for the arm64-v8a platform (currently disabled in the inspector, but simply enable it once Unity has added support for this architecture)
 - macOS / iOS / tvOS
 - Added support for passing custom HTTP header fields
 - Added support for videos containing orientation data. The orientation transform is now retrievable and the uGUI display component correctly displays the video
 - WebGL
 - Fixed bug in Internet Explorer and Firefox where video would not display
 - Added support for displaying multiple ranges of buffered time
 - Windows / WSA / Hololens
 - Fixed FinishedPlaying rarely not firing on Media Foundation
 - General
 - DisplayUGUI component no longer generates any garbage when vertices are dirtied. Also some minor optimisations
 - ApplyToMesh component no longer generates any per-frame garbage
 - ApplyToMesh component has improved interface
 - Improved time display in the editor to be millisecond accurate, and also fixed time rounding error bug
 - Changed EnableSubtitles() to return true while it is loading in a coroutine
 - Added new example script VideoTrigger that shows how to trigger videos when entering/exiting collider volumes, including audio fading
 - Added more streaming video URLs to documentation

- **Version 1.5.25 - 20 February 2017**
 - Windows Desktop
 - Patch fix for regression in 1.5.24 which caused DirectShow videos to display in green
- **Version 1.5.24 - 19 February 2017**
 - General
 - Shaders improved to also work on older hardware that only support shader model 2.0
 - Windows Phone / WSA / UWP / Hololens
 - Added support for audio to be played through Unity's audio system
 - Fixed a serious bug which could cause video to not appear and native plugin functions to return incorrect values
 - Fixed the hardware decoding option not being passed through to the plugin correctly
 - Fixed support for older GPUs that only supported D3D11 feature set 9.x
 - Trial version watermarking optimised for speed and memory
 - Windows Desktop
 - Fixed support for older GPUs that only supported D3D11 feature set 9.x
 - Trial version watermarking optimised for speed and memory
 - Known Issues
 - Regression in this version causes Windows DirectShow decoded videos to display green. Fixed in v1.5.25
- **Version 1.5.22 - 14 February 2017**
 - General
 - Improved performance of CubemapCube component. Due to a typo it would previously regenerate the cube mesh each frame.
 - Improved the fix for Unity 5.4.2 and above where changing texture quality during runtime would cause the video texture to turn black. The expensive fix now doesn't apply to Unity 5.4.1 and 5.4.0, and can be disabled in the global options
 - Fixed bug in subtitles that would cause them to go blank for a frame
 - Workflow
 - Android OES path now displays hint about using correct shaders
 - Error message display is more detailed
 - Improved user feedback when selecting stereo packing to warn about the need for the UpdateStereoMaterial component
 - Improved UI for UpdateStereoMaterial component to give more feedback about its setup
 - Android
 - Better reports error when a video fails to decode due to

- insufficient resources
 - Added option to not show the “poster” frame, leading to faster start and less resource usage for loaded videos. A video that is loaded but not played and not displaying the poster frame will not engage the decoder hardware and use up resources
 - Saved some memory in OES mode by no longer allocating unnecessary render texture
 - Improved playback rate timer
- WebGL
 - Fixed issue where no video displays when using WebGL 2.0 (default in Unity 5.5.0 and above)
 - Cached texture pointer for improved performance
 - Fixed subtitle loading by changing to use a coroutine
- Windows
 - Added new events for when a stream has stalled and resumed - useful for detecting connection loss when live streaming
 - Added new option to generate texture mipmap levels automatically - this reduces aliasing when the texture is scaled down
 - Updated Snappy library (used in Hap codec) to latest 1.1.4 which has 20% decompression speedup
 - Fixed bug in DirectShow where calls to SetMuted() or setting very low audio volume would be ignored
- UWP / Windows Phone / Hololens
 - Added new option to generate texture mipmap levels automatically - this reduces aliasing when the texture is scaled down
- Breaking Changes
 - For Android if you previously loaded videos in a paused state to see the initial “poster” frame now you’ll need to tick the new “Show Poster Frame” option in the Platform Specific settings. In previous versions this was enabled by default, but now it is disabled by default as it has performance implications.
- **Version 1.5.20 - 25 January 2017**
 - General
 - Added more notes to the Hap codec documentation
 - Added more notes to the Android OES documentation
 - Android
 - Fixed fast OES rendering path in Unity 5.4.x and 5.5.x
 - Fixed various stereo rendering issues
 - Fixed OES GLSL shaders failing to compile due to inline keyword
 - Fixed OES path displaying debug GUI panel
 - Fixed OES shader compiling on Google Daydream platform
 - Fixed Unity 5.6beta GearVR stereo rendering issue
 - Disabled minor Daydream stereo eye shader optimisation as it

