Best Practices for Multi-Device Transcoding

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INTRODUCTION

In 2011 video is everywhere. Every site. Every device. Everywhere you turn video is streaming. Consumer eyes are better trained than ever, expecting higher and higher quality with faster and faster service.

Story is king and no one wants that story interrupted because of video buffering, skipped frames or the dreaded crashed player.

The following document details the current Best Practices for Multi-Device Transcoding. Each section will detail the recommended encode settings and resolutions for the current array of supported devices (iPad to Roku to Desktop) along with use cases and background information.

IT'S ALL ABOUT A BALANCE

The challenge of streaming video is to find the right balance between bitrate and resolution as it relates to an end user's connection speed and system ability. There are far too many variables that could interrupt playback to account for them all, at least as of the time of this writing. Here is a short list of these stream killing variables:

- Internet Service Provider Connection Speed or Cap
- CPU ability
- Problems on the user's system (viruses, outdated drivers, etc.)
- Bandwidth of the Wireless connection as it fluctuates in a busy household
- Browser Used
- Version of products (often an outdated version of Flash, Silverlight or some other necessary component causes poor playback)
- Distance from wireless router
- Device used – desktop or mobile or set top
- Programs running in background
- Network traffic to and from the CDN

These are just the more obvious variables to consider and though we can not control them all we can take steps to avoid or account for most of them.

STREAMING CONTENT

Content flows to an end users system in a stream of data much like a river might flow from a mountain reservoir to a small town. All content that is viewed on the internet inside an application is considered streaming content. This document focuses on streaming video.

Goals of Streaming Video

- Fast start up
- No Buffering
- No Frame Skips
- No Crashing

ADAPTIVE STREAMING

For Adaptive Streaming there would be multiple bitrates available and the player or server (Akamai, etc) would know what bitrate to serve up to the guest based on their connection speed and ability. To exemplify this let's pretend we're wanting to stream a movie called The Big Movie. Though the end user would only see one piece of video, unknown to them multiple streams are actually available and may be seamlessly switched to if their connection drops lower or improves. The key here is "seamless". When adaptive is done correctly there should be no interruption of playback.

So for The Big Movie a player might be serving up the following all at once:

The Big Movie @ 2612 kbps

The Big Movie @ 1600 kbps

The Big Movie @ 1200 kbps

The Big Movie @ 800 kbps

USE CASE: If a user's connection dropped from over 2.5 Mbps to say 1600kbps the video player would switch, again seamlessly, from the 2612 bit rate down to the 1600. Now many times a player is designed to start on the lowest possible bit rate so that playback starts immediately. So for this example the 800 kbps stream might be served up first and then as the player realizes that the user can handle a higher bitrate it would then switch up.

ADAPTIVE SET

An Adaptive Set is a package of transcodes for the same video that span multiple bit rates and are meant to find a balance between connection speed and resolution.

In order for Adaptive to work all the streams in an Adaptive Set must be in alignment. Mid to upper bit rates should have the same frame rate, key frame interval, audio sample rate, etc.

Lower end bitrates from 240 kbps and below behave differently and do not need to match the upper bit rates as they are designed to keep the stream from ending and crashing the player.

Every device has different requirements currently for what they ideally want in an Adaptive Set. This can become overwhelming to video producers, editors and managers as it does, in reality, mean you need many bitrates for one video to be playable across multiple devices. This list could go as high as 40 different transcodes that need to take place however, do not panic, you do not need to use all 40 if your budget and time does not permit it. You can compromise, but understand that those variables we discussed in the first section of this document may become a factor and cause poor playback. In a later section we will discuss specific device groups and the settings and use cases applicable to each.

GENERAL SETTINGS and CONCEPTS

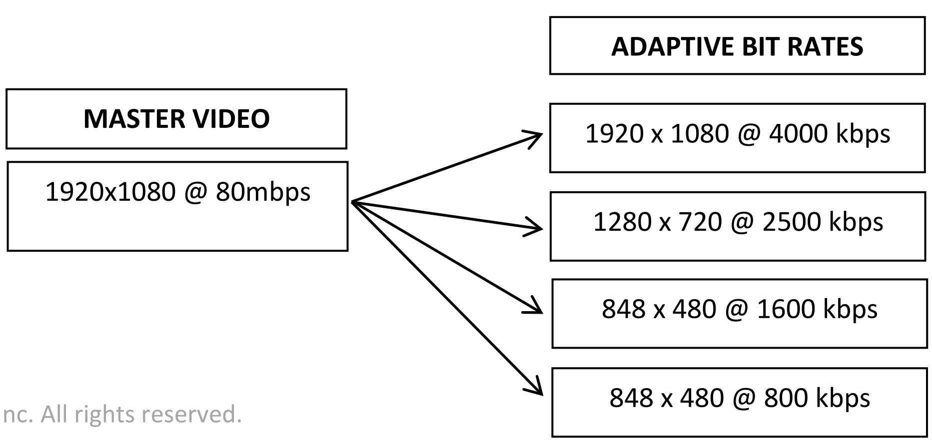
Before we can dive into the specific device groups and their intended settings it is important to understand the essentials of transcoding. This section will detail the most commonly used settings in this process ranging from GOP size (or I-Frame interval) to resolutions and frame rates and so on.

