

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

Based on information presently available, Advanced Coding Technologies LLC (“ACT”) contends that Defendant Google LLC (“Defendant” or “Google”) infringe Claims 1-3 (the “Asserted Claims”) of U.S. Patent No. 9,042,448 (the “’448 Patent”) through the Accused Products which are manufactured, sold, offered for sale, and/or used by Google.

Representativeness: Each Accused Product that is capable of performing AV1 encoding, including at least (i) Google’s products and services, such as the Pixel 6, Pixel 6 Pro, Pixel 6a, Pixel 7, Pixel 7 Pro, Pixel 7a, Pixel Fold, Pixel 8, Pixel 8 Pro, and Pixel 8a, Google Chromebook laptop products, Google Pixel Slate, Google Chrome, Google Chromecast, Android/Google TV, YouTube, Google Meet/Duo, that use either (a) third party or Google-produced AV1 encoder chipsets (e.g., Google Tensor processors) or (b) third party or Google-produced AV1 encoder software (e.g., libaom); (ii) Android OS versions which enable software-based AV1 encoding; and (iii) Google’s Tensor processors with integrated AV1 encoding capabilities, is representative of other Accused Products for the purposes of infringement of the ’448 Patent.

Based on publicly available information, ACT believes each Accused Product shares substantially the same structure and functionality with respect to the components which are relevant to infringement given that, among other things, the listed products all purport to support the AV1 standard for encoding. AV1 encoding can be implemented through either hardware or software-based encoders, including “libaom” for AV1 encoding.

Google directly infringes each of the Asserted Claims by using, importing, testing, selling, and/or offering for sale the Accused Products in violation of 35 U.S.C. § 271(a).

Google indirectly infringes the Asserted Claims in violation of 35 U.S.C. § 271(b) by inducing third parties, including its users and/or customers, to directly infringe through their operation and use of the Accused Products. Google has knowingly and intentionally induced this direct infringement by, *inter alia*, (i) selling, importing, or otherwise providing the Accused Products to third parties with the intent that the Accused Products will be operated and used in a manner that practices the Asserted Claim; and (ii) marketing and advertising the Accused Products. Google’s marketing and promotional materials for the Accused Products are found, for example, on Google’s website, and in App stores of operating systems for which the Accused Products are made available. For example, Google’s website offers customers instructions and/or manuals for the Accused Products that instruct customers to, among other things, use the accused functionality in the Accused Products. Google’s website also offers support to customers, including instruction to, among other things, use the Accused Products.

Additionally, Google is contributing to and/or inducing infringement because Google induces third parties (e.g., entertainment studios or content creators) to create and encode AV1 content so that products (and users of such products) utilizing Google services, such as Google Chrome, Google Chromecast, Android/Google TV, YouTube, Google Meet/Duo, may decode and consume decoded AV1

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content (whether on Google's devices or on third party devices). *See, e.g.,* <https://aomedia.org/av1-adoption-showcase/google-story/#:~:text=The%20Key%20to%20Product%20Innovation,of%20HDR%20video%20using%20AV1> ("Google started using AV1 early, in particular as a key technology at YouTube. "AV1's advanced technology allows Google to innovate with 4K, 8K, and high frame rate videos for users with premium devices, while also delivering high-resolution content over unreliable networks to lower-end mobile device users," said Frost. In Google Meet, AV1 enhances reliability for large multi-party conferencing, ensuring users enjoy smooth, higher-resolution video, even in challenging network conditions. Both the Android platform and Chrome support AV1 natively, benefiting mobile and TV users, video services from companies such as Netflix and Meta, and powering emerging experiences such as game streaming and VR.").

On information and belief, Google knows that its actions will result in infringement of the Asserted Claims, or subjectively believes that there is a high probability that its actions will result in infringement of the Asserted Claims but has taken deliberate actions to avoid learning these facts.

Plaintiff contends that the Accused Products perform each step of the claimed methods. Plaintiff contends that use, testing, and qualification of the Accused Products by Google itself, as well as use by customers and end-users of the Accused Products, perform each step of the claimed methods. On information and belief, backend servers, under the direction and control of the Accused Products, may perform certain steps of the claimed methods. Google, its customers, and users of the Accused Products derive benefits from their infringement.

On information and belief, the charted version of Google's products is representative of all versions of the Accused Products, including all variants of the Accused Products made, sold, offered for sale, or used on any operating system.

ACT does not concede that any claims of the '448 Patent that are not listed below are not infringed by the identified Accused Products. Moreover, the citations to certain documents and other information below are intended to be exemplary only and in no way foreclose ACT from citing or relying on additional documents, information, source code, and/or testimony at a later time. These contentions are preliminary in nature, and an analysis of Google's products, internal documentation, source code, and/or testimony from relevant witnesses may more fully and accurately describe the infringing features of its Accused Products. Accordingly, ACT reserves the right to supplement, correct, modify, and/or amend these contentions once such additional information is made available to ACT. Furthermore, ACT reserves the right to supplement, correct, modify, and/or amend these contentions as discovery in this case progresses; in view of the Court's claim construction order(s); in view of any positions taken by Google including, but not limited to, positions on claim construction, invalidity, and/or non-infringement; and in connection with the preparation and exchange of expert reports.

The contents of every below claim cell on which another claim cell depends are expressly incorporated by reference in that dependent

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cell, as if set forth in their entirety therein.

Further, to the extent this element is performed at least in part by software source code, ACT reserves the right to supplement these contentions pursuant to production of such source code and to the extent Defendants require additional information in accordance with P.R. 3-1 and for any other reasons.

Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google’s Accused Products
[1P] A moving picture encoding system that makes an encoding of a sequence of moving pictures with a resolution higher than a standard resolution using moving pictures contents which include a sequence of moving pictures with the standard resolution and do not include a sequence of moving pictures with a resolution higher than the standard resolution, the moving picture encoding system comprising:	The Google Accused Products are each: A moving picture encoding system that makes an encoding of a sequence of moving pictures with a resolution higher than a standard resolution using moving pictures contents which include a sequence of moving pictures with the standard resolution and do not include a sequence of moving pictures with a resolution higher than the standard resolution, the moving picture encoding system. Google directly infringes by using, importing, testing, selling, and/or offering for sale devices having an AV1 encoder. For example, the Accused Products perform AV1 encoding, that is moving picture encoding, using the Google Tensor G3 SoC and/or libaom AV1 software encoder. For example, the Google Tensor G3 SoC supports AV1 encoding at 4K 60fps that allows for moving picture encoding. the Tensor G3. Earlier, it was stated that Google’s latest and greatest chipset supported hardware-accelerated AV1 encoding at 4K 30FPS, and while that might have been true at one point, the Mountain View-based firm updated the Tensor G3’s specifications and upped that framerate to 60FPS. https://wccfttech.com/google-tensor-g3-first-smartphone-soc-to-support-av1-encoding-4k-60fps/

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	Source code confirms Google Tensor G3 as the first smartphone SoC to have hardware-accelerated AV1 encoding support Android expert Mishaal Rahman confirmed that Google Tensor G3 is the first smartphone chipset to have hardware-accelerated AV1 encoding support. The SoC has hardware-level support for  https://www.notebookcheck.net/Source-code-confirms-Google-Tensor-G3-as-the-first-smartphone-SoC-to-have-hardware-accelerated-AV1-encoding-support.806980.0.html

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	Chrome for Developers > BlogWas this helpful?   Improved video calling with faster AV1 encoding   Roshan Baliga  Marco Paniconi  Yunqing Wang Videoconferencing brings us together, even when we're thousands of miles apart. Whether it's catching up with your best friend, or having a quick meeting with a coworker, video calls have become an integral part of our lives. State of the art video codecs such as AV1 can dramatically improve video call quality, while using less bandwidth to transmit higher quality video. We're now seeing AV1 hardware encoders in desktops and laptops, but what about users who have older devices? The Chrome Open Media team has worked for the last 18 months to make the AV1 software encoder (libaom) much faster, unlocking better quality AV1 video calling on all devices. Chrome 113 includes libaom v3.6.0, which greatly improves real-time communications performance—both speed and quality—for speeds 6 through 10. In particular we added a "Speed 10" setting for devices with limited CPU capabilities. Google Meet has tested AV1 successfully in extremely low bandwidth conditions—down to 40 kbps—which unlocks video calling to users whose poor Internet connections previously prevented them from making video calls. Users with better Internet connectivity get improved video calls. Compared to VP9 speed 7, AV1 Speed 10 provides 12% better quality at the same bandwidth, while running 25% faster on desktops. The 3.6.0 release of libaom also includes improvements targeting screen sharing. Compared to VP9 speed 7, AV1 Speed 10 provides 45% better compression while running 35% faster. Starting with Chrome 113 any WebRTC app can take advantage of these AV1 improvements. https://developer.chrome.com/blog/av1/ .