- was causing too many problems with older versions of Unity
 - Windows
 - Fixed bug where changing playback rate when playback has finished would result in an error
 - Fixed the DirectShow audio volume level so it matches that of Media Foundation
- **Version 1.5.18 - 18 January 2017**
 - General
 - Added support to UpdateStereoMaterial for DisplayUI component so that uGUI can render stereo videos correctly
 - WSA / UWP / Hololens
 - Fixed a script compile error introduced in 1.5.16
- **Version 1.5.16 - 16 January 2017**
 - General
 - Optimised stereo left-right shader for Google VR support
 - Improved shaders to use UnityObjectToClipPos() instead of UNITY_MATRIX_MVP to give better support for Unity 5.6 and above
 - Fixed bug in stereo left-right shader introduced in 1.5.14
 - Fixed various bugs in subtitle support
 - Android
 - Fixed subtitles not loading
 - Known Issues
 - Regression from 1.5.14
 - WSA and UWP platforms will fail to compile due to new Thread.Sleep() which isn't defined on these platforms.
- **Version 1.5.14 - 9 January 2017**
 - General
 - Added subtitle support for external SRT files
 - Added a new demo showing the new subtitle support
 - Improved 03_Demo_VideoControls demo scene to use two MediaPlayers for seamless playlisting
 - Fixed issue where initial playback fields (volume, mute, playback rate, looping) could be reset to incorrect values in certain cases such as such AutoOpen option was disabled
 - Shader improvements such as inlining for performance, sRGB to Linear shader corrections and optimisations
 - iOS
 - Added documentation note about using AAC instead of MP3 for the audio tracks
 - WSA / UWP / Hololens
 - Fixed bug where video would often not appear, due to audio track being loaded first and reporting metadata loaded. This appears to be a bug/change in the new Anniversary UWP Media Foundation version.
 - Plugin DLL file sizes are smaller

- Windows Desktop
 - Plugin DLL file sizes are smaller
- Known Issues
 - Regression from 1.5.12
 - Bug in stereo shader causing only left eye to render
 - Subtitles
 - New subtitle feature doesn't load files from StreamingAssets on Android and WebGL
 - Bug in script don't allow subtitles to be loaded via code
- **Version 1.5.12 - 12 December 2016**
 - WSA / UWP / Hololens
 - Fixed crash issue when using Unity 5.5
- **Version 1.5.10 - 9 December 2016**
 - macOS
 - Fixed issue where OpenVideoFromFile() called multiple times quickly would cause a crash
 - Removed PLIST modification from the PostProcess build script
 - iOS
 - Fixed issue where OpenVideoFromFile() called multiple times quickly would cause a crash
 - Fixed issue with Unity 5.5.x which caused XCode project not to run due to missing Metal symbol (only affects watermarked trial version)
 - tvOS
 - Fixed issue where OpenVideoFromFile() called multiple times quickly would cause a crash
 - Fixed issue with Unity 5.5.x which caused XCode project not to run due to missing Metal symbol (only affects watermarked trial version)
 - Android
 - Fixed issue with Unity 5.4.2 and above where changing the TextureQuality level in the QualitySettings would cause the texture to go black
 - Windows
 - Fixed issue with Unity 5.4.2 and above where changing the TextureQuality level in the QualitySettings would cause the texture to go black
 - General
 - Added support to uGUI shaders for RectMask2D
 - ApplyToMesh component now works with other renderer components (eg Skinned Mesh)
 - Updated documentation and FAQs
- **Version 1.5.8 - 23 November 2016**
 - macOS
 - Fixed issue with OpenGLCore where texture wouldn't update due to GL state not being restored correctly when using a