TRANSCODING

Let's start with that word "transcoding". A correctly formatted video master will NOT stream on the internet and must be converted, or transcoded, in order to be viewed. A transcode is made from taking an encoded piece of video and then converting it into one or more newly and more compressed streams that can then be played in a player on a computer or mobile device depending on the settings and methods used.

USE CASE: A user wishes to take a piece of video shot in 1920 x 1080 and make it playable in an adaptive player on the internet. In order to do this the Master Video, which is of a high quality at 1080 in resolution, must be converted to at least 3 or more different bitrates that may even scale down in resolution.

So the desired result would be:



Note that the 1920 x 1080 master video which was created at 80 mbps is converted to four different and more compressed bit rates. Though the first on the list is a 1920x1080 resolution the bit rate is only 4000 kbps, much lower than the 80,000 kbps (or 80 Mbps) stream. The next three bitrates that are produced scale down from the 1080 resolution to 720 and then 480 – making this video playable for a wide range of users and connections.

Different methods can be used to transcode video that trade quality for time. An Encoder can choose between at least 3 different encoding methods that effect bit rate and picture quality:

- Constant Bit Rate (CBR)
- Variable Bit Rate (VBR)
- 2-Pass Variable Bit Rate (2-Pass VBR)

CBR – As the name suggests this method will encode each frame of video with the same bitrate, no matter what his happening in the frame or what is changing from frame to frame. Encodes done in this method often have lower visual quality but also lower file sizes. This method is also the fastest in terms of transcode time.

USE CASE: A news organization may choose to encode CBR so that the video is outputted quickly enough to make a news deadline. Time for them is more important than video quality. If they choose CBR (or even 1-Pass VBR) they may make the decision to encode it at a medium resolution (say 480) at a mid-level bit rate (say 1200 kbps) so that they can maintain some level of visual quality.

VBR – Unlike Constant, Variable Bit Rate adjusts the amount of bits assigned to a frame depending on what the encoder believes is happening in the frame. This means the bit rate fluctuates over time, going over the average when a complex frame is encountered. How far above the average bit rate is determined by setting the Max Bit rate appropriately. (discussed in a later section)

2-PASS VBR – This is the most recommended method for transcoding when picture quality is important. Like VBR, 2-Pass allows the bit rate to increase for complex scenes (say a rainy scene where every frame is different). Unlike straight VBR 2- Pass does a little more work. It does a first pass at the encode that creates a log file. This file is then used on a second pass to improve quality on difficult scenes. This results in a higher picture quality (fairly significant compared to 1-Pass) and a more consistent stream with fewer data/bit rate spikes.

BANDWIDTH

Bandwidth refers to the amount of data that a user may be able to receive and/or transmit. Often this is thought in terms of kilobits per second and is separated into both upload and download ability. Internet Service Providers tend to cap these data rates depending on the plan that the user has purchased which presents a challenge to content creators as they try to meet the needs of a broad range of users who have a varied range of bandwidths.

NOTE: According to Cisco's latest report Mobile connections in the U.S. currently are at 1,059 kbps and by 2014 should be, per their forecast, 2902 kbps.

Also, per a 2009 analysis of connection abilities across the country by newamerica.net, due to tiered pricing by ISP's, a U.S. customer may only have a connection as low as around 1.5 Mbps or, if they could afford a better plan, up to 50 Mbps – that's an incredibly wide range of possible connections for which to account and presents a challenge. On one hand a content creator wants their guests to experience the highest level of quality, but on the other hand that guest may simply not be capable of handling that quality. So a balance, yet again, must be considered.