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	AV1 Video Encoding Guide ➦ AV1 is an open source & royalty-free video codec developed by the ➦ Alliance for Open Media (AOMedia), a non-profit industry consortium. Depending on the use case, AV1 can achieve about 30% higher compression efficiency than VP9, and about 50% higher efficiency than H.264. There are currently three AV1 encoders supported by FFmpeg: libaom (invoked with libaom-av1 in FFmpeg), SVT-AV1 (libsvtav1), and rav1e (librav1e). This guide currently focuses on libaom and SVT-AV1. libaom libaom (libaom-av1) is the reference encoder for the AV1 format. It was also used for research during the development of AV1. libaom is based on libvpx and thus shares many of its characteristics in terms of features, performance, and usage. To install FFmpeg with support for libaom-av1 , look at the Compilation Guides and compile FFmpeg with the --enable-libaom option. https://trac.ffmpeg.org/wiki/Encode/AV1 For example, the libaom-av1 encoder, an implementation of the AV1 encoder specification developed and used by the Google Accused Products, allows input video pictures at a higher resolution to be coded at a low resolution. Libaom-av1 allows encoding with different sizes of reference frames (i.e., upscaled or downscaled frames). The encoding pipeline in libaom-av1 consists of different open-loop and closed-loop processes.

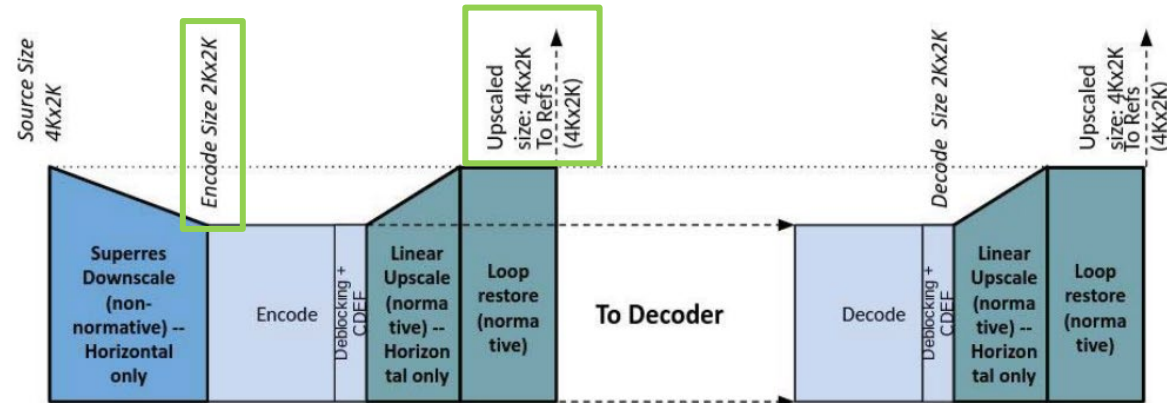
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	<i>Abstract—</i> AV1 is a recently standardized royalty-free video codec from the industry consortium Alliance for Open Media. One of the most innovative coding tools supported in AV1 is an in-loop frame super-resolution mode, that allows an encoder to code any frame at a horizontally reduced spatial resolution by one of several levels, followed by upsampling and super-resolving to full resolution, before replacing reference buffers. This mode is partly enabled by a feature in AV1 that natively allows the motion compensated prediction loop to operate across scales between a coded frame and the available references, thereby allowing on-the-fly resolution change mid-stream within a sequence. For the actual super-resolving process a normative upscaler is followed by an in-loop restoration tool that recovers some of the high frequency information lost in the downsampling process. On-the-fly resolution change capability in conjunction with the frame-superresolution mode in AV1 opens up a new dimension for codec bitrate and quality optimization that has not been possible to explore in any prior standardized video codec with (soon expected) decoding hardware support. This paper provides an overview of how the relevant tools work in AV1, but unlocking them with intelligent encoder decisions to extract real-world benefit, is largely left as future work. Source: IEEE, “In-loop Frame Super-resolution in AV1,” at 1 (available at https://ieeexplore.ieee.org/document/8954553).

3.7.4 Frame super-resolution

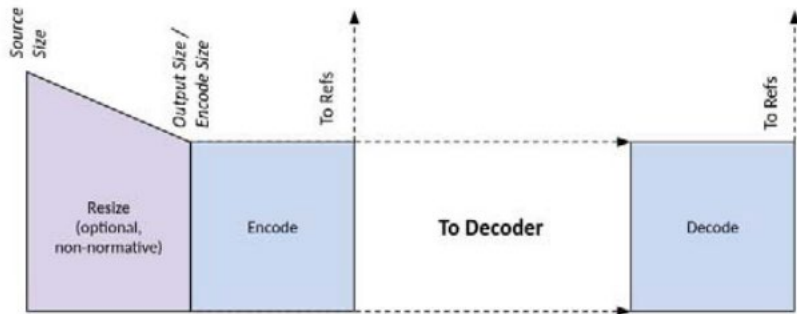
To improve the perceptual quality of decoded pictures, a super-resolution process can be applied at low bitrates. The super-resolution process can be performed on a per-frame basis. First, at the encoder side, the source video is downsampled as a nonnormative procedure. Second, the downsampled video is encoded, followed by deblocking and CDEF filtering processes. Third, a linear upscaling process is applied as a normative procedure to convert the encoded video back to its original resolution. Finally, an LR filter is applied to further recover some lost details of the upscaled picture. The last two steps make up the super-resolving process; the deblocking and CDEF filters are applied at lower spatial resolution on the decoder side, after which the frames are passed through the super-resolution process. To reduce complexity regarding the use of line buffers in hardware implementation, the upscaling and downscaling processes are applied to the horizontal dimension only.

Source: https://aomedia.org/docs/AV1_ToolDescription_v11-clean.pdf, 36.