- uGUI mask
 - Fixed issue where RelativeToProjectFolder was pointing to inside the .app package instead of at the same level
- Android
 - Streaming video no longer blocks while loading (but video frame-rate may now not be available)
 - Removed duplicate function call, minor performance win
 - Fixed number of audio tracks reported for streams
 - Fixed potential case issue with URL detection
- Windows
 - Platform specific settings exposed better in the editor
- General
 - Fixed some shader build errors for older versions of Unity
 - Added some in-editor warnings for using unsupported file extensions on various platforms
 - Fixed broken scripting reference link in 'About'
- **Version 1.5.7 - 16 November 2016**
 - Android
 - Minor optimisation for non-OES rendering path by eliminating blending during blit
 - Added frame timestamp support via TextureProducer.GetTextureTimeStamp()
 - macOS, iOS and tvOS
 - Added support for OS X 10.8
 - Added frame timestamp support via TextureProducer.GetTextureTimeStamp()
 - Fixed issue when Seek and Play were called before another command had completed
 - Fixed issue of events not firing
 - Added support for custom URL schemes
 - Improved support for device simulator
 - Various small bug fixes
- **Version 1.5.6 - 8 November 2016**
 - General
 - Added "Scale and Crop" scaling mode to uGUI component (replaces old "keep aspect ratio" option)
 - Added helper function for seeking to a specific frame
 - Improved MediaPlayer event handling code
 - Fixed null exception when unloading scene from the event callback
 - Windows
 - Fixed major issue using hardware decoding which caused videos to crash or not load
 - Improved DirectShow colour reproduction by using more accurate linear colour-space and YUV conversion functions
 - Added ability to get the presentation timestamp of the current

video frame - useful for more accurate frame syncing:

TextureProducer.GetTextureTimeStamp()

- Fixed issue with HLS streaming crashing when changing stream quality and resizing texture
- Fixed AudioOutput issue where playing back multi-channel videos would cause the video not to load
- Fixed AudioOutput issue where some videos would play back at the wrong pitch

- **Version 1.5.5 - 1 November 2016**

- Windows
 - Fixed issue on old Windows versions without D3D11 which caused the plugin to not load
- WebGL
 - Fixed width and height being zero when MetaDataReady event fires

- **Version 1.5.4b - 31 October 2016**

- Fixed broken iOS, tvOS and macOS release from v1.5.4
- Fixed “null id” error in in multi-video demo in WebGL builds

- **Version 1.5.4 - 28 October 2016**

- General
 - 02_Demo_imGui demo scene updated to show network streaming progress
 - Improved how destroyed MediaPlayer components are shut down
 - Fixed alpha packing in background transparent shader
 - Fixed some bugs in three of the sample scene scripts that would cause a crash due to null values or invalid textures left behind when destroying MediaPlayer
 - Added documentation about hardware GPU decoding
- Android
 - Fixed bug where IsPlaying would return false during playback
 - Fixed a shader compiler error for newer Android phones with Snapdragon chipset when using the OES shaders
 - Optimised code to generate less garbage
 - Some internal JNI caching for speed
 - Added new unlit OES shader
- macOS
 - Added support for Linear colour space
 - Improved feedback when progressive and streamed movies are buffering
 - Added support for macOS 10.12 streaming auto wait behaviour
- iOS and tvOS
 - Fixed a case where some HLS streams wouldn't play
 - Improved feedback when progressive and streamed movies are buffering
 - Added support for iOS/tvOS 10 streaming auto wait behaviour

