

VIDEO COMPRESSION

MC 4324: VISUAL STORYTELLING

OVERVIEW

Compression is essential for reducing the size of movies so that they can be stored, transmitted, and played back effectively. Compression is achieved by an encoder; decompression is achieved by a decoder. Encoders and decoders are known by the common term *codec*.

No single codec or set of settings is best for all situations. For example, the best codec for compressing cartoon animation is generally not efficient for compressing live-action video. Similarly, the best codec for playback over a slow network connection is generally not the best codec for an intermediate stage in a production workflow.

Video compression is the last step before uploading your file online. As the name implies, compressing video reduces its file size. This is very important, because smaller files upload faster, save bandwidth and storage costs, and load quicker when played back. However, if video is compressed too much, the file can lose its detail, resolution, clarity, and much much more.

Here's how video compression works: every second of video is composed of a series of still frames (typically 24-60 frames per second). Depending on the subject, only part of the image changes from frame to frame. Instead of storing two nearly-identical frames within a video file, only the parts of the image that have changed are recorded. So if you have a friend waving to the camera, and your friend's arm is the only thing moving in the shot, the image information of your friend's arm is the only thing that is recorded. The method a computer uses to determine the amount of change between frames is called the codec.

Every couple of frames, the codec will pick a keyframe that will serve as a reference for all the frames after it. Each keyframe consists of the entire image, and the following frames base their changes off of it. It's important to select a keyframe interval that isn't too frequent, or too infrequent. If you set the interval too frequent, you'll end up with a large video file, set it too infrequent and you'll have strange ghosting artifacts. Matching your keyframe interval to your frame rate (essentially making a new keyframe once every second) is usually a good place to start, but depending on what you're shooting this may vary.

Bit rate (also known as data rate) is the amount of data that is used for each second of video. In the world of video, this is generally measured in kilobits per second (kbps). Bit rates come in two flavors: constant and variable. A constant bit rate (CBR) uses the same amount of data every second, while a variable bit rate (VBR) adjusts the amount of data used depending on the complexity of the changes between frames. Generally, a variable bit rate will produce a smaller file, using less data for less complex frames. However, if there is a lot of action going on in your video, a variable bit rate will use more data to account for more movement.

Again, you'll want to find that sweet spot between a high and low bit rate; too high and you'll have a larger file without a significant increase in quality, too low and you'll lose detail and start to see blocky areas in your video. Quality between CBR and VBR can vary, so try exporting two versions of your video using either bit rate type and see which one gives you the best quality for your video.

Resolution is the actual size of your video, measured in pixels. When you're exporting your video, most of the time you'll want to match the resolution of your camera. (See resolution below)

The number of frames shown every second is called frame rate. Just like resolution, when exporting you'll want to match the frame rate of your camera, which is typically 24, 25, or 30 frames per second (fps) when it comes to video.

One thing to watch out for when exporting your video is the option for a variable frame rate. Just like variable bit rate, exporting with a variable frame rate changes the number of frames per second depending on the amount of movement in your video. While theoretically this can save space, not all programs or websites can play back variable frame rate videos, and the audio can fall out-of-sync. To play it safe, stick with a constant frame rate.

What settings you use overall depends on where your video is ultimately going. If you're exporting a rough cut for a director, maybe a low bit rate, low resolution video is best. Videos going to Blu-Ray should have the highest quality possible. Always keep the final location of your video in mind when choosing your export settings.

VIDEO COMPRESSION GUIDELINES

Follow these guidelines to create video files that will upload successfully.

Video Codec: H.264

A codec is the format in which your video will be encoded. Different upload sites like Vimeo or YouTube accept most major video codecs, but for best results I recommend using H.264.

Advanced H.264 Settings: To make your uploads extra smooth, choose the following advanced settings whenever possible.

- No edit lists (otherwise, you may have sync issues)
- Closed GOP (In video terminology, when encoding in MPEG video GOP is the abbreviation for Group Of Pictures. In a motion sequence, GOPs are individual frames of pictures that are grouped together and played back so that the viewer registers the video's spatial motion.)
- CABAC (to reduce your file size) (Context-adaptive binary arithmetic coding (CABAC) is a form of entropy encoding used in H.264/MPEG-4 AVC video encoding. It is a lossless compression technique. It is notable for providing much better compression than most other entropy encoding algorithms used in video encoding, and is one of the primary advantages of the H.264/AVC encoding scheme.)

Frame Rate: 24, 25, or 30 FPS (Constant)

If you know the frame rate of your footage, it's best to encode your final video at the same frame rate. However, if your footage exceeds 30 FPS (frames per second), you should encode your video at half that frame rate. For example, if you shot at 60 FPS, you should encode your final video at 30 FPS. If you're uncertain what frame rate you shot at, set your frame rate to either "Current" or 30 FPS. If there is an option for **keyframes**, choose the same value you used for frame rate. **Important:** Always choose "constant" frame rate instead of "variable" frame rate.

Bit rate: 2,000 – 5,000 kbps (SD) / 5,000 – 10,000 kbps (720p HD) / 10,000 – 20,000 kbps (1080p HD)

Bit rate (aka data rate) controls both the visual quality of the video and its file size. In most video editors, this is measured in kilobits per second (kbps). When you have the option, choose a "variable" bit rate and set the target to at least 2,000 kbps for standard definition (SD) video or 5,000 kbps for HD.