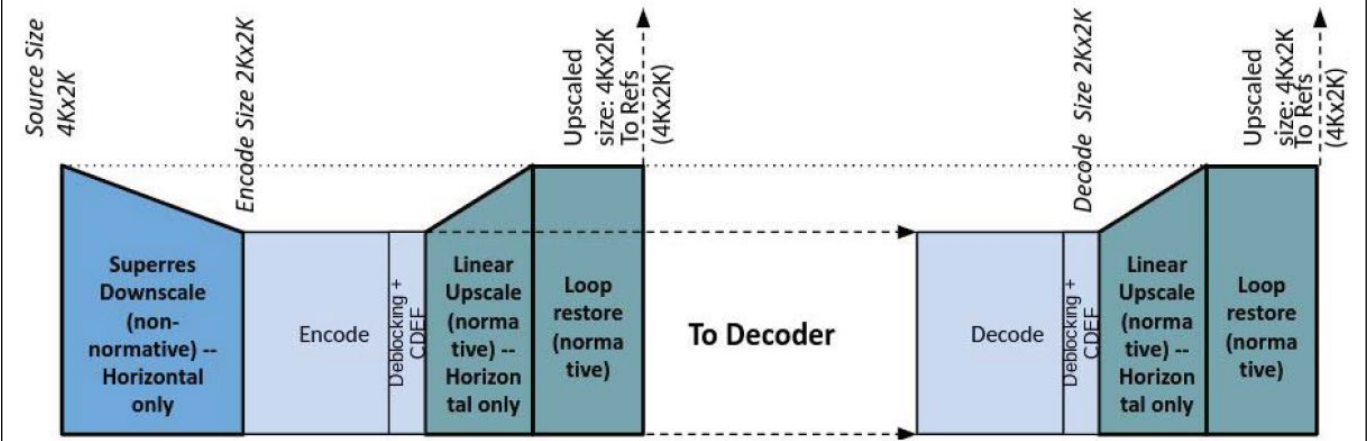


Source: IEEE, "In-loop Frame Super-resolution in AV1," at 3 (available at <https://ieeexplore.ieee.org/document/8954553>).

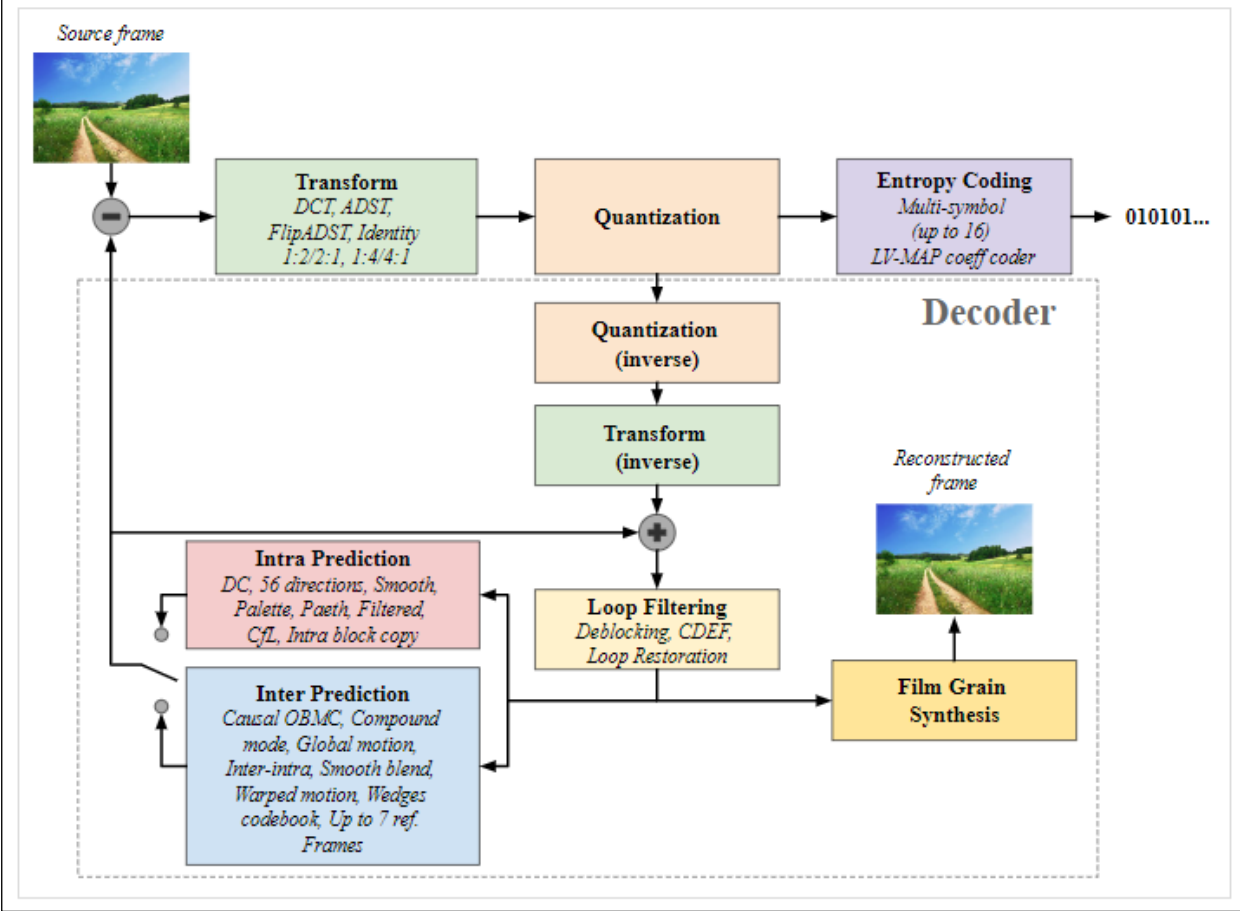
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	resolution. Therefore, at any point during the encoding and decoding process, any inter frame could be predicted from references that are at different resolutions, and consequently a normative mechanism to predict a block in that frame from a different resolution reference buffer needs to be defined. In principle, as long as we have defined a normative upscaler and a normative downscaler, such prediction across scales would be possible to support. However it would be Source: IEEE, “In-loop Frame Super-resolution in AV1,” at 4 (available at https://ieeexplore.ieee.org/document/8954553). As shown below, the AV1 encoder side processes mirror the decoder side processes such that it is able to be determined from the decoder processes what the encoder processes are, and vice versa.  The diagram illustrates the scaled prediction framework. It shows a sequence of processes: 'Resize (optional, non-normative)' which takes 'Source Size' as input and outputs 'Output Size / Encode Size'. This is followed by an 'Encode' block. A dashed arrow labeled 'To Refs' points from the output of the 'Encode' block to a 'Decode' block. Another dashed arrow labeled 'To Decoder' points from the 'Decode' block back to the 'Encode' block. The 'Decode' block also has a dashed arrow labeled 'To Refs' pointing upwards. Fig. 1. Scaled prediction framework IEEE, “In-loop Frame Super-resolution in AV1,” at 2 (available at https://ieeexplore.ieee.org/document/8954553).

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	 The diagram illustrates the Frame Super-resolution Framework, showing the flow from source to upscaled output. The process begins with a 'Source Size 4Kx2K' input. This input is processed by a 'Superres Downscale (non-normative) -- Horizontal only' block, which is part of the 'Encode Size 2Kx2K' stage. The output of this block is then processed by an 'Encode' block, followed by a 'Deblocking + CDEF' block. The resulting signal is then processed by a 'Linear Upscale (normative) -- Horizontal only' block, which is part of the 'Decode Size 2Kx2K' stage. The output of this block is then processed by a 'Loop restore (normative)' block. The final output is an 'Upscaled size: 4Kx2K To Refs (4Kx2K)'. A dashed arrow labeled 'To Decoder' points from the 'Loop restore (normative)' block to the 'Decode' block, which is part of the 'Decode Size 2Kx2K' stage. The 'Decode' block is followed by a 'Deblocking + CDEF' block, then a 'Linear Upscale (normative) -- Horizontal only' block, and finally a 'Loop restore (normative)' block. The output of the final 'Loop restore (normative)' block is an 'Upscaled size: 4Kx2K To Refs (4Kx2K)'. Fig. 4. Frame Super-resolution Framework https://ieeexplore.ieee.org/document/8954553

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Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google's Accused Products
	 The diagram illustrates the AV1 encoding and decoding process. It begins with a Source frame (a landscape image) which is processed by a Transform block (containing DCT, ADST, FlipADST, Identity, and various resolutions). The output goes through Quantization and Entropy Coding (Multi-symbol up to 16, LV-MAP coeff coder) to produce a bitstream (010101...). This bitstream is then decoded by a Decoder block. The decoder processes the bitstream through Quantization (inverse) and Transform (inverse). The output is then combined with Intra Prediction (DC, 36 directions, Smooth, Palette, Paeth, Filtered, CFL, Intra block copy) and Inter Prediction (Causal OBMC, Compound mode, Global motion, Inter-intra, Smooth blend, Warped motion, Wedges codebook, Up to 7 ref. Frames) to produce a Reconstructed frame. The reconstructed frame is then processed by Loop Filtering (Deblocking, CDEF, Loop Restoration) and Film Grain Synthesis to produce the final Reconstructed frame. https://wenxiaoming.github.io/2019/03/02/The-overview-of-AV1-coding/ Further, to the extent this element is performed at least in part by software source code, ACT reserves the right to supplement these contentions pursuant to production of such source code and to the extent Defendants require additional information in accordance with P.R. 3-1 and for any other reasons.