- Windows
 - Added new AudioOutput component so that audio can be played directly through a Unity AudioSource node. This allows Unity audio effects to be used, spatial 3D movement with falloff and doppler, and most importantly allows sound to move with the head in VR!
 - Fixed a visual glitch when using the hardware decoder path, most noticeable at the end of videos
 - Streaming can now return multiple buffered ranges using method GetBufferedTimeRange()
 - Windows watermark improved for GPU decoding path
 - Potential fix for DirectShow seeking issue causing hanging on some systems
- VR
 - Support for 3D audio via the new AudioOutput component (Windows only, supports Oculus Rift and HTC Vive)
 - InsideSphere transparency shader now supports transparency packing
- **Version 1.5.2 - 11 October 2016**
 - General
 - uGUI and IMGUI components now automatically displays videos with stereo or alpha packing correctly without having to assign material manually
 - Fixed shader build errors in Unity 5.4.1
 - Fixed shader build errors in Unity 4.x for D3D9 and OpenGL
 - Added stereo support to more shaders including uGUI
 - Workflow
 - Improved component menu layout by grouping components
 - Logging improved so some log messages can be clicked on to highlight the logging MediaPlayer
 - Windows
 - Linear colour space now automatically rendered correctly when using GPU decoder
 - Fixed memory leak in GPU decoder introduced in v1.5.0
 - Fixed old memory leak in Notify system
 - Fixed HLS adaptive resolution changing when using GPU decoder and improved texture switch to remove 1 frame glitch
 - WebGL
 - Cubemap script fixed to not show texture seam
 - Texture filtering and wrapping modes applied correctly now
 - Added crossOrigin="anonymous" to video element
- **Version 1.5.1 - 30 September 2016**
 - Windows
 - Fixed crash bug when playing audio files in DirectShow path
 - Fixed visual flicker bug in Unity editor in DirectShow path

- **Version 1.5.0 - 29 September 2016**
 - General
 - Added new shader for uGUI to support stereo videos
 - Added global option to disable logging
 - Added audio track selection to IMGUI demo
 - Fixed editor bug where “\” character could be used in file path
 - Updated documentation
 - Android
 - Added display of initial “poster” frame for videos set to not auto-play
 - Fixed bug that prevented files with escape characters from loading
 - Fixed bug causing audio files to not play
 - Fixed issue where GetCurrentTimeMs() could report values greater than Duration
 - macOS
 - Fixed no error being returned for loading videos without correct plist permissions set
 - Windows
 - Hardware decoding enabled by default
 - Hardware (GPU) decoding no longer require command-line parameter
 - Better video API selection in editor
 - Added support for multiple audio tracks to DirectShow playback path via IAMStreamSelect.
 - Added Media Foundation multiple audio track code back in
 - Fixed some minor resources leaks
 - Windows Phone / UWP
 - Added option for hardware decoding (enabled by default)
 - WebGL
 - Added support for multiple audio tracks
 - Fixed frame rate and count not displaying
 - Fixed issue where multiple videos wouldn’t unload cleanly
 - Cleaned up plugin code, removing unneeded code
- **Version 1.4.8 - 12 September 2016**
 - General
 - Less garbage generation
 - Optimised ApplyToMesh component
 - Optimised rendering coroutine of MediaPlayer component
 - Added global option to disable debug GUI
 - Workflow
 - Improved file path display and editing
 - Added watermark description to trial version
 - VR
 - Cubemap script (for 3:2 cubemap VR)
 - Fixed vertical flip issue

- Improved performance
 - Added fog and transparency options to VR sphere shader
 - Android OES optimisation (see below)
 - Shaders support GLSL better
 - Android
 - New faster rendering path, less memory, faster, no overheating - see OES playback path notes above
 - Added ability to load file from within another file by specifying an offset
 - Which lets you hide video files from prying eyes
 - macOS
 - Fixed occasional memory leak when destroying player
 - Fixed editor warning about absolute path
 - iOS / tvOS
 - Fixed occasional memory leak when destroying player
 - Windows
 - HLS streams now dynamically adjust texture size
 - Resulting in support for higher quality streams
 - Fixes issue where videos would become letterboxed
 - WebGL
 - Fixed broken build issue when using the “use pre-built” build option
- **Version 1.4.4 - 20 August 2016**
 - General
 - Packed transparency support added
 - Use top-bottom or left-right packed layout to encode alpha channel
 - Set the packing type in the “Media Properties panel”
 - Supported by all display components automatically
 - See “Transparency Notes” section of this document for encoding tips
 - “Platform Specific” section now highlights platforms with modified settings
 - Minor optimisations to the ApplyToMaterial and ApplyToMesh components (used property ints instead of strings)
 - Minor optimisation to DisplayIMGUI (disables layout pass)
 - Fixed CubemapCube.cs to handle vertically flipped video textures
 - Changed many components to use UpdateLate() instead of Update() to fix some crash issues
 - Various minor improvements
 - macOS
 - Fixed compatibility issue with OS X 10.10 (Yosemite)
 - Windows
 - Huge performance improvements when using DirectShow playback path due to usage of NV12 format (D3D11 only)
 - Added support for Hap Q format (D3D11 only)