BIT RATE

A Bitrate is a measurement of data speed across a network, often in Kilobits per second or kbps (1000 bits per second). This number correlates with potential bandwidth levels that a user may experience and should be in balance to the resolution of the stream. A household who's data plan is limited to 3 Mbps can not handle a bit rate over 2500 kbps. You may wonder why if that household can handle up to 3 Mbps they would only be able to handle 2500 kbps, why not the full 3 Mbps? The answer is because though the average data rate may be 2500 kbps for that video stream, it will spike at least 30% up to 50% of the average at various points in the video stream if the content creator has transcoded using variable bit rate, which is a common method. Therefore a buffer must be considered.

If you are using Akamai HD HTTP Streaming bit rate spikes are less of an issue as it uses client side caching allowing for a higher threshold – however if network conditions worsen those spikes may still present a problem. Again it is always about a balance between performance and visual quality.

AVERAGE vs MAX

The Video Bit rate has two main components: The Average and the Max

AVERAGE: The average bit rate for video should coincide with the target bandwidth of the end user and should be in balance with the resolution.

Just changing a bit rate alone is not sufficient for dealing with bandwidth limitations and is not recommended. It is advised that low bitrates also scale down in resolution so that the end user has a good balance between image and playback quality.

USE CASE: It is not advisable to send a user a 1080 resolution at a low bitrate of 500kbps not only because the image quality will be unwatchable but also because the end user, though able to handle 500 kbps, does not possess a system that can comfortably handle 1080 lines of resolution. Potentially such a user would have their player crash or at the least a poor playback experience if they tried to watch that 1080 video. Also low bitrates at high resolutions show larger digital artifacts/errors which make the image look undesirable.

MAX BIT RATE

A Max Bit Rate governs the ceiling that a variable bit rate may reach and should be within balance of the average and the target connection/device. Max Bit rates do not effect Progressive Download and some services like Akamai have some built in functionality that limit the impact of bit rate spikes. That being said, not everyone uses Akamai and Progressive download is not often ideal for streaming.

Potential Performance Issues Due to High Max Bit Rate:

- Unwanted Bit Rate Switching
- Stutter
- Player Crash
- Buffering

Industry standards say you should calculate the Max bit rate by taking the Average and adding 50%. It is recommended to reduce this even to 30% in order to create a truly consistent stream but still taking advantage of a variable bit rate.

USE CASE: If a transcoded stream has an Average of say 1400 kbps but spikes at 2600 kbps that user may experience one of the above performance issues if their bandwidth can only support between 1000 kbps and 2000 kbps, which is highly likely for many users who's ISP's cap their data plans. This would mean that when the stream spiked to 2600 it is outside the threshold that the user can handle.

ADAPTIVE BIT RATE REQUIREMENTS

Bit rates should be at least 400 kbps apart in an adaptive step for the mid range to high range encodes. The lower encodes can be closer together and should scale down in resolution. There is no need to create a low bit rate for 720 and higher resolutions because a user that can only handle a lower bitrate also can only handle a lower resolution. The two settings should always be in alignment.

NOTE: Lower bitrates are not meant to look perfect. They are only meant to keep the signal from being interrupted and to minimize the risk of the player crashing. The hope is that these lower bitrates only appear briefly while the users bandwidth fluctuates.

RESOLUTION

The resolution of a video is measured in the height in pixels. A content creator could use any resolution she wanted however there are industry standards to consider. Currently those standards can be thought about in three distinct levels:

- Standard Definition (SD) @ 480p
- high definition (hd) @ 720p
- High Definition (HD) @ 1080p

HD - True High Definition, HD, is defined as 1080 lines of horizontal progressive resolution. Think of your television as a series of very small lines – these lines make up the image of one frame and are scanned onto the screen in order, one line progressing after the other. Another way to imagine it is to take a painting and cut it into 1080 thin strips that are 1 pixel tall (very small) and then reassemble those strips one at a time in the order they would appear going from the top of the frame to the bottom. This form of High Definition is referred to as 1080p – where the 'p' stands for progressive and is identified by the HD acronym. The highest resolution possible for internet streaming is 1920 x 1080, or 1080p.

NOTE: 1080i video also exists and uses an interlaced method similar to standard definition broadcast and along with 720p is the more common, modern broadcast format. 1080i is not used for internet streaming.

hd - In addition to 1080p and 1080i there is also a 720p resolution. This resolution is used for broadcast television and sometimes independent filmmaking and home video. It is of a lower resolution than it's big brother 1080 which makes it easier to transmit and store.

This smaller version of High Definition can sometimes be referred to with the lower case acronym, hd. This is, by the way, not true high definition. High definition must be at least twice the resolution of Standard Definition Video which is comprised of 525 lines of resolution.