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[1A] a first encoder configured to work on a sequence of moving pictures with a standard resolution to implement a first combination of processes for an encoding and a decoding to create a first sequence of encoded bits and a set of decoded pictures with the standard resolution;	The Google Accused Products comprise: a first encoder configured to work on a sequence of moving pictures with a standard resolution to implement a first combination of processes for an encoding and a decoding to create a first sequence of encoded bits and a set of decoded pictures with the standard resolution		
	For example, the libaom-av1 implementation of AV1 encoder, used by the Google Accused Products, includes a first encoder that encodes the images applied at the input. When super-resolution mode is disabled (i.e., in a first pass), the encoder takes the input images at the original resolution and produces encoded images at the same resolution, such as in open loop I-frame encoding:		
	Libaom Source Code Citations:		
	https://aomedia.googlesource.com/aom/+/refs/tags/v3.9.0/av1/encoder/encoder.c		
	Function	Line	Description
	av1_update_frame_size	353-370	Updates the frame size and related parameters
	encode_frame_to_data_rate	3574-3984	Compresses a frame into a bitstream while dynamically updating the reference frame buffer with the encoded frame, enabling it to be reused for interprediction in subsequent frames; no resizing occurs during this state
	av1_encode	3986-4048	Encodes video frame into the AV1 format by configuring frame setting, managing dependencies, and producing a condensed bitstream
	https://aomedia.googlesource.com/aom/+/refs/tags/v3.9.0/av1/encoder/encodeframe.c		
	Function	Line	Description
	encode_nonrd_sb	515-583	Encodes a superblock using a faster, non-rate-distortion method; adds residuals back to predictions to produce decoded sets of pictures
	encode_rd_sb	768-962	Encodes a rectangular zone using rate-distortion optimization and partition search; adds residuals

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			back to predictions to produce decoded sets of pictures
	https://aomedia.googlesource.com/aom/+/refs/tags/v3.9.0/av1/encoder/bitstream.c		
	Function	Line	Description
	pack_txb_tokens	386-416	Packs transform block coefficients into the bitstream
	write_ref_frames	497-599	Encodes reference frame information, including whether a frame is a single or compound reference; Encoder can switch between different sets of reference frames for prediction; Prior encoded frames from reference buffer are used as references for prediction
	write_delta_q_params	957-999	Writes delta quantization parameters to adjust quality settings for blocks in bitstream
	https://aomedia.googlesource.com/aom/+/refs/tags/v3.9.0/av1/common/reconinter.c		
	av1_make_inter_predictor	644-659	Constructs inter-predicted blocks by applying motion vectors to reference frames. Handles scaling and resolution transforms for decoded frames using interpolation and warping.
	Further, to the extent this element is performed at least in part by proprietary software source code, ACT reserves the right to supplement these contentions pursuant to production of such source code and to the extent Defendants require additional information in accordance with P.R. 3-1 and for any other reasons.		
[1B] a first super-resolution enlarger configured to work on the sequence of moving pictures	The Google Accused Products comprise: a first super-resolution enlarger configured to work on the sequence of moving pictures with the standard resolution to implement a process for a first super-resolution enlargement to create a set of super-resolution enlarged pictures with a resolution higher than the standard resolution.		

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with the standard resolution to implement a process for a first super-resolution enlargement to create a set of super-resolution enlarged pictures with a resolution higher than the standard resolution;	For example, after subsequent processing steps in the AV1 encoding process (e.g., deblocking, CDEF), downsampled or upsampled input images and reference images are upsampled and loop restored for super resolution functionality. Thus, the upsampled and encoded pictures generated based on the downsampled input and reference images are super-resolution enlarged pictures, which have a resolution higher than the input images. The component implementing upscaling of the input images for the above processing step acts as the first resolution enlarger. <i>A. Scaled Prediction</i> In order to enable the codec to switch frame resolutions mid-stream, both AV1 and its predecessor VP9 support the ability to predict across scales in the inter prediction loop. As shown schematically in Fig. 1, this allows any frame or frames to be non-normatively downsampled or upsampled (Fig. 1 shows downscaling only) on-the-fly before encoding at a different resolution. The reconstructed frame after encoding at the reduced or increased resolution then replaces one of the reference buffer slots at that resolution. Therefore, at any point during the encoding and decoding process, any inter frame could be predicted from references that are at different resolutions, and consequently a normative mechanism to predict a block in that frame from a different resolution reference buffer needs to be defined. In principle, as long as we have defined a normative upscaler and a normative downscaler, such prediction across scales would be possible to support. However it would be more compute efficient to combine such rescaling with subpel interpolation for motion compensation, and that is what AV1 does. Source: IEEE, “In-loop Frame Super-resolution in AV1,” at 2 (available at https://ieeexplore.ieee.org/document/8954553).

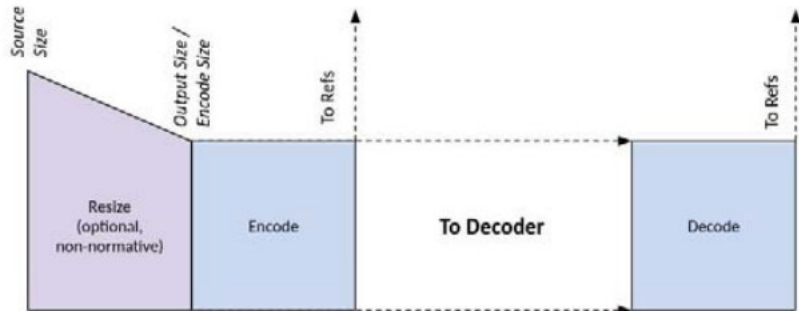


Fig. 1. Scaled prediction framework

Source: IEEE, “In-loop Frame Super-resolution in AV1,” at 2 (available at <https://ieeexplore.ieee.org/document/8954553>).