- Added performance warning message when using software decoder instead of GPU decoder for large videos
 - Fixed bug in DirectShow audio mute not restoring volume
 - WebGL
 - Fixed issue where ImGui text became flipped
 - Upgrade Notes
 - Some shader files have moved (and been renamed) from /Materials and /Demos/Materials to /Resources/Shaders, so make sure to delete duplicates that results from merging
- **Version 1.4.0 - 10 August 2016**
 - WebGL
 - WebGL platform support added
 - macOS
 - Now with Metal rendering support
 - The Hap codec is now supported on macOS
 - iOS / tvOS
 - Metal rendering path now supports multi-threaded rendering
 - Various fixes to rendering and memory resources
 - Android
 - Ability to adjust the playback rate (Android 6.0 and above only)
 - Windows
 - Fixed audio device override not working in builds
 - Fixed fast seeking function
 - General
 - Added support for video files containing multiple audio tracks
 - Video frame rate is now available via `Info.GetVideoFrameRate()`
 - Fixed some issues with events firing at the wrong time
 - Streaming videos can now query `IsBuffering()` and `GetBufferingProgress()`
 - Improved errors reporting
 - Renamed `Info.GetVideoPlaybackRate()` to `GetVideoDisplayRate()` to avoid confusion
 - New “scriptlets” have been added to the /Demos/Scripts folder which give mini examples of how to do simple scripting
 - VR
 - Fixed bug in stereo section of VR sphere shader which caused eyes to flip on some platforms
 - Fixed a bug in Windows where the audio override wasn’t being passed through for VR headphone device name
 - Workflow
 - Added new “SA” button for shortcut to StreamingAssets folder
 - Improved editor inspector performance
 - Upgrade notes
 - Demos scenes have been renamed so you should delete the old .unity files in the /Demos folder otherwise you will have duplicate files.

- The sample video files in StreamingAssets have been moved into a subfolder within StreamingAssets/AVProVideoDemos/ so make sure to delete the old ones.
- **Version 1.3.9 - 15 July 2016**
 - Android
 - Fixed bug for Unity versions < 5.2.0 that caused videos not to display
 - Fixed bug for Android versions < 6 that caused video pausing and other operations to break playback
 - Removed zip classes from plugin package to fix conflicts with other plugins using the same zip classes
 - General
 - Better error handling via new GetLastError() function and a new Error event type
 - NGUI support added via new component
 - TimeScale support feature now disabled by default and exposed in new Global Settings panel
 - ApplyToMesh/Material script improved with new scale and offset parameters
 - Added platform overrides for Windows Phone and Windows UWP
 - Improved documentation
 - Workflow
 - Added new Android warning for loading absolute path without external permission set in PlayerSettings
 - VR
 - Fixed VR audio output device not working
 - New high quality option for sphere shader to improve quality at the poles and general optimisations
 - Fixed issue with left/right eyes becoming swapped sometimes
 - Minor fixes to cube map script
- **Version 1.3.8 - 30 June 2016**
 - Bug fixes
 - Fixed stereo VR script broken in v1.3.6
 - Fixed issues with UWP and Hololens support
 - Fixed Windows DirectShow issue preventing Hap videos playing when another source filter is installed
 - Fixed Windows DirectShow bug in watermark for Hap videos
 - Workflow
 - Improved recent file list to be sorted by when the files were last used
- **Version 1.3.6 - 27 June 2016**
 - General
 - Added (BETA) support for Universal Windows Platform 10 and Windows Phone 8.1
 - Added (BETA) support for Time.timeScale and