HISTORY

The precursor to the High Definition Television needed to carry a signal over a frequency wave – transmitted through the air from antennae to antennae . This method required bundling all the video and audio information into this signal so that when it reached a television set it was decoded properly. Standard Definition television's used an interlace method to deliver this signal – meaning odd lines where scanned onto the television screen followed then by the even lines. This was accomplished by having one frame of video comprised of two fields – field A would contain the odd scan lines and field B the even – combined, or interlaced, they presented a completed image. Each frame of video contained 525 lines of horizontal resolution. This standard also is referred to as NTSC which is the North American broadcast standard that set the television frame rate, at the time, to 29.97 frames per second. This is in contrast to the European, or PAL, method which uses 625 lines of resolution at 25 frames per second.

It is important to understand this history when dealing with modern digital delivery as many users, especially at the Studio Level, may need to handle old footage that was created for analog standard definition signals and up convert it so that it can be streamed.

SD – Standard Definition is still used for internet streaming as it's smaller file sizes and simpler resolution often meets the right balance for end users to have a positive playback experience. Standard Definition for streaming is not the same as broadcast standard definition – though qualitatively they may look similar. For Internet Streaming a common standard definition resolution is 480 progressive lines of resolution, or 480p.

When determining what resolution and/or frame size to use it is important to keep those dimensions divisible by 16. This is because encoders divide the image into 16 x 16 pixel macro blocks. If for some reason 16 is not a possible divisor for you it is also okay to use 8 though some loss in quality may occur.

RESOLUTION vs DIMENSION

It is easy to get resolution and dimension confused – primarily because they often refer to the same thing. However Resolution refers to the amount of detail the image has and Dimension only refers to the Aspect Ratio of that image. Both are measured in Width and Height.

Resolutions should scale according to the desired device and bitrate. It is advisable to not try to scale video up but rather present it in the original resolution of the master. Scaling up will result in noticeable degradation in picture quality. Likewise is it unadivisable to try to fit a larger dimension (a.k.a. frame size) onto a device that has a smaller resolution. (i.e. trying to fit a 1080 HD image onto an iPhone that can only handle 480 and below)

Here are some common Theatrical and Broadcast Aspect Ratios:

133 – 4x3 Television

178 – 16x9 Television and the most common Film Aspect Ratio

185 – A Common Film Aspect Ratio

166 – An older Aspect Ratio that was often used in Animation

235/240 – Next to 178, the second most common Film Aspect Ratio

NOTE: An Aspect Ratio is calculated by dividing the width by the height. 178 is actually 1.78 to 1 as a ratio of that width to height. A Resolution of 848x480 using this formula, for example, comes to 1.766 or rounded up, 1.78 – tradition drops the decimal and so this is simply called 178. As you calculated your resolutions keep this formula and the need to have the resolutions be divisible by 16 in mind.

GROUP OF PICTURES and I-FRAME INTERVALS

The key to video encoding is the use of compression – taking a large resolution image as it might appear on 35mm film or HD video and making it viewable by a home user. Though bit rates and resolutions do much of the work to create a balanced viewing experience there are other factors that also contribute to this compression. The most vital of these is the I-Frame Interval, sometimes referred to as the Key Frame Interval or the Instantaneous Decoder Refresh (IDR). All refer to essentially the same thing – the need for a reference frame from which guesses can be made about the subsequent frames. Every frame of video of a master once transcoded is not fully represented.

Every encoder has the ability to call out how far apart key frames are created – this is referred to as the Key Frame Interval. The frames in between Key frames are called P-Frames (predictive coded picture) and B-Frames (bi-directionally predictive) . P frames make a guess as to what the picture looks like based on those Kay Frames. B frames are additional reference frames that help improve the quality of P-Frames and the overall look of the stream.

Ideal Key Frame intervals should be between 2 and 4 seconds. Meaning, for a 29.97 fps piece of video, the key frames should be between 60 frames and 120 frames.

B-Frame usage should be limited to 1 to 2 reference frames – going over 3 reference frames may cause poor playback on some players (Quicktime for example). However, if you are confident that your users will be using players that support B-Frame decoding (Flash, HTML5, HTTP Live Streaming) you can increase these B-Frames to increase picture quality. Understand though that you will be increasing file size which may slow down load times and cause some buffering.