3.7.4 Frame super-resolution

To improve the perceptual quality of decoded pictures, a super-resolution process can be applied at low bitrates. The super-resolution process can be performed on a per-frame basis. First, at the encoder side, the source video is downsampled as a nonnormative procedure. Second, the downsampled video is encoded, followed by deblocking and CDEF filtering processes. Third, a linear upscaling process is applied as a normative procedure to convert the encoded video back to its original resolution. Finally, an LR filter is applied to further recover some lost details of the upsampled picture. The last two steps make up the super-resolving process; the deblocking and

Source: https://aomedia.org/docs/AV1_ToolDescription_v11-clean.pdf, 36

Libaom Source Code Citations:

<https://aomedia.googlesource.com/aom/+/refs/tags/v3.9.0/av1/common/resize.c>

Function	Line	Description
interpolate_core	237-317	Calculates resized pixel values by mapping input pixels to output pixels, allowing both upscaling and downscaling based on input (in_length) and output (out_length) dimensions

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	interpolate	319-327	Applies interpolation filters to generate intermediate pixel values for resizing, including upscaling
	resize_multistep	474-508	Executes multistep resizing for smoother interpolation during frame upscaling or downscaling
	av1_resize_plane	527-561	Resizes a video plane (frame) to a specified resolution, including super resolution
	av1_superres_upscale	1361-1448	Performs super resolution upscaling by interpolating pixels to enlarge a frame
	https://aomedia.googlesource.com/aom/+/refs/tags/v3.9.0/av1/encoder/encoder.c		
	Function	Line	Description
	set_tile_info	291-352	Sets up tile sizes for encoding and adjusts to match changes in frame size caused by super resolution
	av1_update_frame_size	353-370	Updates the frame size and related parameters during encoding, aligning with super resolution scaling
	https://aomedia.googlesource.com/aom/+/refs/tags/v3.9.0/av1/encoder/superres_scale.c		
	Function	Line	Description
	calculate_next_superres_scale	184-270	Determines the scaling factor for super resolution based on encoder configuration
	setup_frame_size_from_params	376-388	Configures frame size for encoding, including super resolution scaling factors
	av1_superres_post_encode	400-423	Manages post-encoding adjustments related to super-resolution, including both upscaling and downscaling
	Further, to the extent this element is performed at least in part by proprietary software source code, ACT reserves the right to supplement these contentions pursuant to production of such source code and to the extent Defendants require additional information in accordance with P.R. 3-1 and for any other reasons.		
[1C] a second super-resolution enlarger	The Google Accused Products comprise: a second super-resolution enlarger configured to acquire the set of decoded pictures from the first encoder to implement thereon a process for a second super-resolution		

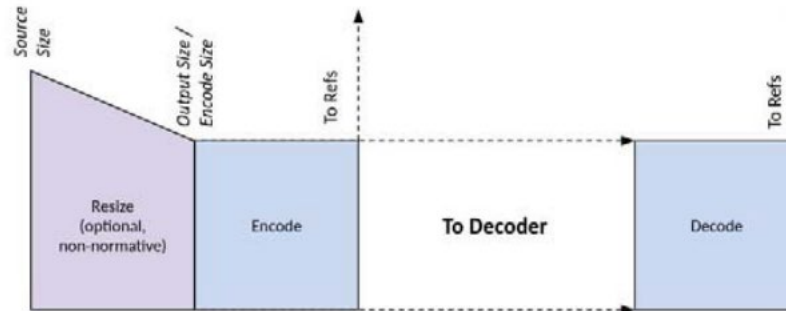
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configured to acquire the set of decoded pictures from the first encoder to implement thereon a process for a second super-resolution enlargement to create a set of super-resolution enlarged decoded pictures with a resolution higher than the standard resolution;	enlargement to create a set of super-resolution enlarged decoded pictures with a resolution higher than the standard resolution. For example, while in-loop processing for super-resolution functionality is enabled, the libaom-av1 encoder uses the downscaled/upscaled reference images (i.e., reconstructed reference images) and input images. After subsequent processing steps (e.g., deblocking, CDEF) these images are upscaled and loop restored for super resolution. Thus, the upscaled and encoded reference pictures generated based on the downscaled/upscaled input images for encoding of the next set of input images have a resolution higher than the input images. The component implementing the above processing step acts as the second resolution enlarger. super-resolution mode in the bit-stream syntax. Specifically, if the super-resolution mode is enabled for a frame, the frame is non-normatively downsampled to a lower resolution and coded at lower resolution using higher resolution references in the motion compensation loop, followed by normative upsampling and super-resolving to generate a full resolution output frame that is displayed and that updates a reference frame store slot for use in subsequent frames. Note also that high-performant CNN based and/or Source: IEEE, “In-loop Frame Super-resolution in AV1,” at 4 (available at https://ieeexplore.ieee.org/document/8954553). 3.7.4 Frame super-resolution To improve the perceptual quality of decoded pictures, a super-resolution process can be applied at low bitrates. The super-resolution process can be performed on a per-frame basis. First, at the encoder side, the source video is downscaled as a nonnormative procedure. Second, the downscaled video is encoded, followed by deblocking and CDEF filtering processes. Third, a linear upscaling process is applied as a normative procedure to convert the encoded video back to its original resolution. Finally, an LR filter is applied to further recover some lost details of the upscaled picture. The last two steps make up the super-resolving process; the deblocking and Source: https://aomedia.org/docs/AV1_ToolDescription_v11-clean.pdf, at 36

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google’s Accused Products
	<i>A. Scaled Prediction</i> In order to enable the codec to switch frame resolutions mid-stream, both AV1 and its predecessor VP9 support the ability to predict across scales in the inter prediction loop. As shown schematically in Fig. 1, this allows any frame or frames to be non-normatively downsampled or upsampled (Fig. 1 shows downscaling only) on-the-fly before encoding at a different resolution. The reconstructed frame after encoding at the reduced or increased resolution then replaces one of the reference buffer slots at that resolution. Therefore, at any point during the encoding and decoding process, any inter frame could be predicted from references that are at different resolutions, and consequently a normative mechanism to predict a block in that frame from a different resolution reference buffer needs to be defined. In principle, as long as we have defined a normative upscaler and a normative downscaler, such prediction across scales would be possible to support. However it would be more compute efficient to combine such rescaling with subpel interpolation for motion compensation, and that is what AV1 does. Source: IEEE, “In-loop Frame Super-resolution in AV1,” at 2 (available at https://ieeexplore.ieee.org/document/8954553).

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders



Source: IEEE, “In-loop Frame Super-resolution in AV1,” at 2 (available at <https://ieeexplore.ieee.org/document/8954553>)

Libaom Source Code Citations:

<https://aomedia.googlesource.com/aom/+/refs/tags/v3.9.0/av1/common/resize.c>

Function	Line	Description
interpolate_core	237-317	Calculates resized pixel values by mapping input pixels to output pixels, allowing both upscaling and downscaling based on input (in_length) and output (out_length) dimensions
interpolate	319-327	Applies interpolation filters to generate intermediate pixel values for resizing, including up scaling
resize_multistep	474-508	Executes multistep resizing for smoother interpolation during frame upscaling or downscaling
av1_resize_plane	527-561	Resizes a video plane (frame) to a specified resolution, including super resolution
av1_superres_upscale	1361-1448	Performs super resolution upscaling by interpolating pixels to enlarge a frame

https://aomedia.googlesource.com/aom/+/refs/tags/v3.9.0/av1/encoder/superres_scale.c

Function	Line	Description
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Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google’s Accused Products		
	calculate_next_superres_scale()	184-270	Determines scaling factor for super-resolution, allowing for dynamic scaling adjustments based on encoder settings, frame quality, or user parameters.
	av1_superres_post_encode	400-423	Manages post-encoding adjustments related to super-resolution, including both upscaling and downscaling
	av1_superres_upscale	1361-1448	Performs super resolution upscaling by interpolating pixels to enlarge a frame
	Further, to the extent this element is performed at least in part by proprietary software source code, ACT reserves the right to supplement these contentions pursuant to production of such source code and to the extent Defendants require additional information in accordance with P.R. 3-1 and for any other reasons.		
[1D] a third resolution converter configured to acquire the set of decoded pictures from the first encoder to implement thereon a process for a third resolution conversion to create a set of resolution converted enlarged decoded pictures with a resolution higher than the standard resolution; and	The Google Accused Products comprise: a third resolution converter configured to acquire the set of decoded pictures from the first encoder to implement thereon a process for a third resolution conversion to create a set of resolution converted enlarged decoded pictures with a resolution higher than the standard resolution. For example, during the encoding of I-frames, while in loop proceeding for super-resolution functionality is enabled, the libaom-av1 encoder uses the upscaled reference images (i.e., reconstructed reference images) and downsampled input images, since these downsampled input images are at 2K*2K size and encoded using upscaled reconstructed reference images and output images are produced at 4K*2K size, the component implementing the above processing step acts as the 3rd resolution converter. These images are super-resolution converted enlarged pictures, which have a resolution higher than the input images.		