- Time.captureFramerate allowing video playback to work properly with video capture systems that alter Unity time
 - Added ExtractFrame function to MediaPlayer
 - Added Extract Frames demo scene
 - Added SeekFast function which will try to seek to keyframes only so it's less accurate but faster. On unsupported platforms it will just do a normal seek operation
 - Added functions to change the playback rate. Note that the behaviour of this varies between platforms and is not available yet on Android
 - General API improvements, platform overrides system improved
 - Fixed bug where disabled gameObject would cause rendering to stop
 - Fixed bug where destroying MediaPlayer while uGUI component is using it could cause a crash
 - Fixed rare bug where uGUI component would become offset or hidden
 - Fixed rare bug where m_events would be null
- VR
 - Fixed VR sphere shader coordinates on some platforms, especially cardboard
 - Added "Media Properties" section to MediaPlayer where you can define the stereo packing of a video. This then automatically adjust the sphere shader to render the video correctly per eye
 - Fixed bug in InsideSphere shader where stereo rendering would flip the eyes at some angles
 - Added support for Unity 5.4 "Single-Pass Stereo Rendering" to 360 InsideSphere shader
 - Added new VR sample with "cubemap 3x2" (facebook layout) support
- Workflow
 - Added button in preview panel to save frame to PNG
 - Added persistent option to preserve the media player between level loads
 - Added multi-object MediaPlayer component editing support
 - Texture properties (wrap mode, filtering) can be set via Media Properties panel
 - Debug GUI now shows preview of video
- Android
 - Fixed bug where no visuals would appear when old devices
 - Switched from AAR to JAR/SO files to improve Unity 4 compatibility
 - Added x86 support
 - Fixed bug where Pausing a stopped video would lock it up
- OS X / iOS / tvOS
 - Large performance boost on iOS and tvOS (removed texture

- copy)
 - Streaming video buffering stalls now recover and IsBuffering function added
 - Seek accuracy improved
 - Looping handled better to reduce seam time
 - Fixed texture memory leak in Metal rendering path
 - Fixed mute not working with autoStart
 - Windows
 - DirectShow video playback smoother
 - Fixed DirectShow support for showing images or videos with zero duration
 - Added platform-override option to force DirectShow player
 - Added platform-override option to force audio output device. This is useful for VR hardware that has its own audio device.
 - Fixed poster frame not displaying
 - Fixed videos not displaying due to empty RGB32 alpha channel
 - Fixed D3D9 lost device issue
 - Fixed D3D9 issue of texture not being released
 - Fixed DirectShow player time displaying NaN sometimes at the end of video
 - Fixed crash bug if you closed Unity with video was playing
 - Fixed Windows N edition crash
- **Version 1.3.0 - 20 April 2016**
 - Android
 - Added multi-threaded rendering support
 - Fixed various rare bugs
 - Windows
 - Exposed GPU video player path (when using command-line argument “-force-d3d11-no-singlethreaded”), this requires Win8.1 minimum and D3D11
 - Windows XP, Windows Vista and Windows 7 support added by adding DirectShow playback path
 - Hap1 and Hap5 codec support added for Windows 7 and below (via DirectShow playback path)
 - Fixed audio only media not being seekable
 - iOS
 - Fixed iOS 8.2 compatibility issue
 - Workflow
 - Editor pause button now pauses/resumes playing videos
 - Added new ‘about’ section with handy links
 - Improvements to editor UI
 - UI fixes for standard Unity editor ‘light’ skin
 - Bugs
 - Fixed IsFinishedPlaying event not firing on some platforms
 - Fixed player freezing when component is disabled. It now pauses OnDisable() and resumes OnEnable().