RESOLUTION

Format	Resolution	Bit Rate
Standard Definition (SD) 4:3 Aspect Ratio	640 x 480 px	2,000 – 5,000 kbps
Standard Definition (SD) 16:9 Aspect Ratio	640 x 360 px	2,000 – 5,000 kbps
720p HD Video 16:9 Aspect Ratio	1280 x 720 px	5,000 – 10,000 kbps
1080p HD Video (Plus/PRO) 16:9 Aspect Ratio	1920 x 1080 px	10,000 – 20,000 kbps

Common resolutions for SD video include 640 x 480 px (4:3 aspect ratio) and 640 x 360 px (16:9 aspect ratio). The most common setting for HD video is 1280 x 720 px (16:9 aspect ratio). 1920 x 1080 px is the most common resolution for 1080p video.

AUDIO

Codec: AAC-LC (Advanced Audio Codec)

For best results use AAC-LC (low complexity) for the audio codec.

Data rate: 320 kbps

For best results, encode your audio at constant rate of 320 kbps.

Sample rate: 48 kHz

For best results, set your audio sample rate to 48 kHz. If your working setting is already less than or equal to 48 kHz, leave it as is.

THE BASICS OF IMAGE RESOLUTION

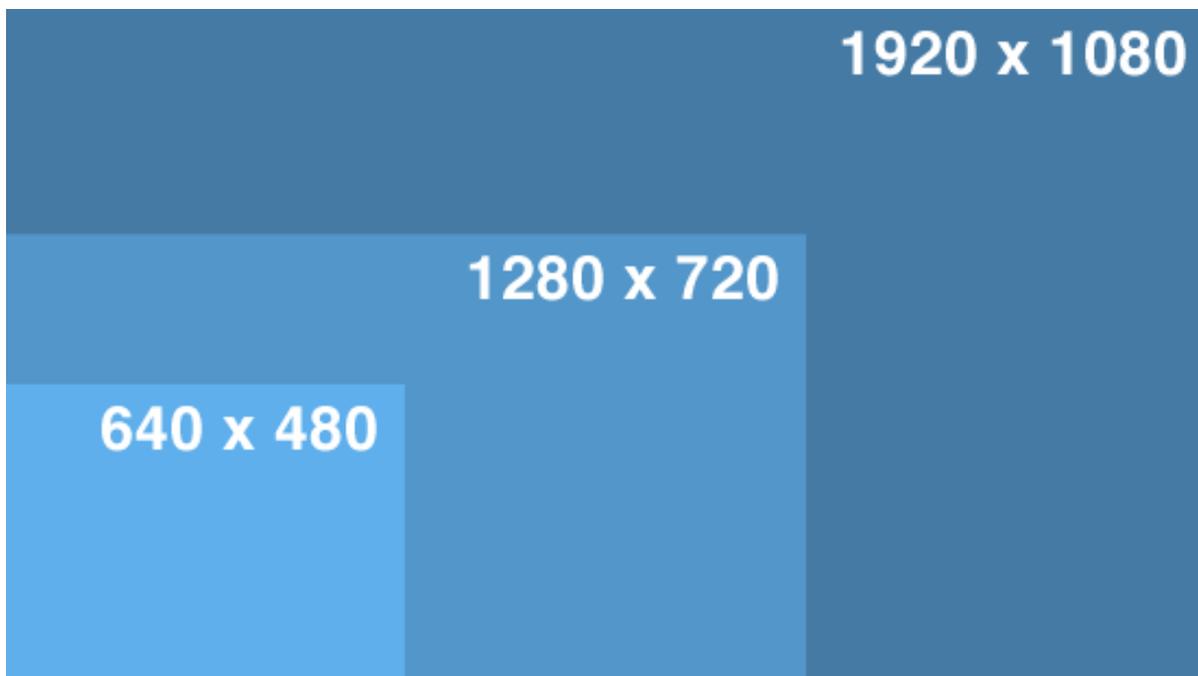
When it comes to making and watching videos, it's important to know about image resolution, if only because the concept is thrown around so frequently. For example, if you go to an electronics store you'll be bombarded with information about how every gizmo and gadget is HD, Full HD, HD 3D, 480, 1080, etc.

Many factors determine the quality of an image, but for the purpose of this section I'm going to focus on just one aspect: resolution. At its most basic level, resolution is a measure of how many pixels an image contains. Pixels are the tiny squares that make up a digital image. Each square is a piece of a puzzle — by itself it might not mean much, but when combined with other pixels it becomes a critical piece of information that helps to tell a larger visual story.

Typically, resolution is expressed as image length (in pixels) times height (also in pixels). So if you read that a camera records video at 1280 by 720, what that means is it records a rectangular image that is 1,280 pixels wide and 720 pixels tall.

Let's review a few common resolutions that you'll encounter with online video. There's 640x480, commonly referred to as standard definition (or SD). Then there's 1280x720, which is the minimum for what's called high definition (or HD). And finally there's 1920x1080, which is sometimes referred to as full HD. (Keep in mind that all of these terms are relative, and that as technology marches on HD will include higher and higher resolutions. So don't get too attached to these numbers.)

Below is a chart showing the relative sizes of these common display resolutions (the images are not to scale).



Nowadays there's discussion of cameras that shoot at 2k, 4k, and even 8k resolution (k meaning thousand), which will deliver ever higher levels of picture detail. Around 4k resolution you start to run into issues where there are few, if almost no, monitors that can natively display so many pixels, you won't find many televisions yet that can show images above 1920 x 1080, so that leaves you with a theater setting to be able to view all those pixels. Many modern movie theaters now show movies at 2k resolution and some computer monitors can as well.

Keep in mind that more pixels doesn't always equal a better video, but being familiar with how they affect resolution and the typical dimensions can help you follow the conversation when the numbers and abbreviations start to fly.