IMPORTANT CONSIDERATION: Key Frames are also Adaptive Switch Points – an adaptive player will switch bitrates when needed at Key Frames. If the Key Frame Interval is too short bit rate switching may happen too frequently and if too long a user's player may crash if a switch is required because the users's bandwidth has dropped. Also if a Key Frame Interval is too close together file sizes increase and the work needed to decode the picture increases causing a poor playback experience, especially for users with mid to low range bandwidths.

BUFFER

The player loads information from a video payload (your encoded video asset) ahead of your real time playback. This buffer should be in balance between the bit rate and connection speed. To calculate the Bitrat Buffer Size all you need to do is take the Average bit rate and add at least 50% so that the buffer would be 150% of Average.

PROFILES

There are three primary encoding methods used – these Profiles allow different levels of complexity in the video stream and are useful, if not required, to find that balance between connection and stream. The three levels are:

Baseline – This is the simplest method used and the most limiting. One would use this setting for mid to low end delivery on a mobile device or for videoconferencing. The benefit of this method is it is fast to transcode. The downside is the image quality will be limited as neither VBR nor B-Frames are allowed.

Main – Used primarily for standard definition broadcast and streaming. (Level 3.1)

High – Used for high definition video streams and is the profile used for Blu-Ray authoring.

VIDEO & PLAYBACK ARTIFACTS

If the above settings are not followed a variety of playback artifacts or errors may appear. These artifacts may include:

Buffering – If there are huge bit rate spikes or if file sizes are large for various bit rates a player may stop playback and pause – loading the video and waiting for system resources to free up. This also may be because the buffer is set too low during transcoding.

Frame Skips/Drops – Frames of video may drop if signal strength is not sufficient or if the wrong frame rate was used during transcoding. Resolution may also be a culprit of frame skips. If a user is using an average laptop over a wireless connection in their home, 720 and 1080 resolutions will most likely skip frames, creating a choppy playback experience.

Stutter – Like frame skips, frames are dropping, but the perceived experience is that the video is stuttering. This may appear as if a frame is pausing for a split second before catching up to audio which normally does not stutter or skip. (audio typically plays back fine even if video artifacts are present as the two, though bundled in the same container, are treated separately)

Macro-Blocking (or just Blocking) – The image may appear as a mosaic of blocks – this is often referred to as pixilation. This especially happens on fast motion scenes or scenes with heavy detail like rain.

Aliasing – Lower resolutions do not handle diagonal lines well – these may appear as steps and be jagged rather than smooth diagonals.

Banding – Though on a video master an image may appear to have a consistent color, often after transcoding to mid to low bit rates/resolutions that same color appears as a gradient or a series of bands. This is referred to as banding. An encoder, especially if 1-Pass or CBR was used, may not be able to tell the difference between subtle color changes and instead presents them as big changes, rather than subtle shifts. This is most often in sky shots and in animation; the latter is most problematic and challenging to transcode – especially modern CG based animation. Many transcoders have built in algorithms to deal with banding and over time this issue should dissipate.

AUDIO

Audio tends to be simpler to transmit and is significantly lower than a Video bit rate. Audio Bit Rates range from 20kbps up to only 384 kbps (for 5.1 Audio Only) and typically use 44.1 khz per second or 22 khz for a sample rate.

THE BEST PRACTICES CHARTS

Over the next several pages you will find a series of charts detailing the best practice settings. These are meant as guidelines. You can move from these settings but always remember you are trying to achieve a balance and there are potential consequences for varying from recommendations.

The charts assume 23.98 fps which is fast becoming the standard for media content. If your content is 29.97 (or 30) fps the key frame interval would be all that would need adjustment from what is presented here. For example: The Key Frame interval for the SD-High_2612 at 23.98 fps is 96 (or roughly 4 seconds) if it was instead 29.97 fps the interval, for four seconds, would be 119.

Also, all these charts only reference 16x9, 178 material. Resolutions/Dimensions should be adjusted according to your source.

VIDEO MASTERS

Transcoding always starts with a Video Master. The transcode can never be of a better quality than the Master.

A transcode is only as good as the Master it was made from.

A master file intended for transcoding is often referred to as a Mezzanine file – as it's an intermediary step in the post production process. A true 4k uncompressed piece of video is far too large to even play back on most computers and certainly too big to transcode from as it would take a substantial amount of time to even move the files so that an encoder can pick it up and complete the transcode.

Ideally the video master should be at the native resolution of active picture – in other words – if the video has an aspect ratio of 178 than the master should be 178, if the video, however, was 235 the master should also be 235 with no burned in matting.