3.7.4 Frame super-resolution

To improve the perceptual quality of decoded pictures, a super-resolution process can be applied at low bitrates. The super-resolution process can be performed on a per-frame basis. First, at the encoder side, the source video is downscaled as a nonnormative procedure. Second, the downscaled video is encoded, followed by deblocking and CDEF filtering processes. Third, a linear upscaling process is applied as a normative procedure to convert the encoded video back to its original resolution. Finally, an LR filter is applied to further recover some lost details of the upscaled picture. The last two steps make up the super-resolving process; the deblocking and

Source: https://aomedia.org/docs/AV1_ToolDescription_v11-clean.pdf

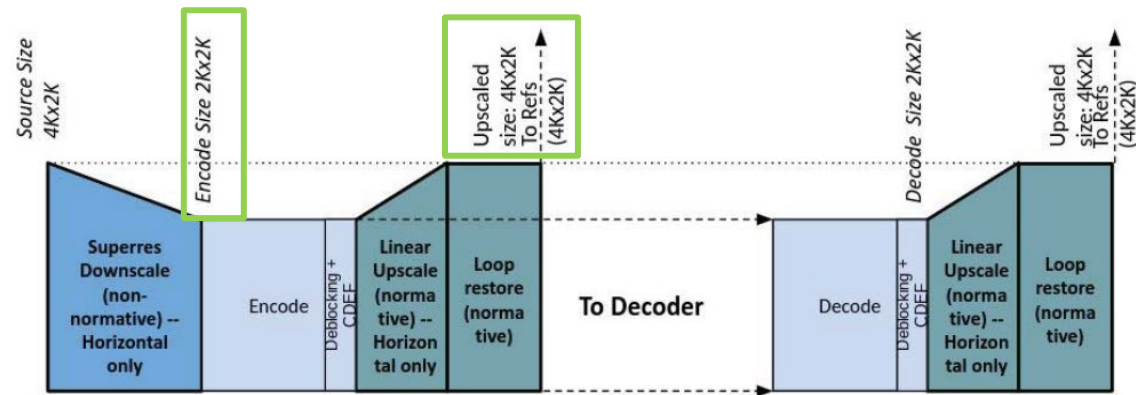


Fig. 4. Frame Super-resolution Framework

Source: IEEE, "In-loop Frame Super-resolution in AV1," at 4 (available at <https://ieeexplore.ieee.org/document/8954553>)

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google’s Accused Products
	super-resolution mode in the bit-stream syntax. Specifically, if the super-resolution mode is enabled for a frame, the frame is non-normatively downsampled to a lower resolution and coded at lower resolution using higher resolution references in the motion compensation loop, followed by normative upsampling and super-resolving to generate a full resolution output frame that is displayed and that updates a reference frame store slot for use in subsequent frames. Note also that high-performant CNN based and/or Source: IEEE, “In-loop Frame Super-resolution in AV1,” at 4 (available at https://ieeexplore.ieee.org/document/8954553) 3.7.4 Frame super-resolution To improve the perceptual quality of decoded pictures, a super-resolution process can be applied at low bitrates. The super-resolution process can be performed on a per-frame basis. First, at the encoder side, the source video is downsampled as a nonnormative procedure. Second, the downsampled video is encoded, followed by deblocking and CDEF filtering processes. Third, a linear upscaling process is applied as a normative procedure to convert the encoded video back to its original resolution. Finally, an LR filter is applied to further recover some lost details of the upsampled picture. The last two steps make up the super-resolving process; the deblocking and Source: https://aomedia.org/docs/AV1_ToolDescription_v11-clean.pdf, 36

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google’s Accused Products										
	<i>A. Scaled Prediction</i> In order to enable the codec to switch frame resolutions mid-stream, both AV1 and its predecessor VP9 support the ability to predict across scales in the inter prediction loop. As shown schematically in Fig. 1, this allows any frame or frames to be non-normatively downsampled or upsampled (Fig. 1 shows downscaling only) on-the-fly before encoding at a different resolution. The reconstructed frame after encoding at the reduced or increased resolution then replaces one of the reference buffer slots at that resolution. Therefore, at any point during the encoding and decoding process, any inter frame could be predicted from references that are at different resolutions, and consequently a normative mechanism to predict a block in that frame from a different resolution reference buffer needs to be defined. In principle, as long as we have defined a normative upscaler and a normative downscaler, such prediction across scales would be possible to support. However it would be more compute efficient to combine such rescaling with subpel interpolation for motion compensation, and that is what AV1 does. Source: IEEE, “In-loop Frame Super-resolution in AV1,” at 2 (available at https://ieeexplore.ieee.org/document/8954553) Libaom Source Code Citations: https://aomedia.googlesource.com/aom/+/refs/tags/v3.9.0/av1/common/resize.c <table> <tr> <th>Function</th><th>Line</th><th>Description</th></tr> <tr> <td>interpolate_core</td><td>237-317</td><td>Calculates resized pixel values by mapping input pixels to output pixels, allowing both upscaling and downscaling based on input (in_length) and output (out_length) dimensions</td></tr> <tr> <td>interpolate</td><td>319-327</td><td>Applies interpolation filters to generate intermediate pixel values for resizing, including upscaling</td></tr> </table>		Function	Line	Description	interpolate_core	237-317	Calculates resized pixel values by mapping input pixels to output pixels, allowing both upscaling and downscaling based on input (in_length) and output (out_length) dimensions	interpolate	319-327	Applies interpolation filters to generate intermediate pixel values for resizing, including upscaling
Function	Line	Description									
interpolate_core	237-317	Calculates resized pixel values by mapping input pixels to output pixels, allowing both upscaling and downscaling based on input (in_length) and output (out_length) dimensions									
interpolate	319-327	Applies interpolation filters to generate intermediate pixel values for resizing, including upscaling									

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google’s Accused Products		
	resize_multistep	474-508	Executes multistep resizing for smoother interpolation during frame upscaling or downscaling
	av1_resize_plane	527-561	Resizes a video plane (frame) to a specified resolution, including super resolution
	Further, to the extent this element is performed at least in part by proprietary software source code, ACT reserves the right to supplement these contentions pursuant to production of such source code and to the extent Defendants require additional information in accordance with P.R. 3-1 and for any other reasons.		
[1E] a third encoder configured to have the set of super-resolution enlarged pictures from the first super-resolution enlarger as a set of encoding target pictures, employing the set of super-resolution enlarged decoded pictures from the second super-resolution enlarger and the set of resolution converted enlarged decoded pictures from the third resolution converter as sets of reference pictures, to implement thereon a third combination of processes for a prediction and an encoding to create a third sequence of encoded bits.	The Google Accused Products comprise: a third encoder configured to have the set of super-resolution enlarged pictures from the first super-resolution enlarger as a set of encoding target pictures, employing the set of super-resolution enlarged decoded pictures from the second super-resolution enlarger and the set of resolution converted enlarged decoded pictures from the third resolution converter as sets of reference pictures, to implement thereon a third combination of processes for a prediction and an encoding to create a third sequence of encoded bits.		
	For example, when an I-frame is encoded, the encoder acts as a third encoder, using two reference picture sets (i.e., p-reference-frames and downsampled/upsampled reconstruction reference frames). The p-reference-frames (i.e., first reference picture set that is the output of the first encoder) denotes the list of reference pictures consisting of input pictures at the original resolution. On the other hand, reconstruction reference frames (i.e., second reference set that is the output of second resolution converter) denotes the reference picture list which contains the reconstructed pictures.		
	Libaom Source Code Citations:		
	https://aomedia.googlesource.com/aom/+refs/tags/v3.9.0/av1/encoder/encoder.c		
	Function	Line	Description
	av1_update_frame_size	353-370	Updates the frame size and related parameters
	encode_frame_to_data_rate	3574-3984	Compresses a frame into a bitstream while dynamically updating the reference frame buffer with