- Fixed crash in VCR demo related to uGUI component when changing videos
 - Fixed bug closing application with many videos open
 - Fixed seeking bug for audio-only media
 - Documentation
 - Updated FAQ
 - Added stereo virtual reality notes
- **Version 1.2.0 - 1 April 2016**
 - General
 - Improved support for audio-only media
 - Improved streaming support
 - Added HasVideo, HasAudio and HasMetaData functions
 - Added MetaDataReady event
 - First frame now displays without starting playback
 - Added new ApplyToMesh component
 - Removed troubled #AVPRO defines
 - Android
 - Fixed issue where Finished event wouldn't fire
 - Minimum API level bumped from 15 to 16
 - Mac, iOS, tvOS
 - improved performance of multiple video playback
 - Windows
 - Improved performance (duplicate frame handling)
 - Added missing IsSeeking function
 - Fixed IsFinished function always returning false
 - Fixed URL parsing
 - Fixed OpenGL texture cleanup
 - Fixed minor D3D11 leak caused by views not being released
 - Improved init/deinit
 - Workflow
 - Resulting file name is now displayed clearly and is copyable
 - More file extensions in inspector file browser
 - Components now have AVPro icon
 - Added warnings for incorrect Player Settings for streaming videos
 - Editor platform override tab is restored
 - Debugging
 - Improved logging
 - VR
 - Improved 360 Sphere demo support for GearVR
 - InsideSphere shader has color tint option for stereo debugging
 - Docs
 - Added video streaming notes
 - Added VR notes
 - Improved notes on supported formats
- **Version 1.1.0 - 11 March 2016**
 - Added Windows support
 - Added lat-long stereo top-bottom and left-right video support for VR

- Added per-platform file path overrides
 - Absolute and relative path loading support added
 - Android loading from OBB support added
 - Workflow improvements
 - Added browse button
 - Added recent file list
 - Added relative folder support
 - Improved MediaPlayer UI, including preview in editor
 - Created a scripting class reference
 - Improved documentation
 - Fixed Linear colour space support in Windows
 - Fixed shutdown and memory freeing
 - Various bugs fixed
- **Version 1.0.0 - 25 February 2016**
 - Initial release on the asset store
 - Added new events
 - **Version 0.9.0 - 17 February 2016**
 - Initial beta release

Appendix C - Roadmap

- **Version 2.0.0**
 - High quality glitch free multi video player with optional transitions and nice user interface
- **Version X.X.X**
 - Split out media definitions from player
 - Loading from memory/resources
 - Fallback to using MovieTexture/VideoPlayer on some platforms?
 - 10-bit / HDR support?
- **Version X**
 - ← Your suggestions here, let us know :)

Appendix D - Unity Bugs

Some versions of Unity have new bugs or regressions that prevent AVPro Video from operating as expected.

In our experience it's best to avoid using new major releases of Unity (eg version X.Y.0) and wait for the follow-up releases where bugs introduced in the major update have had time to be fixed.

Please vote and comment on these issues so they get high priority to be fixed.

- **Unity 5.6.0f3 - Present**

- Has an Android bug that prevents GLSL shaders from compiling, which prevents our OES rendering path to work.
<https://issuetracker.unity3d.com/issues/android-ios-glsl-shader-compilation-failure-on-some-mobile-devices>
Latest version where it works is 5.5.4
- Single-pass stereo mode on the Android GearVR introduces strange shader bugs on some platforms. We added two bug reports here:
<https://issuetracker.unity3d.com/issues/android-gearvr-left-eye-is-rendered-with-green-distortions-when-using-single-pass-stereo-rendering-method-star-on-mali-gpu>
<https://issuetracker.unity3d.com/issues/android-gearvr-both-eyes-are-rendered-in-the-same-color-when-using-single-pass-stereo-rendering-method-star-on-mali-gpu>

- **Unity 5.x - Present**

- Support for Android OBB (split application binary option) seems slightly broken in many versions of Unity. It seems to try to load OBB content from the APK file, so it's as though it's resolving Application.streamingAssetsPath incorrectly. It appears that the first time you deploy to the Android device it works but then subsequent builds will fail. Uninstalling the application from the device and building to a new APK file seems to solve this.

- **Android OES Texture Support**

- OES Textures used to work reasonably well, but in some versions of Unity they no longer work:
- <https://forum.unity3d.com/threads/android-oes-texture-support.436979/>

- **Android Cardboard in Unity 2017.3.1**

- Unity temporarily broke Cardboard support for non-Daydream devices around these versions:
2018.1.0 b3 - Fixed in 2018.1.0 b12
2017.3.1 p1 - Fixed in LTS 2017.4.1 f1
2017.2.1 p3 - Fixed in 2017.2.2 p3
2017.1.3 p1 - Fixed in 2017.1.3 p3
- <https://forum.unity.com/threads/for-people-targeting-cardboard-on-android-please-update-your-google-vr-sdk-to-1-12-or-later.520986/>