Often Producers decide to use the master as is and allow the black mattes to be transcoded as well, rather than cropped out. This takes away from image quality as that black matte still gets compressed and still has bits assigned to it – therefore you are taking away resources from the actual active picture that may improve not only picture quality but the overall playback experience.

Here is a chart detailing possible Master settings:

MASTER VIDEO SETTINGS

Assumptions:
H.264/MPEG-4 AVC or ProRes 422

	RESOLUTION	
BITRATE	WIDTH	HEIGHT
80 Mbps	1920	1080
50 Mbps	1920	1080
25 Mbps	1920	1080
15 Mbps	1920	1080
80 Mbps	1280	720
50 Mbps	1280	720
25 Mbps	1280	720
15 Mbps	1280	720

You may wish to create a sub-master that is easier to transmit to partners and can be used to transcode lesser quality streams. This chart details what a sub-master transcode could look like:

Intermediary Master aka Sub-Master Settings

KALTURA FLAVOR NAME	A/V BITRATE	VIDEO BIT RATE	AUDIO BIT RATE	WIDTH	HEIGHT	TYPE	Key Frame Inter.	FPS
HD-Master	8128	8000	128	Auto	1080	High	96	23.98
hd-Master	8128	8000	128	Auto	720	High	96	23.98
SD-Master	8128	8000	128	Auto	480	Main	96	23.98

DESKTOP SETTINGS

Settings for Desktop applications differ greatly from those used on other devices primarily because a desktop may be able to handle a more complex set of transcodes albeit with a wider variety of potential stream killers. Though desktop can serve up even High Definition most users still do not have home desktop systems nor ISP connections that can stream HD in a manner that is acceptable. Currently HD streams cause skip frames and stuttering and may even crash the video player causing a poor user experience. As bandwidths and devices improve these problems will dissipate but it is important to understand this when designing your desktop bit rates as you must account for what consumers can actually handle, not what you wish they could handle.

The following chart details the Best Practices for Desktop:

DESKTOP BEST PRACTICES

KALTURA FLAVOR NAME	A/V BITRATE	VIDEO BIT RATE	AUDIO BIT RATE	WIDTH	HEIGHT	TYPE	Key Frame Inter.	FPS
HD-High_6128	6128	6000	128	Auto	1080	High	96	23.98
HD-High_5128	5128	5000	128	Auto	720	High	96	23.98
hd-High_4628	3628	4500	128	Auto	720	High	96	23.98
hd-High_3628	3628	3500	128	Auto	720	High	96	23.98
SD-High_2612	2612	2484	128	Auto	480	Main	96	23.98
SD-High_1616	1616	1488	128	Auto	480	Main	96	23.98
SD-Med_1028	1028	900	128	Auto	480	Main	96	23.98
SD-Med_816	816	688	128	Auto	480	Main	96	23.98
SD-Low_552	552	488	64	Auto	352	Main	96	23.98
SD-Low_448	*448*	384	64	Auto	352	Main	96	23.98

MOBILE SETTINGS

Mobile requirements are separated into two device platform sets – iOS for Apple devices and Android/Other for non-Apple mobile devices.

IMPORTANT CONSIDERATION: Though it may be tempting to try to fit your streaming video to the maximum resolution/dimension of the target device it is not recommended. Each device requires a small buffer to allow processing. This buffer is achieved partially by feeding video at a slightly smaller resolution/dimension than the max allowed for that device. This is improving and even recently Apple has begun adding full resolution to their recommendations – though some playback problems may still occur. This is primarily true for older non-iOS devices.

iOS DEFINITION BEST PRACTICES (Mobile)

Apple has strict requirements for how video should stream. The following is based upon their recommendation.

KALTURA FLAVOR NAME	A/V BITRATE	VIDEO BIT RATE	AUDIO BIT RATE	WIDTH	HEIGHT	TYPE	Key Frame Inter.	FPS
iOS_WiFi_hd_4540	*4540*	4500	40	1024	576	Main	72	23.98
iOS_WiFi_hd_2540	2540	2500	40	1024	576	Main	72	23.98
iOS_WiFi_SD_1840	1800	1800	40	960	544	Main	72	23.98
iOS_WiFi_SD_1240	1240	1200	40	640	352	Base	72	23.98
iOS_WiFi_SD_640	640	600	40	640	352	Base	72	23.98
iOS_Cell_SD_440	440	400	40	416	234	Base	72	23.98
iOS_Cell_SD_240	240	200	40	416	234	Base	36	12
iOS_Cell_SD_110	150	110	40	416	234	Base	24	8

NOTE: Apple also recommends creating an audio only bit rate at 64kbps with a still image – the reason for this is simply that if a signal drops very low this 64 kbps stream will allow the stream to continue playing while the signal improves –hopefully quickly – and returns to above 150 kbps.