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google’s Accused Products		
implement thereon a third combination of processes for a prediction and an encoding to create a third sequence of encoded bits,			the encoded frame, enabling it to be reused for interprediction in subsequent frames
	av1_encode	3986-4048	Encodes video frame into the AV1 format by configuring frame setting, managing dependencies, and producing a condensed bitstream
	https://aomedia.googlesource.com/aom/+/refs/tags/v3.9.0/av1/encoder/bitstream.c		
	Function	Line	Description
	write_ref_frames	497-599	Encodes reference frame information, including whether a frame is a single or compound reference; Encoder can switch between different sets of reference frames for prediction; Prior encoded frames from reference buffer are used as references for prediction
	https://aomedia.googlesource.com/aom/+/refs/tags/v3.9.0/av1/common/resize.c		
	Function	Lines	Description
	av1_resize_plane	527-561	Resizes a video plane (frame) to a specified resolution, including super resolution
	https://aomedia.googlesource.com/aom/+/refs/tags/v3.9.0/av1/common/reconinter.c		
	Function	Lines	Description
	av1_make_inter_predictor	644-659	Selects reference frames from reference frame buffer for interprediction; Constructs inter-predicted blocks by applying motion vectors to reference frames; Handles scaling and resolution transforms for decoded frames using interpolation and warping
	https://aomedia.googlesource.com/aom/+/refs/tags/v3.9.0/av1/encoder/superres_scale.c		
	Function	Lines	Description

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google’s Accused Products		
	av1_superres_post_encode	400-423	Handles post-encode super-resolution process, adjusting frames to super-resolution dimensions. Manages both standard-res and super-res frames.
	Further, to the extent this element is performed at least in part by proprietary software source code, ACT reserves the right to supplement these contentions pursuant to production of such source code and to the extent Defendants require additional information in accordance with P.R. 3-1 and for any other reasons.		
[1F] wherein a spatial resolution of the set of super-resolution enlarged pictures, that of the set of super-resolution enlarged decoded pictures, and that of the set of resolution converted enlarged decoded pictures are made equal; and	The Google Accused Products comprise: wherein a spatial resolution of the set of super-resolution enlarged pictures, that of the set of super-resolution enlarged decoded pictures, and that of the set of resolution converted enlarged decoded pictures are made equal For example, as discussed above, the AV1 encoding process uses downscaled input images which are upscaled using upscaled reconstructed reference images (i.e., reference pictures) and a linear upscale process after deblocking and CDEF steps. Thus, the encoder converts the resolution of applied downscaled input images at various stages to generate the respective upscaled output images (i.e., super-resolution enlarged pictures, super-resolution enlarged decoded pictures, resolution converted enlarged decoded pictures). Since the upscaling is done on the output of all three stages, the resolution of the output images generated via all of the three processes is equal.		

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

3.7.4 Frame super-resolution

To improve the perceptual quality of decoded pictures, a super-resolution process can be applied at low bitrates. The super-resolution process can be performed on a per-frame basis. First, at the encoder side, the source video is downsampled as a nonnormative procedure. Second, the downsampled video is encoded, followed by deblocking and CDEF filtering processes. Third, a linear upscaling process is applied as a normative procedure to convert the encoded video back to its original resolution. Finally, an LR filter is applied to further recover some lost details of the upsampled picture. The last two steps make up the super-resolving process; the deblocking and CDEF filters are applied at lower spatial resolution on the decoder side, after which the frames are passed through the super-resolution process. To reduce complexity regarding the use of line buffers in hardware implementation, the upscaling and downscaling processes are applied to the horizontal dimension only.

Source: https://aomedia.org/docs/AV1_ToolDescription_v11-clean.pdf, 36

Libaom Source Code Citations:

<https://aomedia.googlesource.com/aom/+/refs/tags/v3.9.0/av1/encoder/encoder.c>

Function	Line	Description
av1_update_frame_size	353-370	Updates the frame size and related parameters, verifies frame resolution for both target and reference frames

<https://aomedia.googlesource.com/aom/+/refs/tags/v3.9.0/av1/common/resize.c>

Function	Line	Description
interpolate	319-327	Applies interpolation filters to generate intermediate pixel values for resizing, including upscaling, to ensure resolution consistency
resize_multistep	474-508	Executes multistep resizing for smoother interpolation during frame upscaling or downscaling
av1_resize_plane	527-561	Resizes a video plane (frame) to a specified resolution, ensuring frames maintain consistent spatial resolution

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google’s Accused Products								
	https://aomedia.googlesource.com/aom/+refs/tags/v3.9.0/av1/common/reconinter.c								
	Function	Line	Description						
	av1_make_inter_predictor	75-121	Handles scaling and resolution transforms for decoded frames using interpolation and warping						
	Further, to the extent this element is performed at least in part by proprietary software source code, ACT reserves the right to supplement these contentions pursuant to production of such source code and to the extent Defendants require additional information in accordance with P.R. 3-1 and for any other reasons.								
[1G] wherein the third encoder controls a selection of a set of reference pictures and creates a set of data on the selection of the set of reference pictures to identify a selected set of reference pictures during the process for prediction of the third combination.	The Google Accused Products comprise: wherein the third encoder controls a selection of a set of reference pictures and creates a set of data on the selection of the set of reference pictures to identify a selected set of reference pictures during the process for prediction of the third combination. For example, as discussed above, the AV1 encoding process uses two sets of reference frames. Since different processes (e.g., motion estimation and mode decision) in encoding use reference pictures from “pa_ref” (i.e., set of first reference pictures) and “recon_ref” (i.e., set of second reference pictures) respectively, it appears that the encoder selects one reference frame from each of the first and second reference picture set, which further constitutes the set of selected reference frames. Further, the reference frame from each first and second set is selected based on the denominator value, which matches the width and current resolution of the input picture. Libaom Source Code Citations https://aomedia.googlesource.com/aom/+refs/tags/v3.9.0/av1/encoder/bitstream.c <table><tr><td>Function</td><td>Line</td><td>Description</td></tr><tr><td>write_ref_frames</td><td>497-599</td><td>Encodes reference frame information into the bitstream, including whether a frame is a single or compound reference, determining a selection of reference frames to use for inter-prediction</td></tr></table> https://aomedia.googlesource.com/aom/+refs/tags/v3.9.0/av1/common/reconinter.c			Function	Line	Description	write_ref_frames	497-599	Encodes reference frame information into the bitstream, including whether a frame is a single or compound reference, determining a selection of reference frames to use for inter-prediction
Function	Line	Description							
write_ref_frames	497-599	Encodes reference frame information into the bitstream, including whether a frame is a single or compound reference, determining a selection of reference frames to use for inter-prediction							