It may be tempting to limit your mobile encodes to 3 or 4 bit rates. This is not recommended as mobile, by it's nature, is incredibly variant in its signal stability and though a user may even be using a 4G or WiFi connection their signal could fluctuate enough to cause their player to crash if the recommended number of variants are not included.

USE CASE:

1) A Media Company has decided to only offer 3 mobile bit rates:

320 x 240 @ 128 kbps

480 x 320 @ 414 kbps

480 x 320 @ 564 kbps

This Media Company is trying to achieve a lot with just three bitrates. The 320x240 bit rate is an iPod dimension and they feel comfortable with this bitrate showing up on an iPhone or iPad with black bars on all sides. They also have two other bitrates at 320 resolution within 100 kbps of each other which are a bit too close together to create any benefit.

These bitrates will work but will result in potentially a poor user experience.

2) Consider a real world scenario with a slightly different set of variants:

A single mother is driving from Los Angeles to San Diego with her daughter. Her daughter, age 7, is watching an iPAD 2 during the journey but she is watching a stream that only has 3 bit rates – 1240 kbps, 640 and 440. The content creator likes the look of these on an iPad but doesn't want to go below 440 because of the image quality loss. The daughter is enjoying her film but because they are traveling down a highway they are moving from one zone to another and her signal fluctuates wildly. Because the content creator is not offering a bit rate below 440 the player crashes forcing the mother to either tell her daughter to do something else or she must decide to pull over and reload her child's iPAD and re-launch the player.

NOTE: The way iOS works is that each of the above bit rates would be segmented into small chunks (10 seconds to maybe a minute) that are then called by the player one at t time in a progressive manner. This allows the amount of data flowing to a mobile device to be in small enough packets to allow smooth playback, limiting the drag on system resources.

ANDROID/OTHER BEST PRACTICES (Mobile)

KALTURA FLAVOR NAME	A/V BITRATE	VIDEO BIT RATE	AUDIO BIT RATE	WIDTH	HEIGHT	TYPE	Key Frame Inter.	FPS
Low_Edge_80	80	56	24	128	72	Base	48	23.98
Low_Edge_150	150	102	48	128	72	Base	48	23.98
Low_Edge_250	250	202	48	256	144	Base	48	23.98
Low_Edge_400	400	352	48	256	144	Base	48	23.98
Low_3G4G_600	600	552	48	512	288	Base	48	23.98
Med_3G4G_800	800	736	48	512	288	Base	48	23.98
Med_4GWiFi_1000	1000	936	64	512	288	Base	48	23.98
Med_4GWiFi_1300	1300	1236	64	512	288	Base	48	23.98
Med_4GWiFi_1600	1600	1536	64	512	288	Base	48	23.98
High_4GWiFi_1900	1900	1836	64	512	288	Base	48	23.98
High_4GWiFi_2200	2200	2136	64	512	288	Base	48	23.98
High_4GWiFi_2500	2500	2436	64	512	288	Base	48	23.98
Adv_4GWiFi_1200	1200	1136	64	768	432	Main	48	23.98
Adv_4GWiFi_1600	1600	1536	64	768	432	Main	48	23.98
Adv_4GWiFi_1900	1900	1836	64	768	432	Main	48	23.98

*Dimensions/Resolutions reflect Horizontal View Only

The above bit rates may appear at first to be daunting but remember – you can always pair down a set of bitrates as long as you include a wide enough range. The downside of having too few bit rates spanning several bandwidth levels is that the shift in quality becomes more obvious as the player switches between them. One reason for a larger number is simply to give the end user the smoothest experience. Also for non-iOS devices there is a wider range of possible devices to account for – thus the long list of potential encodes. The above is based on Adobe's recommendation, combining their Variant 8 and 9 charts.

CONNECTED DEVICE BEST PRACTICES (Roku, etc.)

KALTURA FLAVOR NAME	A/V BITRATE	VIDEO BIT RATE	AUDIO BIT RATE	WIDTH	HEIGHT	TYPE	Key Frame Inter.	FPS
HD-High_5128	5128	5000	128	Auto	1080	High	96	23.98
hd-High_3628	3628	3500	128	Auto	720	High	96	23.98
SD-High_2612	2612	2484	128	Auto	480	Main	96	23.98
SD-Med_1616	1616	1488	128	Auto	480	Main	96	23.98
SD-Med_1028	1028	900	128	Auto	480	Main	96	23.98
SD-Low_816	816	688	128	Auto	480	Main	96	23.98
SD-Low_552	552	488	64	Auto	480	Main	96	23.98

The above dimensions and bit rates are based on the requirements for the Roku player.

Best Practices Master Chart

Formats	Assumptions
Desktop - MP4 (H264), VP8 (WebM)	2 Pass VBR
iOS Mobile - MP4/M4V (H264)	Moov Atom At Beginning
Android - MP4	

TARGET DEVICE/USE	KALTURA FLAVOR NAME	A/V BITRATE	VIDEO BIT RATE	AUDIO BIT RATE	WIDTH	HEIGHT	TYPE	Key Frame Inter.	FPS
Mastering	HD-Master	8128	8000	128	Auto	1080	High	96	23.98
	hd-Master	8128	8000	128	Auto	720	High	96	23.98
	SD-Master	8128	8000	128	Auto	480	Main	96	23.98
DESKTOP	HD-High_6128	6128	6000	128	Auto	1080	High	96	23.98
	HD-High_5128	5128	5000	128	Auto	720	High	96	23.98
	hd-High_4628	3628	4500	128	Auto	720	High	96	23.98
	hd-High_3628	3628	3500	128	Auto	720	High	96	23.98
	SD-High_2612	2612	2484	128	Auto	480	Main	96	23.98
	SD-High_1616	1616	1488	128	Auto	480	Main	96	23.98
	SD-Med_1028	1028	900	128	Auto	480	Main	96	23.98
	SD-Med_816	816	688	128	Auto	480	Main	96	23.98
	SD-Low_552	552	488	64	Auto	352	Main	96	23.98
	SD-Low_448	*448*	384	64	Auto	352	Main	96	23.98
iOS	iOS_WiFi_hd_4540	*4540*	4500	40	1024	576	Main	72	23.98
	iOS_WiFi_hd_2540	2540	2500	40	1024	576	Main	72	23.98
	iOS_WiFi_SD_1840	1800	1800	40	960	544	Main	72	23.98
	iOS_WiFi_SD_1240	1240	1200	40	640	352	Base	72	23.98
	iOS_WiFi_SD_640	640	600	40	640	352	Base	72	23.98
	iOS_Cell_SD_440	440	400	40	416	234	Base	72	23.98
	iOS_Cell_SD_240	240	200	40	416	234	Base	36	12
	iOS_Cell_SD_110	150	110	40	416	234	Base	24	8
bile Android/Other_1	Low_Edge_80	80	56	24	128	72	Base	48	23.98
	Low_Edge_150	150	102	48	128	72	Base	48	23.98
	Low_Edge_250	250	202	48	256	144	Base	48	23.98
	Low_Edge_400	400	352	48	256	144	Base	48	23.98
	Low_3G4G_600	600	552	48	512	288	Base	48	23.98
	Med_3G4G_800	800	736	48	512	288	Base	48	23.98
	Med_4GWiFi_1000	1000	936	64	512	288	Base	48	23.98
	Med_4GWiFi_1300	1300	1236	64	512	288	Base	48	23.98
	Med_4GWiFi_1600	1600	1536	64	512	288	Base	48	23.98
	High_4GWiFi_1900	1900	1836	64	512	288	Base	48	23.98
	High_4GWiFi_2200	2200	2136	64	512	288	Base	48	23.98
	High_4GWiFi_2500	2500	2436	64	512	288	Base	48	23.98
	Adv_4GWiFi_1200	1200	1136	64	768	432	Main	48	23.98
	Adv_4GWiFi_1600	1600	1536	64	768	432	Main	48	23.98
	Adv_4GWiFi_1900	1900	1836	64	768	432	Main	48	23.98
TVApp	HD-High_5128	5128	5000	128	Auto	1080	High	96	23.98
	hd-High_3628	3628	3500	128	Auto	720	High	96	23.98
	SD-High_2612	2612	2484	128	Auto	480	Main	96	23.98
	SD-Med_1616	1616	1488	128	Auto	480	Main	96	23.98
	SD-Med_1028	1028	900	128	Auto	480	Main	96	23.98
	SD-Low_816	816	688	128	Auto	480	Main	96	23.98
	SD-Low_552	552	488	64	Auto	480	Main	96	23.98

Sources, Recommended Links and Resources:

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