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google’s Accused Products		
	av1_make_inter_predictor	644-659	Constructs inter-predicted blocks by applying motion vectors to reference frames; Handles scaling and resolution transforms for decoded frames using interpolation and warping; Encoder uses selected reference frames for prediction
	av1_setup_pre_planes	725-741	Prepares the selected reference frames so they can be accessed and used during inter-prediction
	av1_build_obmc_inter_prediction	925-943	Calculates the OBMC prediction for a block by blending predictions from its neighboring blocks (left and above); Shows how selected frames are applied during prediction process
	Further, to the extent this element is performed at least in part by proprietary software source code, ACT reserves the right to supplement these contentions pursuant to production of such source code and to the extent Defendants require additional information in accordance with P.R. 3-1 and for any other reasons.		
[2P] A moving picture encoding system that makes an encoding of a sequence of moving pictures with a resolution higher than a standard resolution using moving pictures contents which include a sequence of moving pictures with the standard resolution and do	The Google Accused Products are each: moving picture encoding system that makes an encoding of a sequence of moving pictures with a resolution higher than a standard resolution using moving pictures contents which include a sequence of moving pictures with the standard resolution and do not include a sequence of moving pictures with a resolution higher than the standard resolution, the moving picture encoding system. Google directly infringes by using, importing, testing, selling, and/or offering for sale devices having an AV1 encoder. <i>See Claim [1P].</i>		

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google’s Accused Products
not include a sequence of moving pictures with a resolution higher than the standard resolution, the moving picture encoding system comprising:	
[2A] a first encoder configured to work on a sequence of moving pictures with a standard resolution to implement a first combination of processes for an encoding and a decoding to create a first sequence of encoded bits and a set of decoded pictures with the standard resolution;	The Google Accused Products comprise: a first encoder configured to work on a sequence of moving pictures with a standard resolution to implement a first combination of processes for an encoding and a decoding to create a first sequence of encoded bits and a set of decoded pictures with the standard resolution. <i>See Claim [1A].</i>
[2B] a first super-resolution enlarger configured to work on the sequence of moving pictures with the standard resolution to	The Google Accused Products comprise: a first super-resolution enlarger configured to work on the sequence of moving pictures with the standard resolution to implement a process for a first super-resolution enlargement to create a set of super-resolution enlarged pictures with a resolution higher than the standard resolution. <i>See Claim [1B].</i>

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google’s Accused Products
implement a process for a first super-resolution enlargement to create a set of super-resolution enlarged pictures with a resolution higher than the standard resolution;	
[2C] a third resolution converter configured to acquire the set of decoded pictures from the first encoder to implement thereon a process for a third resolution conversion to create a set of resolution converted enlarged decoded pictures with a resolution higher than the standard resolution; and	The Google Accused Products comprise: a third resolution converter configured to acquire the set of decoded pictures from the first encoder to implement thereon a process for a third resolution conversion to create a set of resolution converted enlarged decoded pictures with a resolution higher than the standard resolution. <i>See Claim [1D].</i>
[2D] a third encoder configured to have the set of super-resolution enlarged	The Google Accused Products comprise: a third encoder configured to have the set of super-resolution enlarged pictures from the first super-resolution enlarger as a set of encoding target pictures, employing the set of resolution converted enlarged decoded pictures from the third resolution converter as a set of reference

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google’s Accused Products
pictures from the first super-resolution enlarger as a set of encoding target pictures, employing the set of resolution converted enlarged decoded pictures from the third resolution converter as a set of reference pictures, to implement thereon a third combination of processes for a prediction and an encoding to create a third sequence of encoded bits,	pictures, to implement thereon a third combination of processes for a prediction and an encoding to create a third sequence of encoded bits. <i>See Claim [1E].</i>
[2E] wherein a spatial resolution of the set of super-resolution enlarged pictures, and that of the set of resolution converted enlarged decoded pictures are made equal; and	The Google Accused Products include wherein a spatial resolution of the set of super-resolution enlarged pictures, and that of the set of resolution converted enlarged decoded pictures are made equal. <i>See Claim [1F].</i>
[2F] wherein the third encoder controls a selection of a set of reference	The Google Accused Products include wherein the third encoder controls a selection of a set of reference pictures and creates a set of data on the selection of the set of reference pictures to identify a selected set of reference pictures during the process for prediction of the third combination.

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google’s Accused Products
pictures and creates a set of data on the selection of the set of reference pictures to identify a selected set of reference pictures during the process for prediction of the third combination.	<i>See Claim [1G].</i>
[3P] A moving picture encoding system that makes an encoding of a sequence of moving pictures with a resolution higher than a standard resolution using moving pictures contents which include a sequence of moving pictures with the standard resolution and do not include a sequence of moving pictures with a resolution higher than the standard resolution, the moving picture	The Google Accused Products are each: A moving picture encoding system that makes an encoding of a sequence of moving pictures with a resolution higher than a standard resolution using moving pictures contents which include a sequence of moving pictures with the standard resolution and do not include a sequence of moving pictures with a resolution higher than the standard resolution, the moving picture encoding system. Google directly infringes by using, importing, testing, selling, and/or offering for sale devices having an AV1 encoder. <i>See Claim [1P].</i>

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google’s Accused Products
encoding system comprising:	
[3A] a first encoder configured to work on a sequence of moving pictures with a standard resolution to implement a first combination of processes for an encoding and a decoding to create a first sequence of encoded bits and a set of decoded pictures with the standard resolution;	The Google Accused Products comprise: a first encoder configured to work on a sequence of moving pictures with a standard resolution to implement a first combination of processes for an encoding and a decoding to create a first sequence of encoded bits and a set of decoded pictures with the standard resolution. <i>See Claim [1A].</i>
[3B] a first super-resolution enlarger configured to work on the sequence of moving pictures with the standard resolution to implement a process for a first super-resolution enlargement to create a set of super-resolution enlarged pictures with a	The Google Accused Products comprise: a first super-resolution enlarger configured to work on the sequence of moving pictures with the standard resolution to implement a process for a first super-resolution enlargement to create a set of super-resolution enlarged pictures with a resolution higher than the standard resolution <i>See Claim [1B].</i>

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google’s Accused Products
resolution higher than the standard resolution;	
[3C] a second super-resolution enlarger configured to acquire the set of decoded pictures from the first encoder to implement thereon a process for a second super-resolution enlargement to create a set of super-resolution enlarged decoded pictures with a resolution higher than the standard resolution; and	The Google Accused Products comprise: a second super-resolution enlarger configured to acquire the set of decoded pictures from the first encoder to implement thereon a process for a second super-resolution enlargement to create a set of super-resolution enlarged decoded pictures with a resolution higher than the standard resolution. <i>See Claim [1C].</i>
[3D] a third encoder configured to have the set of super-resolution enlarged pictures from the first super-resolution enlarger as a set of encoding target pictures, employing the set of super-resolution enlarged	The Google Accused Products comprise: a third encoder configured to have the set of super-resolution enlarged pictures from the first super-resolution enlarger as a set of encoding target pictures, employing the set of super-resolution enlarged decoded pictures from the second super-resolution enlarger as a set of reference pictures, to implement thereon a third combination of processes for a prediction and an encoding to create a third sequence of encoded bits, <i>See Claim [1E].</i>

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google’s Accused Products
decoded pictures from the second super-resolution enlarger as a set of reference pictures, to implement thereon a third combination of processes for a prediction and an encoding to create a third sequence of encoded bits,	
[3E] wherein a spatial resolution of the set of super-resolution enlarged pictures, and that of the set of super-resolution enlarged decoded pictures are made equal; and	The Google Accused Products include wherein a spatial resolution of the set of super-resolution enlarged pictures, and that of the set of super-resolution enlarged decoded pictures are made equal <i>See Claim [1F].</i>
[3F] wherein the third encoder controls a selection of a set of reference pictures and creates a set of data on the selection of the set of reference pictures to identify a selected set of reference pictures during the	The Google Accused Products include wherein the third encoder controls a selection of a set of reference pictures and creates a set of data on the selection of the set of reference pictures to identify a selected set of reference pictures during the process for prediction of the third combination. <i>See Claim [1G].</i>

Appendix D - Claim Chart for U.S. Patent No. 9,042,448 Against Google Products having AV1 Encoders and Google Encoders

Claim – 9,042,448	Exemplary Supporting Evidence Regarding Google’s Accused Products
process for prediction of the third combination.	